



How relevance of philosophy, science and philosophy science through the study of mathematical logic?

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Article Information

Submitted Feb 15, 2024

Revised April 27, 2024

Published June 25, 2024

Keywords

Mathematical logic; Philosophy;
Science.

Abstract

Background: Philosophy, science, and the philosophy of science serve as interconnected systems of expression that can be utilized as benchmarks and standards of truth across various fields. Through the study of mathematical logic, the complexity of thought will contribute to analyzing a strong epistemological and methodological foundation for modern science, while also reinforcing the philosophical underpinnings of science in understanding nature and scientific processes.

Aim: This research aims to provide information and descriptions about the relevance of philosophy, science and philosophy of science through the study of mathematical logic.

Method: The writing of this work is included in qualitative research using the literature review method.

Results: Mathematical logic is a very important element in life as the source of all actions that print the history of everyone's life wherever and whenever, so this also means that mathematical logic has important relevance in efforts to explain things in terms of philosophy and science. and philosophy of science.

Conclusion: The quality of mathematics education in fostering professional teachers in madrasahs is based on management functions, namely planning, organizing, implementing, and evaluating.

INTRODUCTION

The development of philosophy since the classical era has laid the groundwork for human thought in understanding the world and oneself (Manik et al., 2022). The ideas of classical philosophers such as Plato and Aristotle have formed the foundation for many disciplines, and their inquiries into the nature of knowledge and reality remain relevant today (Brenner & Igamberdiev, 2021; Mousavi & Ghanbari, 2024; Uzoigwe, 2022). During the Enlightenment, philosophy became crucial in the development of modern science. Rational thinking and skepticism towards religious dogma provided the basis for the scientific method that later evolved. In the 17th century, the scientific revolution brought about fundamental changes in the scientific paradigm (Setio et al., 2024; Xu et al., 2021). Empirical thinking and experimental scientific methods began to dominate, and natural philosophy became increasingly intertwined with the progress of science (Benton & Craib, 2023; Oghly, 2023).

Science has evolved into various specialized branches, forming distinct disciplines. This separation of scientific disciplines has posed philosophical challenges regarding the relationship between disciplines and scientific truth. Science continues to advance with the emergence of new fields that encompass multiple disciplines, eventually giving rise to more

How to cite	Farida, Rotama, A., Dharmawan., & Pahrudin, A. (2024). How relevance of philosophy, science and philosophy science through the study of mathematical logic?. <i>Al-Jabar: Pendidikan Matematika</i> , 15(1), 75-86.
E-ISSN	2540-7562
Published by	Mathematics Education Department, UIN Raden Intan Lampung

specific subfields and specializations (Permana et al., 2023). Science can be viewed as an interconnected and consistent system of expression, whose inherent nature can be determined using standards and benchmarks of truth within each field (Harweli & Ahida, 2024).

To overcome these philosophical challenges, an approach is needed that can bridge various scientific disciplines and ensure the consistency and accuracy of the knowledge produced. One highly influential approach is through the study of mathematical logic. The relevance of philosophy, science, and the philosophy of science can be clearly observed through the application of mathematical logic. The study of mathematical logic helps develop a strong epistemological and methodological foundation for modern science (Oljayevna & Shavkatovna, 2020; Sumarni et al., 2023), and reinforces the philosophical basis of science in understanding nature and scientific processes (Ashshiddiqi, 2021). For instance, the use of mathematical logic in constructing scientific models and proving theories has helped overcome ambiguities and various interpretations in scientific reasoning (Haloho, 2022; Kaiser, 2020; Melkisedek et al., 2024; Setiana & Purwoko, 2021).

The emergence of the philosophy of science in the 20th century established it as a branch of philosophy focused on the nature, methods, and objectives of science (Laudan, 2020; Pradeu et al., 2024). Philosophers like Karl Popper and Thomas Kuhn explored philosophical aspects in the development of science, including issues related to theoretical falsification and paradigm shifts (Kuhn, 2014; Matthews, 2022; Shea, 2016). From this exploration, it became evident that mathematical logic plays a crucial role in constructing arguments and proving truths within the context of science (Hanna, 2020). The clarity and precision of mathematical logic help to overcome ambiguities and various interpretations that can arise in scientific reasoning.

Several prior studies on the relevance of philosophy, science, and mathematical logic have provided valuable insights. Research by Fadli (2021) and Nurhayati (2021) highlighted the relationship between philosophy and science, emphasizing their relevance in the era of the Industrial Revolution 4.0. These studies explain how the definition of science depends on the philosophical system adopted. Additionally, the significance of philosophy in mathematics offers an understanding of philosophy's role within the discipline of mathematics (Hartatik et al., 2023; Lakatos, 1980; Nyoman, 2022). Research by Fairus et al. (2023) demonstrates that philosophy can influence the development of mathematical learning models that incorporate technology. Meanwhile, Damayanti & Prasetyono (2022) discuss the relationship between humans, science, philosophy, and technology, providing perspectives on how technological advancements philosophically impact human life.

