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PROBLEM-SOLVING AS THE CATALYST FOR SCIENTIFIC PROGRESS

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Abstract
Almost every scholar today agrees that modern science makes progress. This is obvious in the remarkable technological and theoretical achievements recorded by modern science throughout its history. However, difficulty arises when it comes to explaining in both ontological and epistemological terms what constitutes scientific progress and how it should be evaluated. Regarding this, philosophers of science are broadly divided into two categories, namely; the rationalists who argue that truth is the ultimate aim of science and that scientific progress is measured in terms of increasing verisimilitude, and the pragmatists, who argue that progress should be evaluated according to the problem-solving effectiveness of scientific theories. Using the method of conceptual analysis and library research, this paper examines this debate through the philosophical frameworks of Karl Popper and Larry Laudan. While Popper conceives science as an unending quest for truth and identifies verisimilitude as the criterion of scientific progress, Laudan argues that truth is not a measurable standard and therefore proposes problem-solving as a more practical criterion for evaluating scientific progress. This paper argues that despite their laudable insights, both philosophers offer only partial accounts of scientific progress. Popper emphasizes the teleological aim of science while giving insufficient attention to the practical criterion by which scientific progresss is assessed, while Laudan develops a compelling criterion of evaluation without adequately accounting for the ultimate end of the scientific enterprise. In this regard, the paper contends that the apparent disagreement between Popper and Laudan is mainly one of emphasis rather than outright opposition. Popper addressed the teleological question of why science is pursued, identifying truth as the ultimate end, whereas Laudan addresses the epistemological question of how scientific progress is recognized and evaluated, identifying problem-solving effectiveness as the most reliable criterion. Properly understood, these two perspectives are two sides of the same coin and are therefore complementary rather than incompatible.

Keywords: Scientific Progress, Karl Popper, Larry Laudan, Verisimilitude, Problem-Solving, Truth

Introduction

Two central questions that have occupied philosophy of science in recent decades are the questions concerning the goal of science and nature of scientific progress. However, these two questions are intrinsically connected because any meaningful account of scientific progress presupposes some conception of the end towards which science is directed. Without such an end, it becomes difficult to determine whether science is genuinely progressing or merely changing. Thus, while there is widespread scholarly consensus that science advances, philosophers remain deeply divided over the criterion by which such advancement should be understood and evaluated. At the heart of this disagreement lies a fundamental question: what exactly constitutes scientific progress? Is science progressive because successive theories move closer to the truth, that is, is truth the goal of science, or because they provide increasingly effective solutions to the problems that confront scientific inquiry, that is, is problem-solving the goal of science? Underlying these competing questions are different conceptions of what science is ultimately meant to achieve: truth or solving problem. Disagreements over these answers have generated one of the most enduring debates in contemporary philosophy of science.

Generally speaking, positions in the debate over the goal of science and the nature of scientific progress have tended to reflect two broad philosophical orientations. On one side are truth-oriented or rationalist accounts, which regard the pursuit of truth as the defining aim of science. On the other are problem-solving or pragmatic accounts, which evaluate science primarily in terms of its capacity to resolve scientific problems. The rationalist tradition argues that the primary aim of science is the discovery of objective truth through critical inquiry and rational evaluation. Within this tradition, Karl Raimund Popper argues that scientific knowledge grows through the formulation of bold conjectures and their rigorous testing. Although scientific theories can never be conclusively verified, they can be critically scrutinized and replaced by theories possessing greater explanatory power and a higher degree of truth-likeness (verisimilitude). Underpinning this stance, Popper famously underscores that “the game of science is, in principle, without end. He who decided one day that scientific statements do not call for any further test, and that they can be regarded as finally verified, retires from the game”.[1] For Popper therefore, scientific progress consists not in accumulation of certain of knowledge but in an unending process of eliminating error and approximating the truth.

