



Philosophy as The Foundation of Science in The Development of Chemistry

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Abstract: Philosophy As The Foundation Of Science In The Development Of Chemistry.

Philosophy is the basis of human thinking as rational reasoning in seeking and exploring a science. Philosophy and science can complement each other because both use reflective thinking methods in an effort to show a critical attitude, with an open mind, and an impartial will, to know the nature of truth, chemistry is no exception. Philosophy and chemistry both grew out of an attitude of reflection, curiosity, and based on a love of truth so that in the development of chemistry true and objective facts were obtained. This article aims to present an explanation of philosophy as the basis of science in the development of chemistry. This article uses the literature review method. The library sources used in this article are journals and books on the development of chemistry. The results of the research show that (1) Philosophy serves as the basis from which philosophy is obtained the truth which becomes the basis or foundation of chemistry. By learning something related to chemistry through knowledge (philosophy) is a step to get true and objective knowledge about chemistry. (2) Chemists and scientists agree on the basis of the development of chemistry, namely to obtain answers to the what and why questions about matter in nature, each of which will produce facts and theoretical knowledge about matter whose truth can be explained by mathematical logic. Finally, (3) The study of chemistry in its development includes aspects of ontology, epistemology, and axiology. The ontology aspect includes the chemical concept of matter and matter. The epistemological aspect includes the understanding of chemistry that is obtained and developed based on experiments and theories. While the axiological aspect of chemistry includes the usefulness of values for human understanding so that humans will be better at the surrounding nature and use various natural processes that take place in it to meet the needs of human life.

Keywords: Philosophy, Development of Chemistry

Abstrak: Filsafat Sebagai Landasan Ilmu dalam Perkembangan Ilmu Kimia. Filsafat merupakan landasan berpikir manusia sebagai penalaran akal dalam mencari dan mendalami suatu ilmu pengetahuan Filsafat dan ilmu pengetahuan dapat saling melengkapi sebab keduanya menggunakan metode pemikiran reflektif dalam usaha untuk menunjukkan sikap kritik, dengan pikiran terbuka, dan kemauan yang tidak memihak, untuk mengetahui hakikat kebenaran, tidak terkecuali terhadap ilmu kimia. Filsafat dan ilmu kimia keduanya tumbuh dari sikap refleksi, ingin tahu, dan dilandasi kecintaan pada kebenaran sehingga dalam perkembangan ilmu kimia diperoleh fakta yang benar dan objektif. Artikel ini bertujuan untuk memaparkan penjelasan filsafat sebagai landasan ilmu dalam perkembangan ilmu kimia. Artikel ini menggunakan metode kajian pustaka. Sumber pustaka yang digunakan dalam artikel ini berupa jurnal dan buku tentang perkembangan ilmu kimia. Hasil penelitian menunjukkan bahwa (1) Filsafat berfungsi sebagai

landasan dimana melalui filsafat diperoleh kebenaran yang menjadi pijakan atau landasan ilmu kimia. Dengan mempelajari sesuatu hal yang berkaitan dengan ilmu kimia melalui pengetahuan (filsafat) merupakan sebuah langkah untuk mendapatkan pengetahuan yang benar dan objektif tentang ilmu kimia. (2) Ahli kimia dan ilmuwan menyepakati dasar perkembangan ilmu kimia yakni untuk memperoleh jawaban atas pertanyaan apa dan mengapa tentang materi yang ada di alam, yang masing-masing akan menghasilkan fakta dan pengetahuan teoritis tentang materi yang kebenarannya dapat dijelaskan dengan logika matematika. Terakhir, (3) Kajian ilmu kimia dalam perkembangannya meliputi aspek ontologi, epistemologi, dan aksiologi. Aspek ontologi mencakup konsep kimia mengenai zat dan materi. Aspek epistemologi mencakup pemahaman ilmu kimia yang diperoleh dan dikembangkan berdasarkan percobaan dan teori. Sedangkan aspek aksiologi ilmu kimia mencakup kebermanfaatannya nilai terhadap pemahaman manusia sehingga manusia akan lebih baik terhadap alam sekitar dan menggunakan berbagai proses alam yang berlangsung di dalamnya untuk memenuhi kebutuhan hidup manusia.

Kata kunci: *Filsafat, Perkembangan Ilmu Kimia*

• INTRODUCTION

In essence, humans will always try to improve the knowledge they have. This is done because the increase in knowledge will produce the truth of that knowledge. Learning everything with science, is basically an attempt by humans to get to the truth. Truth is a state in which a thing corresponds to the actual object, thus learning something through knowledge (philosophy) is a step to gain true and objective knowledge (Istikhomah & Suharto, 2021).

