AMERICAN JOURNALS
Open Access, Peer Reviewed Journals

American Journal of Technology and Applied Sciences
ISSN (E): 2832-1766 Volume 37, June - 2025

AXIOM, HYPOTHESIS, AND THEORY AS FUNDAMENTAL CONCEPTS OF SCIENTIFIC METHODOLOGY

Malikov Shokhrukh Shokirovich
Student, Faculty of Digital Economy and Information Technologies
Specialty: Digital Economy "Tashkent State University of Economics" Uzbekistan, Tashkent
E-mail: malikovshokhrukh2002@gmail.com
ORCID: https://orcid.org/0009-0000-7813-068X

Askarova Dilorom Xojimuratovna
Tashkent State University of Economics, Tashkent, Uzbekistan
PhD, Associate Professor, " Economic analysis " Department
Email: d_askarova@umail.uz
ORCID: https://orcid.org/0009-0005-8401-1106

Gulmurodova Dinora Akram qizi
Tashkent State University of Economics, Tashkent, Uzbekistan
Assistant at the Department of Artificial Intelligence
Email: dinoragulmurodova1@gmail.com
ORCID: https://orcid.org/0009-0009-4155-3190

Omonov Sanjar Ganisher o‘g‘li
Tashkent State University of Economics, Tashkent, Uzbekistan
Assistant at the Department of Artificial Intelligence

Hakimov O‘ktam Axtam o‘g‘li
Tashkent State University of Economics, Tashkent, Uzbekistan
Assistant at the Department of Artificial Intelligence

A B S T R A C T	K E Y W O R D S
This article explores the fundamental concepts of axiom, hypothesis, and theory in the methodology of science. It analyzes their interconnections, differences, and roles in scientific research. The study is based on a comparative analysis of these terms, supported by historical examples from mathematics, physics, and economics. The paper also examines the process of transitioning from a hypothesis to a theory and the conditions under which theories may evolve into	Science methodology, axiom, hypothesis, theory, scientific paradigms, empirical validation, knowledge structure, scientific evolution.

axioms. The discussion highlights the role of scientific paradigms, as described by Kuhn and Popper, in shaping scientific knowledge. The findings emphasize the dynamic nature of scientific theories and their dependence on empirical validation.

Introduction

Scientific methodology ensures the reliability of knowledge and the systematic development of scientific inquiry. The fundamental concepts of **axiom, hypothesis, and theory** form the basis of the scientific method and define its logical framework. An **axiom** is a statement accepted without proof, serving as a foundation for further reasoning. A **hypothesis** is an assumption that requires empirical validation. A **theory** is a system of verified knowledge based on experimental data and logical reasoning. These elements are interconnected: a hypothesis, once tested and confirmed, can evolve into a theory, while some theories may eventually become axioms over time.

The relevance of this study lies in the fact that the role of these concepts varies across disciplines. In **mathematics**, axioms form the foundation of logical structures. In **natural sciences**, theories dominate as explanatory models, while in **social sciences**, hypotheses often remain subjects of debate. The works of **Kuhn (1962)** and **Popper (2002)** explore the formation of theories and the transition of hypotheses into established knowledge. **Hilbert (1899)** advanced the axiomatic method in mathematics, while **Einstein (1915)** applied it in physics. Modern research, such as that of **Piaget (1970)**, demonstrates that scientific theories are dynamic and evolve with new empirical data.

The objective of this study is to analyze the differences and interrelations between axioms, hypotheses, and theories, as well as their application across various scientific disciplines. The article addresses key questions: **How do these concepts differ? How are they applied in different fields? What conditions are necessary for a hypothesis to become a theory?** The study includes a literature review, comparative analysis, visual representations, and examples from scientific practice.

Methodology

This study is based on an in-depth analysis of scientific literature, including textbooks, monographs, and research articles that explore the methodology of science, the formation of hypotheses, and the development of theories. Particular emphasis is placed on Kuhn's (1962) work on scientific paradigms, Popper's (2002) concept of falsifiability, as well as Hilbert's (1899) and Einstein's (1915) contributions, which illustrate the application of the axiomatic method in mathematics and physics.

To systematize the material, a **comparative analysis** of the characteristics of axioms, hypotheses, and theories was conducted, highlighting their key differences and interconnections. The findings are presented in the form of tables and diagrams that visualize the process of scientific inquiry and the gradual transformation of hypotheses into theories.