These studies underscore the important role of philosophy in understanding science, including in the context of mathematical logic, and how philosophical understanding can offer insights into various disciplines. However, research that simultaneously highlights philosophy, science, and the philosophy of science through the lens of mathematical logic has not been found. Therefore, this study aims to fill this gap by expanding our understanding by emphasizing mathematical logic, which unites these three fields holistically. This study seeks to provide information and descriptions about the relevance of philosophy, science, and the philosophy of science through the study of mathematical logic.

METHODS

Design

This study is written as part of a qualitative research study employing a literature review methodology. This method collects data from various literature sources by recording all findings related to the relationship between philosophy, science, and the philosophy of science. Every research discussion found in the literature and sources, along with recent discoveries related to these relationships, will be documented. This qualitative approach emphasizes natural phenomena, often referred to as naturalistic inquiry (Gunawan, 2016).

Data Collection

The data used in this research are secondary data obtained from literature materials. The data collection process involves reading and reviewing literature sources such as books and scientific journals that discuss the relevance of philosophy, science, and the philosophy of science. Data is gathered through a literature study by collecting the necessary information. The collected data is then organized, analyzed, and synthesized to draw conclusions based on the literature review.

Data Analysis

Data analysis is conducted by reading and reviewing literature sources, followed by classifying the relevant information. Subsequently, the data is analyzed qualitatively with an emphasis on meaning rather than generalization (Sugiyono, 2016). The results of the analysis are presented descriptively, illustrating the relationships between philosophy, science, and mathematical logic.

RESULTS AND DISCUSSION

This research examines the relationship between philosophy, science, and the philosophy of science through the study of mathematical logic using a literature review approach. The word falsafah or philosophy in Indonesian is a loan word from Arabic, which is also taken from the Greek philosophia. In this language, this word is a compound word and comes from the words philia (= friendship, love, etc.) and sophia (= wisdom). So the meaning of lughowinya (semantic) is a lover of wisdom or knowledge. These two words are then combined into the word philosophia which means love of wisdom (Nasution, 2022). Parallel to the word philosophy, the word philosophy is also known in Indonesia with a fairly broad meaning and is often used by all groups.

Philosophers such as Plato defined philosophy as knowledge to achieve truth. Philosophy is a science that includes truth regarding the sciences of metaphysics, logic, rhetoric, ethics, economics, politics and aesthetics. Philosophy is the science of searching for the first truth, the science of everything that exists which shows that there is something that acts as the first mover (Aristotle). Meanwhile, AlFarabi defines philosophy as the science of existing nature and its true nature (Rofiq, 2014). Then combined with the word Sophia, which means wisdom, cleverness and deep understanding. By referring to this conception, it is understood that philosophy can be interpreted as a manifestation of the desire to achieve intelligence and love of policy.

Someone who studies philosophy is called a philosopher. The definition of the word philosophy can be said to be a philosophical problem as well. However, at least it can be said that philosophy is a study that studies all phenomena of human life and thought critically, detects problems radically, looks for solutions for them, provides appropriate arguments and reasons for certain solutions, and the end of these processes is put into practice. in a scientific work process.

In connection with the concept of philosophy, Harun Nasution without a doubt provides an affirmation that philosophy in the Islamic treasury uses the word as a reference, namely philosophy. The term philosophy comes from Arabic because Arabs came first and influenced Indonesian compared to other languages in Indonesia's homeland. Therefore, the consistency that should be established is the mention of philosophy with the word philosophy (eL-Mawa, 2016).

On the other hand, philosophical studies in Muslim discourse also often use the equivalent sentence "hikmah" so that the science of philosophy is equated with the science of wisdom. Hikmah is used as a form of expression to refer to the meaning of wisdom, discretion. so that in various classical literature it is said that people who are experts in wisdom are called Hukama. Often, when studied in various Islamic boarding school literature, expressions appear on a theme with concepts in Arabic, for example sentences wa qala min ba'di al hukama and is also parallel to the word al-hakim which means wise. For example, the verse that reads as follows:

قَالُوا سُبْحَانَكَ لَا عِلْمَ لَنَا إِلَّا مَا عَلَّمْتَنَا ۗ إِنَّكَ أَنْتَ الْعَلِيمُ الْحَكِيمُ

It means: they answered: "Glory to You, we know nothing except what You have taught us; Indeed, you are the all-knowing, the most wise." (Al Baqarah: 32).