Against the rationalist, the problem-solving approach questions the assumption that truth is what drives scientific progress. Representing this approach, Larry Laudan argues that philosophers have placed excessive emphasis on the elusive notion of truth while neglecting the practical achievement of science. According to him, the success of a scientific theory should be judged primarily by its ability to resolve empirical anomalies and conceptual difficulties rather than by unverified claims about its proximity to truth. In other words, Laudan argues that, "science progresses when successive theories solve more problems than their predecessors."[2]

The disagreement between Popper and Laudan represents a broader philosophical controversy on the criterion of scientific progress. While truth-oriented accounts emphasize correspondence with reality as the ultimate catalyst of scientific inquiry, problem-solving accounts evaluate scientific theories according to their capacity to overcome empirical and conceptual challenges. As Allan Chalmers observes there is no universally accepted account of scientific progress, largely because philosophers differ over the standard by which scientific theories ought to be assessed.[3] The persistence of this disagreement shows that the concept of scientific progress remains as much a philosophical problem as it is reality.

To examine this problem, this paper interrogates the competing conceptions of scientific progress advanced by Popper and Laudan. Fundamentally, it seeks to answer the following questions: what constitutes scientific progress? How does Popper's truth-oriented conception explain the growth of scientific knowledge? In what ways does Laudan's problem-solving model depart from Popper's account? Which of these approaches provide a more convincing criterion for evaluating scientific progress? In the final analysis, the paper argues that although Popper is right in identifying truth as the catalyst of scientific inquiry, Laudan's problem-solving approach offers the more convincing criterion for assessing scientific progress. It further contends that the apparent opposition between their positions is less profound than it appears, since Popper is primarily concerned with the end towards which scientific inquiry is directed, while Laudan is concerned with the standard by which scientific progress is assessed.

Popper's Truth-Oriented Account of Scientific Progress

Central to Popper's philosophy of science is the conviction that the ultimate goal of science is the pursuit of objective truth. Rejecting both the inductivist belief that scientific knowledge arises from the accumulation of observations and the positivist claim that theories can be conclusively verified, Popper maintains that science advances through critical inquiry directed towards discovering increasingly adequate explanations of reality. What this means in Popperian terms is that although absolute certainty is unattainable the impossibility does not imply that the search for truth should be abandoned. On the contrary, truth constitutes the regulative ideal of scientific investigation, guiding scientists in the continual improvement of their theories. Popper was insistent that "the idea of truth is absolutely indispensable for the idea of error. We cannot consistently speak of error unless we have an objective criterion of correctness".[4]

At the foundation of Popper's critical rationalism is the concept of objective knowledge. Unlike subjective opinions, Popper defines objective knowledge as consisting of theories, arguments, and scientific propositions that exist independently of the individual scientist and are open to public criticism. As such, scientific knowledge is not validated by the psychological certainty of those who hold it but by its capacity to withstand rigorous critical examination. In Objective Knowledge, Popper argues that "objective knowledge consists of logical relations between theories, between theories and observations, and between theories and arguments."[5] Consequently, scientific inquiry is essentially a public enterprise in which theories are continually subjected to criticism and testing

Obvious from the following is that Popper's commitment to objective knowledge naturally leads to his conception of truth as the ultimate goal of science. He rejects the view that scientific theories are merely useful instruments for organizing experience or making predictions. For him, scientific theories are genuine attempts to describe the world as it exits. Since no empirical theory can be conclusively verified, scientists can never claim to possess final truth. Instead, they formulate bold explanatory hypotheses that are constantly exposed to severe tests. Those theories that survive repeated attempts at refutation are not regarded as certain or infallible but as the best available approximations to reality. Popper explains this by claiming that:

> Our science is not knowledge (episteme): it can never claim to have attained truth, or even a substitute for it, such as probability. Yet science has more than a mere biological survival value. It is not only a useful toll. Although it cannot attain either

> truth or probability, the striving for knowledge and the search for truth are still the strongest motives of scientific discovery. We do not know: we can only guess.[6]