The study incorporates examples from various scientific disciplines: Euclidean axioms in mathematics, the evolution of the gravitational hypothesis from Newton to Einstein in physics, and theoretical models of market equilibrium in economics. This interdisciplinary approach demonstrates the universal relevance and significance of these concepts in scientific methodology.

Table 1 - Levels of Scientific Knowledge and Their Key Elements

Level of Scientific Knowledge	Key Elements
Empirical	Facts, observations, experiments
Theoretical	Hypotheses, theories, models
Fundamental	Axioms, laws of nature

Results

An analysis of scientific literature has revealed clear distinctions and interconnections between axioms, hypotheses, and theories. A comparative table outlines their key characteristics: an **axiom** is accepted without proof, a **hypothesis** requires empirical validation, and a **theory** is formed based on verified hypotheses and logical reasoning.

The **graph of scientific knowledge validation** illustrates that hypotheses have the lowest degree of substantiation, theories are built upon verified data, and axioms serve as the unchanging foundations of science. The **conceptual flowchart of scientific inquiry** reflects the transition of hypotheses into theories and their potential evolution into axioms.

Historical examples confirm this dynamic process. Newton's hypothesis of gravity was empirically validated, forming the classical theory of gravitation, which was later refined by Einstein's general theory of relativity. In mathematics, Euclidean axioms laid the foundation for geometry, yet the development of non-Euclidean systems demonstrated the relative nature of the axiomatic approach.

The literature review includes Kuhn's (1962) work on **scientific paradigm shifts**, Popper's (2002) criterion of **falsifiability**, Hilbert's (1899) **rigorous axiomatic method**, as well as modern studies on the **evolutionary nature of scientific knowledge**. These findings confirm that the boundaries between hypotheses, theories, and axioms are fluid and depend on the continuous progress of science.