A number of literatures reveal that the first person to use the terms philosophia and philosophos was Pythagoras (592-497 B.C.), namely a mathematician who is now more famous for his postulate in geometry which establishes $a^2 + b^2 = c^2$. Pythagoras considered himself a philosophos (lover of wisdom). For him, true wisdom belongs solely to God. Then, the person who was recognized by the writers of the history of philosophy as the Father of Philosophy was Thales (640-546 B.C.). He was a philosopher who founded the school of philosophy of the universe or cosmos in Greek words. According to the school of cosmos philosophy, philosophy is a study of the universe to find out its origin, its elements and its rules.

The emergence of philosophy because humans feel amazed and surprised. In the initial stages, the admiration or surprise was directed at natural phenomena. In further development, human problems become more complex. Even though it asks about all of reality, philosophy is always "philosophy about" something: about humans, about nature, about God (the afterlife), about culture, art, language, law, religion, history, etc.. Everything always returns to the four main areas : First, philosophy of knowledge; material objects: knowledge (epistem) and truth, epistemology; logic; and criticism of the sciences; Second, philosophy about the whole of reality, its material objects: existence and essence, general metaphysics (ontology); special metaphysics: anthropology (about humans); cosmology (about the universe); theology (about God); The three philosophies about the values contained in an action: material objects: goodness and beauty, ethics; and aesthetics; Fourth, history of philosophy; concerns the dimensions of space and time in a study (Sulastri & Bustam, 2022).

Philosophy is the study of fundamental questions about existence, knowledge, values, logic, ethics, wisdom, and other basic elements of reality. Philosophy attempts to delve into the essence of things and seeks a deeper understanding of the world and man's place in it. Philosophy often uses critical and analytical thinking methods and aims to achieve general and abstract understanding.

Concept of Science

Understanding science The word 'ilm comes from Arabic which means "knowledge" and is the opposite of jahl which means "ignorance or stupidity". The word science is usually equated with other Arabic words, namely ma'rifah (knowledge), fiqh (understanding), hikmah (wisdom), and syu'ur (feeling). In the Big Indonesian Dictionary, science is defined as knowledge about a field that is arranged systematically according to certain methods that can be used to explain certain phenomena in that field of knowledge.

The definition of a Russian Marxist thinker named Alfensyef explains science: Science is the society and thought, if it reflects the word correctness, categories and results received by practical experience. Science is human knowledge about nature, society and the mind. It reflects nature and its concepts, categories and truths are tested practically. The general definition of science is knowledge about certain objects that is systematically arranged objectively, rationally and empirically as a result.

Science is a system of knowledge obtained through observation, experimentation and reasoning. The goal is to understand, explain, and predict natural phenomena or life. Science seeks to use scientific methods to collect empirical evidence that can be tested for truth. There are various scientific disciplines, such as physics, biology, chemistry, and others, each of which focuses on certain aspects of reality.

The object of science refers to a particular collection of phenomena or subjects that are the focus of study in a scientific discipline. Each scientific discipline has its own objects that cover a specific area of reality or knowledge. For example, the object of physics involves the study of the properties and behavior of matter and energy in the universe. Biology, on the other hand, focuses on the study of living things and life processes. By defining its object, science provides a framework for investigating, classifying, and understanding phenomena within certain limits.

Mohammad Hatta stated that science was born because humans were faced with two problems, namely the external world/cosmos and life attitudes/ethics (Ismael & Ahida, 2022). Meanwhile, John Ziman in his writings stated that sciences such as religion, law, philosophy and so on, in a more or less integrated form, consist of a series of ideas. In technical language, science is information (Sulastri & Bustam, 2022). It is not directly related to the body. Many scientists have provided definitions of science, but the definition most popular with many philosophers is that science will show truth through logical conclusions derived from empirical experience.

Philosophy of Science

Philosophy of science is a branch of philosophy that specifically discusses philosophical questions related to science. It includes considerations about the nature of science, scientific methods, sustainability, and the ethics of scientific research. Philosophy of science also tries to

understand how scientific knowledge is acquired, organized, and used. In this case, the philosophy of science opens up space for reflection and criticism of philosophical aspects in scientific practice.

The object of philosophy is very broad and involves basic questions about existence, knowledge, values, ethics, truth, and others. Philosophy does not have certain limitations in terms of its object, because it includes considerations about all aspects of life and reality. The objects of philosophy are abstract concepts and ideas that are often universal and fundamental. For example, the object of the philosophy of ethics involves considerations of goodness, justice, and morality, while the object of the philosophy of epistemology addresses the origins, nature, and limits of knowledge.