To account for scientific progress despite the fallibility of all theories, Popper introduces the concept of verisimilitude or truth-likeness. Since scientific theories cannot be demonstrated to be absolutely true, progress should be understood as the replacement of less adequate theories by those possessing greater explanatory content and closer correspondence with reality. A new theory represents scientific progress if it explains more phenomena, survives more demanding empirical tests, and avoids the errors of its predecessor. Thus, scientific development does not consist in accumulating unquestionable facts but in moving ever closer to the truth through the continuous correction of error. As Chalmers observes, Popper's notion of verisimilitude was intended to explain how science can genuinely progress even through every scientific theory remains provisional and liable to future refutation.[7] Accordingly, for Popper, the pursuit of truth and growth of objective knowledge are inseparable. Scientific inquiry is a rational enterprise directed towards discovering better explanations of the world, while criticism serves as the principal mechanism through which inadequate theories are discarded and superior ones retained. It is this commitment to truth despite the recognition of human fallibility that distinguishes Popper's conception of scientific progress from subsequent accounts that evaluate scientific theories primarily in terms of their practical success in solving problems.

Laudan's Problem-Solving Account of Scientific Progress: From Truth to Problem-Solving: Laudan's Critique of Truth-Centred Accounts

Laudan's philosophy of science represents one of the most influential challenges to traditional truth-centred account of scientific progress. While acknowledging that scientists often speak of discovering the truth about nature, Laudan argues that truth itself cannot serve as the criterion by which scientific progress is evaluated. The fundamental difficulty, he contended is that there exists no reliable method for determining whether one scientific theory is objectively closer to the truth than another. Therefore, any account of scientific progress founded upon notions such as truth or verisimilitude rests upon standards that cannot be independently established or empirically evaluated.

Laudan's attack is levied particularly at philosophers like Popper who regard scientific progress as an increasing approximation to the truth. He contends that such accounts provide little practical guidance for evaluating competing scientific theories because claims about truth-likeness are neither measurable nor historically demonstrable. He was insistent that, "if we cannot determine whether a theory is true or false, neither can we determine whether it is closer to the truth than another theory."[7] For Laudan, the inability to operationalize truth renders it unsuitable as the standard by which scientific progress should be judged. Instead of asking whether a scientific theory corresponds more closely to reality, Laudan proposes that philosophers should ask a different questions: Does the theory solve the problems it was designed to solve? This shift from truth to problem-solving marks a significant reorientation in the philosophy of science. Scientific theories are not valuable primarily because they claim to describe reality but because they successfully explain phenomena, resolve anomalies, and remove conceptual difficulties that hinder scientific understanding.

Scientific problem: Empirical and Conceptual

The foundation of Laudan's philosophy is his distinction between empirical and conceptual problems. Scientific progress, he claims, is measured by the extent to which theories successfully address both categories of problems. Empirical problems arise from observable features of the natural world requiring scientific explanation. These include unexplained phenomena, anomalous observations, and experimental results that existing theories fail to account for satisfactorily. In this context, a scientific theory is successful to the extent that it resolves these empirical difficulties more effectively than competing theories. Thus, the explanatory success of Newtonian mechanics over Aristotelian physics, or Einstein's theory of relativity over Newtonian mechanics in certain domains, illustrates scientific progress because the newer theories explain a broader range of empirical phenomena.

Conceptual problem, by contrast, concerns the internal coherence of scientific theories or their compatibility with other well-established theories and accepted philosophical principles. A theory may successfully explain empirical observations while still generating conceptual difficulties through internal inconsistency, ambiguity, or conflict with other branches of scientific knowledge. According to Laudan, genuine scientific progress requires that not only the resolution of empirical anomalies but also the reduction of conceptual tensions within the broader scientific framework.[8] This distinction enables Laudan to offer a richer account of scientific development than approaches that focus exclusively upon empirical confirmation or falsification. Theories are evaluated according

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to their overall problem-solving effectiveness, considering both their explanatory achievements and their conceptual coherence.