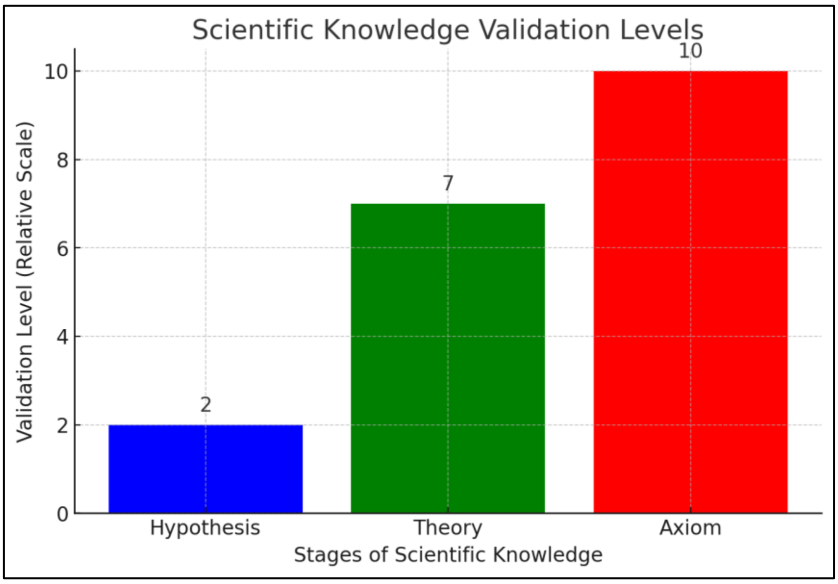

Figure 1 – Scientific Knowledge Validation Levels

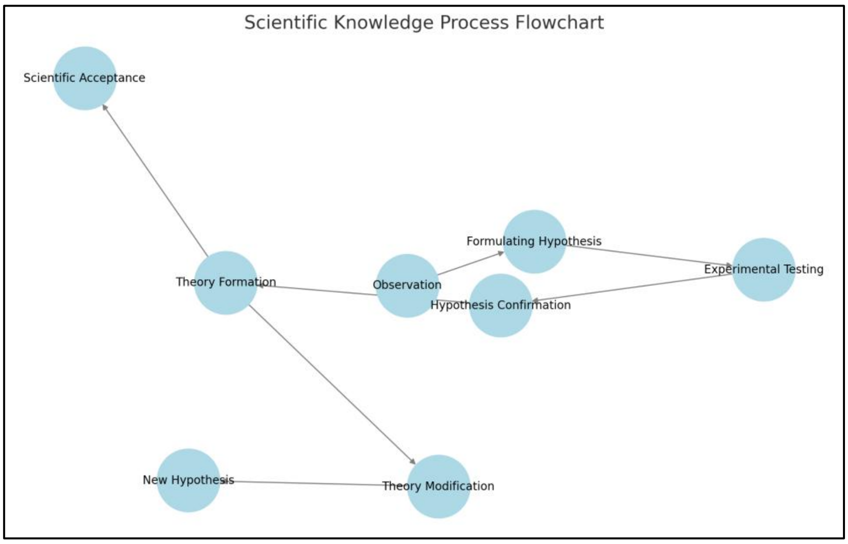

Figure 2 - Scientific Knowledge Development Process

Table 2 - Comparative Table: Axiom - Hypothesis - Theory

Characteristic	Axiom	Hypothesis	Theory
Definition	A fundamental statement accepted without proof	A proposed explanation requiring validation	A system of proven knowledge
Need for proof	Does not require proof	Requires confirmation	Verified by facts
Empirical testing	No	Yes, undergoes testing	Yes, empirically confirmed
Modifiability over time	No, remains unchanged	Can be disproven	Can be refined
Application in science	Mathematics, logic	Physics, economics, biology	All scientific disciplines

Discussion

The analysis reveals that hypotheses, theories, and axioms are interconnected within the scientific knowledge process, yet they serve distinct functions. A **hypothesis** proposes an assumption, a **theory** organizes and systematizes proven knowledge, while an **axiom** forms the foundation of a logical system. However, not every theory evolves into an axiom—scientific knowledge is constantly reassessed and refined.

Popper (2002) emphasized that a scientific theory must be falsifiable, which inherently prevents most theories from becoming axioms. Kuhn (1962) argued that paradigm shifts lead to the reevaluation of fundamental principles, a concept well-illustrated by historical examples: Newtonian mechanics was ultimately replaced by Einstein's theory of relativity, and in mathematics, the emergence of non-Euclidean geometries challenged the universal validity of Euclidean axioms.

This study is limited to an analysis of existing literature and does not explore the evolution of scientific knowledge within specific disciplines. Future research could focus on the empirical validation of hypotheses, the role of computational methods in theory development, and the impact of artificial intelligence on the automation of scientific discovery.

Conclusion

The analysis confirms that axioms, hypotheses, and theories are fundamental components of the scientific method. A hypothesis serves as the foundation for empirical research, a theory organizes verified knowledge, and an axiom acts as an indisputable basis within formal systems. However, the boundaries between these concepts are fluid—new discoveries can challenge or redefine the status of a theory or even an axiom.

Popper (2002) emphasized the importance of falsifiability in hypotheses, while Kuhn (1962) highlighted the role of paradigm shifts in reshaping scientific theories. Historical examples, such as the evolution of mechanics from Newton to Einstein, illustrate the dynamic nature of scientific knowledge.

Scientific methodology continues to evolve, pushing the boundaries of understanding across various disciplines. In mathematics, axiomatic systems ensure logical consistency; in natural sciences, hypotheses drive experimental inquiry; and in social sciences, theories provide frameworks for modeling complex phenomena. Future research into the mechanisms of scientific discovery, including the integration of artificial intelligence and big data analysis, may lead to a reevaluation of traditional approaches to knowledge formation.

References

1. Kuhn, T. S. (1962). The Structure of Scientific Revolutions. University of Chicago Press. - The Structure of Scientific Revolutions - Wikipedia
2. Popper, K. R. (2002). The Logic of Scientific Discovery. Routledge. - https://www.taylorfrancis.com/books/mono/10.4324/9780203994627/logic-scientific-discovery-karl-popper-karl-popper
3. Hilbert, D. (1899). Grundlagen der Geometrie. Teubner, Leipzig. - https://archive.org/details/grundlagendergeo00hilb
4. Einstein, A. (1915). Die Feldgleichungen der Gravitation. Preussische Akademie der Wissenschaften.- https://einsteinpapers.press.princeton.edu/vol6-trans/188
5. Piaget, J. (1970). Psychologie et épistémologie. Gonthier, Paris.- https://www.fondationjeanpiaget.ch/fjp/site/textes/VE/JP70_PsychologieEtEpistemologie.pdf
6. Lebedev, S. A. (2020). Methodology of Scientific Knowledge. Yurait Publishing. - https://urait.ru/book/metodologiya-nauchnogo-poznaniya-451542.