In some cases, the objects of science and philosophy may be interrelated. Philosophy of science, for example, discusses the philosophical concepts underlying scientific practice and ontological and epistemological questions about the nature and limits of scientific knowledge. In general, science and philosophy complement each other to provide a more comprehensive understanding of the world and humans' place in it.

The definition of mathematical logic is reasoning or the basis for thinking to draw a conclusion. Mathematical logic is the basis for obtaining truth based on proof and rational thinking. Mathematical logic is usually applied to find justification for a proposition or statement. The definition of a proposition is a statement that can be true or false. Propositions are statements, so command sentences and questions are not propositions. An example of a proposition is as follows: Indonesia is a rule of law country. Cats are mammals from the Felidae family. The *Aedes Aegypti* mosquito causes dengue fever (DHF). A proposition does not only consist of one sentence, but can also be formed from two sentences. Reporting from Stanford University, mathematical logic can determine how the truth in one proposition or a combination of propositions affects each other.

Mathematical Philosophy and Logic

Philosophy is a science, which seeks to investigate the nature of things to obtain the truth. This is what brings his efforts to a universal conclusion from particular or special realities, from the simplest to the most complex.

Philosophy includes questions about meaning, truth, and logical relationships among basic ideas (beliefs, assumptions and concepts) that cannot be resolved by empirical science (Ismael & Ahida, 2022). Judging from the method and rationale, philosophy provides a conceptual and methodological framework for understanding fundamental aspects of reality, knowledge, ethics and existence. The study of mathematical logic can help philosophy in developing rigorous and clear methods of analysis. As seen from epistemology, mathematical logic can help philosophy in detailing the structure and conditions of knowledge. Concepts such as deduction, induction, and logical inference help understand how knowledge can be obtained and justified. Meanwhile, from the ontological aspect, mathematical logical thinking can also contribute to ontological discussions, namely about the nature of reality and existence. Mathematical models and structures can help understand how an entity can be represented and described. Most logic is mathematical. It includes all symbolic logic, also called formal logic. There are parts of logic that are not so mathematical. Analytical reasoning analyzes arguments that may include more than just logic. Where exactly the boundary lies is unclear. Boole's

treatment of probability is a mathematical analysis of inductive logic. It is true, all probability and statistics can be considered mathematical analysis.

Mathematical Science and Logic

Knowledge is the main source of national civilization, whether advanced or not, and begins with public attention to science (Octaviana & Ramadhani, 2021). A society that prioritizes science will make the progress of that nation's civilization more advanced compared to a society that does not pay attention to science. So we often hear that countries that are developed, in terms of science, are also better than countries that don't pay attention to science.

When discussing science, it is usually inseparable from the means of thinking. The tools of scientific thinking, which include language, logic, mathematics, and statistics, are an important foundation in the development of systematic knowledge and understanding. In an effort to understand the world around us, humans have developed and used these tools extensively, which have helped in exploration and new discoveries in various fields of science (Wang et al., 2023). With this it can be said that mathematical logic is an important foundation in understanding the scientific method which is part of science itself. With good scientific methods, the use of mathematical logic will produce modeling that can be understood by the human mind.

Judging from the scientific method, mathematical logic provides the basis for the scientific method by providing tools for testing the truth and validity of arguments. The application of the scientific method often involves the use of mathematical logic principles in experimental design, data analysis, and inference. Meanwhile, from a mathematical modeling perspective, science often uses mathematical models to represent natural phenomena. Mathematical logic helps ensure the consistency and accuracy of these models in reflecting reality.

Philosophy of Science and Mathematical Logic

Viewed from scientific methods and thinking, philosophy of science examines the nature, limitations and justification of science. Mathematical logic can help in evaluating and detailing scientific arguments, as well as establishing standards of rationality in research. Meanwhile, viewed from the aspect of Uncertainty and Probability, mathematical logic, especially probability, can help the philosophy of science in understanding aspects of uncertainty and randomness in science. It is important to acknowledge the limits and complexity of our knowledge. Logic is the study of the reasoning process which starts from the application of thinking principles in appropriate reasoning which is used in distinguishing good and right from bad and wrong reasoning (Khambali et al., 2021). Thus, the study of mathematical logic provides a solid foundation for philosophy, science, and the philosophy of science, aiding in the development of critical thinking, rigorous analysis, and a deeper understanding of the nature of knowledge and reality. Slamet Ibrahim's opinion is quoted as explaining that from the time of Plato to the time of Al-Kindi, it could be said that the boundary between philosophy and science did not exist. A philosopher (philosopher) must master all sciences. The development of human thinking power which developed philosophy at a practical level was defeated by the development of science which was supported by technology. The area of study of philosophy is narrower than the area of study of science. So there is an opinion that philosophy is no longer

needed. Philosophy is less grounded while science is more useful and more practical. Even though philosophy requires comprehensive knowledge that is broad, general and universal and this cannot be obtained in science. So philosophy can be placed in a position where human thought cannot possibly be reached by science (Bakar et al., 2023).