Problem-Solving as the Criterion of Scientific Progress

Building upon the above distinction between empirical and conceptual problems, Laudan argues that scientific progress should be understood as the increasing effectiveness with which scientific theories solve problems. Rather than measuring progress by unverifiable claims about truth, philosophers should compare competing theories according to the number and significance of the empirical and conceptual problems they successfully resolve. As Laudan famously aerticulates, "science progresses just in case successive theories solve more problems than their predecssors."[9]

Laudan's account possesses an important comparative dimension. Scientific theories are not assessed in isolation but against rival theories addressing the same problems. A new theory represents progress only if it explains more phenomena, resolves anomalies left unexplained by ites predecessor, and introduces fewer conceptual difficulties than the theory it replaces. Scientific change is therefore rational because scientists have good reasons for preferring theories with greater problem-solving effectiveness.

Laudan's account also accommodates the historical development of science. Throughout the history of scientific inquiry, theories have frequently been abandoned before their falsity was conclusively established. They were replaced because competing theories demonstrated greater explanatory success and reolved difficulties that earlier theories could not overcome. Scientific progress, therefore, is best understood as a process of increasing problem-solving capacity rather than an unverifiable movement toward truth.

Truth versus Problem-Solving: A Critical Evaluation

Broadly, a careful reading of the perspectives presented above shows that the distinction between the rationalists and the pragmatists and narrowly between Popper and Laudan is not merely a dispute over scientific method but a more fundamental disagreement about the criterion by which scientific progress ought to be evaluated. Whereas Popper locates scientific progress in the growth of objective knowledge through verisimilitude, Laudan argues that success of science is better measured by the ability of theories to solve scientific problems. The issue, therefore, is whether truth or problem-solving provides a more convincing account of scientific progress.

Can Truth Serve as a Practical Criterion of Scientific Progress?

To address the question posed in this subheading, it needs to be recalled that for Popper, truth is the ultimate objective of scientific inquiry. Although scientific theories remain conjectural and fallible, they are genuine attempts to describe reality. Through rigorous criticism and falsification, less satisfactory theories are replaced by those with greater explanatory power and higher degree of verisimilitude. Scientific progress therefore consists in moving progressively closer to the truth, even if absolute certainty remains unattainable. Laudan challenges this position by questioning the practical value of truth as a criterion of scientific progress. According to him, philosophers possess no independent means of determining whether one theory is closer to the truth than another. Consequently, appeals to verisimilitude do not provide any objective standard for comparing competing scientific theories. What scientists can evaluate, however, is whether a theory explains more phenomena, resolves anomalies more successfully, and introduces fewer conceptual difficulties than its rivals.

Laudan's criticism exposes an important weakness in Popper's position. If verisimilitude cannot be measured independently, then claims that one theory is closer to truth and risks becoming philosophical assertions rather than demonstrable conclusions. Nevertheless, Popper's emphasis on truth should not be dismissed altogether since scientific inquiry is motivated by desire to understand reality rather than merely to produce useful predictions. Without truth as a regulative ideal, the distinction between science and mere instrumental success becomes increasingly difficult to sustain.

Is problem Solving Sufficient for Scientific Progress?

Laudan's emphasis on problem-solving undoubtedly provides a more concrete criterion for evaluating scientific theories. Historians of science generally compare competing theories by examining the range of empirical phenomena they explain and the occasional difficulties they overcome. This criterion reflects actual scientific practice, where theories are often preferred because they solve problems that previous theories could not address satisfactorily. Nevertheless, problem-solving alone appears insufficient to account for scientific progress. The history of science demonstrates that some theories achieved remarkable explanatory success despite later being rejected as fundamentally incorrect. The Ptolemaic system, for example, successfully predicted planetary motions for centuries through increasingly sophisticated epicycles. Likewise, Newtonian mechanics solved an extraordinary range of physical problems and remained the dominant scientific theory until the emergence of relativity and quantum mechanics. These examples show that a theory may be highly successful in solving problems while still failing to provide a completely accurate account of reality.[10]

Conversely, theories initially regarded as unsuccessful sometimes later proved indispensable once additional evidence become available. Alfred Wegner's theory of continental shift, for example, was widely rejected in the early twentieth century because it lacked a plausible physical mechanism. However, subsequent discoveries concerning seafloor spreading and plate tectonic transformed it into the cornerstone of modern geology.[11] This shows that immediate problem-solving effectiveness cannot always serve as the sole measure of scientific progress. Scientific theories should therefore be evaluated not only by the problems they solve but also by their capacity to deepen humanity's understanding of the natural world.

Which Criterion Better Explains the History of Science?

The history of science provides valuable insight into this Popper-Laudan debate. Newton's theory of gravitation replaced earlier mechanical explanations because it unified terrestrial and celestial phenomena under a single mechanical framework while explaining observations that previous theories could not adequately account for. Centuries later, Einstein's theory of relativity superseded Newtonian mechanics in domains involving high velocities and strong gravitational fields because it resolved empirical anomalies, such as the perihelion of Mercury that Newtonian physics could not satisfactorily explain. Similarly, Darwin's theory of evolution transformed biology by providing a coherent explanation for diversity of life, adaptation, and the fossil record, problems that earlier theories left unresolved. In each of these cases, scientific theories were accepted because they offered superior explanatory power and solved problems confronting existing scientific knowledge

Yet it would be misleading to conclude that truth played no role in these scientific revolutions. Einstein did not propose relativity merely because it solved more problems. He proposed it because he believed it offered a more accurate account of physical reality. Likewise, Darwin regarded natural selection not simply as a useful explanatory device but as a true account of biological evolution. These historical records therefore suggest that scientists seek theories that both solve significant problems and provide increasingly accurate descriptions of nature. Problem-solving explains why theories are preferred, whereas truth explains why such preference is considered intellectually worthwhile.

Conclusion

There is a general consensus among philosophers of science that science makes progress through the replacement of older theories by newer ones. However, disagreement arises when it comes to determining the criterion by which such progress should be assessed. Broadly speaking, participants in the debate may be divided into two orientations. On the one hand are the rationalists, who regard truth as both the aim of science and the criterion for measuring scientific progress. On the other hand are the pragmatists, who contend that scientific progress should be evaluated in terms of the problem-solving capacity of scientific theories.

This paper has examined the controversy through the contrasting perspectives of Karl Opper and Larry Laudan, two of the most influential representatives of these orientations in contemporary philosophy of science. While Popper conceives scientific progress as an unending quest for truth through the critical elimination of error, Laudan argues that progress is better understood in terms of the ability of scientific theories to solve empirical and conceptual problems

The discussion showed that Popper successfully preserves the realist aspiration of science by maintaining that truth remains its ultimate goal. However, his appeal to verisimilitude as the measure of scientific progress encounters the criticism that there is no independent means of determining whether, for example theory 2 is genuinely closer to truth than theory 1. Laudan's problem-solving model provides a more practical and historically grounded account by evaluating theories according to their ability to resolve scientific problems. This notwithstanding, Laudan's model standing alone cannot exhaust the meaning of scientific progress because scientific inquiry is not undertaken merely to generate useful solutions but also to attain an increasingly accurate understanding of reality. Therefore, to abandon truth altogether would reduce science to purely instrumental enterprise and obscure its realist aspirations

Based on the following, the paper contends that the apparent disagreement between Popper and Laudan is mainly one of emphasis than outright opposition. Popper addresses the teleological question of why science is pursued, identifying truth as its ultimate end, while Laudan tackles the epistemological question of how scientific progress is recognized and evaluated, identifying problem-solving effectiveness as the most reliable criterion. Properly

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understood, these two perspectives are two sides of the same coin and therefore complementary rather than incompatible.

In conclusion, scientific progress is best understood by distinguishing the aim of science from the criterion of its advancement. Truth as Popper maintains, remains the ultimate aim of scientific inquiry, while problem-solving as Laudan argues provides the most reliable criterion by which scientific progress is assessed. Popper explains why science is undertaken, and Laudan, how its progress is most adequately evaluated. Collectively, these perspectives are two sides of the same coin, offering a more comprehensive account of scientific progress by preserving both the realist aspiration to truth and the pragmatist standard through which scientific achievement is evaluated.

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