Thinking is one of the human activities to find true knowledge, whereas truth itself does not have the same measurement for each individual. Every way of human thought has a criterion of truth that functions as the basis for the process of discovering that truth. In this thinking activity, it is shown in the logic of a fixed insight into thinking or determination of thought or the truth of thinking which is in accordance with logical outlines which is called logical thinking (Khambali et al., 2021).

Logic is a branch of philosophy that functions to provide information on how people should think (Situmeang, 2021). Mathematical logic, which is a development of the logic of human thinking, is a simple way so that knowledge as a result of human thinking can be in accordance with what it should be or should be. Human thinking activities are reflected in their attitudes and behavior, so it can be said that every human behavior is a reflection or symbol of their thinking activities. The dynamics of thinking are apparently not easy, sometimes people make mistakes in thinking, not because their knowledge is wrong, but because their way of thinking is not straight, not according to the rules. In mathematical logic, thinking means arranging a sequence of values with the aim of getting the right conclusion by eliminating any contradictions.

Mathematical logic gives direction to human thinking, and is a kind of guide for humans to act wisely in standard measurements. In this case, mathematical logic must have standards that are understood equally. This is because the human mind is the basis for logic, the will is the basis for ethics and human feelings are the basis for aesthetics, all three are closely related and there needs to be connectivity so that science is not secular in nature and in its development can become the basis of a valuable civilization.

In the study of epistemology, knowledge is called true if it is obtained through responsible methods and shows conformity with reality. What is meant by a responsible method is a method that is formally acceptable to common sense. What is meant by reality is material knowledge that can be proven in reality. In the knowledge process, logic plays a role in the first position, namely as a path or healthy way to obtain correct knowledge (Sulastri & Bustam, 2022).

Logic functions for all sciences to provide clear boundaries regarding the content, extent and shape or form of a science in our understanding (Khambali et al., 2021). Knowledge which is the result of reasoning must be based on logic, otherwise it will lead to misguided thoughts which lead to misleading human actions (Octaviana & Ramadhani, 2021). By applying the laws of straight, correct and healthy thinking, which we enter into the field of logic as a skill, a way of thinking or the results of human thinking (science), beliefs and a series of human life orientations, ultimately underlies the development of civilization will be in accordance with all the principles, rules and procedures for correct reasoning, all of which will greatly influence the formation of a strong and high civilization. Civilization is the fruit of beliefs, ethics and collective behavior of a society. He added, a society will have a high civilization when their beliefs, ethics and behavior are accompanied by knowledge, reason and logic. Likewise, if people's beliefs, ethics and behavior are far from science and logic, then their civilization will also be lower.

Based on the description above, it can be stated that mathematical logic is a very important element in life as the source of all actions that print the history of everyone's life wherever and whenever, so this also means that mathematical logic has important relevance in efforts explain something in terms of philosophy, science and philosophy of science.

Implication

Mathematical logic can help in evaluating and detailing scientific arguments, as well as establishing standards of rationality in research. Uncertainty and Probability in mathematical logic, especially probability, can help the philosophy of science in understanding aspects of uncertainty and randomness in science. It is important to acknowledge the limits and complexity of our knowledge.

CONCLUSIONS

The relevance of philosophy to science and the philosophy of science has a very close relationship. This is based on its third goal, namely seeking the truth. In Philosophy, the study of mathematical logic can help philosophy in developing rigorous and clear analytical methods. In Science, the scientific method of mathematical logic provides the basis for the scientific method by providing the tools for testing the truth and validity of arguments. Meanwhile, for the Philosophy of Science, mathematical logic can help in evaluating and detailing scientific arguments, as well as establishing standards of rationality in research. Uncertainty and Probability in mathematical logic, especially probability, can help the philosophy of science in understanding aspects of uncertainty and randomness in science. It is important to acknowledge the limits and complexity of our knowledge.

AUTHOR CONTRIBUTIONS STATEMENT

F is the research designer and D and AR are the research implementers. AP was the third supervisor in completing the research which then proceeded to writing the article. D is the author of the article which originates from research initiated by F. Criticism and suggestions from F, AR and AP are very important in this research.

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