In obtaining true and objective knowledge, philosophy cannot be separated from the role of philosophy. Philosophy is the footing or foundation of human thinking as reasoning in seeking and exploring a science (Fadli, 2021). Bakhtiar (2012) suggests that substantially and historically philosophy and science have an important role in providing a major influence on human life. These two things cannot be separated because they are integrated with each other. If traced, philosophy and science play a role in bringing about changes in human civilization. Hidayatullah's research (2006) explains that Greek civilization is the place where philosophy was first discovered. Along with the development of philosophy in ancient Greek society has changed their mindset from the initially mythcentric view to logo centric. The link between philosophy and science has a major influence on human knowledge of everything, this influence has brought changes to human civilization to a more advanced level, as is the case with human civilization today (Hidayatullah, 2006).

Philosophy and science are also one unit and have complementary relationships. The relationship between the two is likened to philosophy as the mother of science, while science is the son of philosophy. This means that philosophy is broader or universal in its object. While the object of science is limited because it is only in certain fields. Philosophy and science can meet each other because both use the method of reflective thinking in an attempt to deal with the facts of the world and life. Both show a critical attitude, with an open mind and an impartial will, to know the nature of the truth (Fadli, 2021). The nature of truth applies to all sciences, including chemistry. Philosophy and chemistry are interrelated with each other, both of which grew out of an attitude of reflection, curiosity, and a love of truth. Philosophy with its methods is able to question the validity and truth of chemistry, while chemistry is not able to question its own assumptions, truths, methods, and validity. So that this article aims to explain the explanation of philosophy as the basis of science in the development of chemistry where through philosophy, true and objective chemistry is obtained.

• METHOD

method used in this article is the literature review method. The library sources used in this article are journals and books on the development of chemistry. In addition, the results of empirical research are used as secondary data to strengthen arguments which are then synthesized into a single unit to provide meaningful information.

• RESULT AND DISCUSSION

Philosophy etymologically comes from the Greek, *philos* which means love and *sophia* which means wisdom. Literally philosophy has the meaning of love of wisdom. This shows that humans have never perfectly had a comprehensive understanding of everything that is meant by wisdom, but must continue to pursue it (Widyawati, 2013). Philosophy and science have an important role in giving a big influence on human life. These two things cannot be separated because philosophy and science are integrated with each other (Bakhtiar, 2012).

What is meant by *philosophy of science* is reflective thinking on issues regarding the nature of the foundations of science which include basic concepts, basic assumptions, initial principles, theoretical structures, and measures. the truth of science (Istikhomah & Suharto, 2021). Chemistry is no exception, philosophy is indispensable for its presence at a time when the development of chemistry is increasingly showing its scientific specialization. In the development of chemistry, a scientist must explore philosophy where philosophy serves as the basis for the development of science so that the scientific method and scientific attitude that must be developed have the following objectives.

- (1) Philosophy as a means of testing scientific reasoning, so that humans will become critical of scientific activities (Habibah, 2017). This applies to chemistry where the chemistry developed must be critical in any scientific activity. A scientist must be critical of his own field of science, so that he can avoid being solipsistic, assuming that his opinion is the most correct (Habibah, 2017).
- (2) Philosophy is an attempt to reflect, criticize, and test various assumptions and scientific methods (Habibah, 2017). The chemistry studied by scientists must be able to apply the scientific method in accordance with the specified rules, not the other way around according to their own wishes.
- (3) Philosophy provides a logical basis for the scientific method. Every form of scientific method developed must be logically and rationally accounted for, so that it can be understood and used in general. The wider the acceptance and use of the scientific method, the more valid the method is (Habibah, 2017).

Overall, it can be understood that philosophy can be used as a foundation in science, including chemistry to obtain the truth on which chemistry is based. Through philosophy is a step to get true and objective knowledge about chemistry.

History of the Development of Chemistry

The development of chemistry was preceded by the development of natural science (science). Natural science or science as one of the sciences that developed from the philosophy of science, is a science related to nature and is needed in human life. Science is a human perspective such as curiosity and the desire to understand phenomena so that they are able to be confident in assessing and answering questions to solve problems (Akinbobola & Afolabi, 2010).

The essence of science is an accumulation of *content, process and context*. *Content* includes matters relating to facts, definitions, concepts, models, theories and terminology. *Process* is related to skills or activities to obtain or discover principles and concepts. *The context* includes 3 things, namely the individual, the community, and the surrounding environment (Akinbobola & Afolabi, 2010). In line with this, Chiappetta & Koballa (2010) explain the nature of science

reflects holistic problems in real life. Science is studied from several aspects, namely as *abody of knowledge, a way of thinking, a way of investigation* and its relation to technology and society (Chiappetta & Koballa, 2010). The nature of this science is the basis for the development of chemistry, where chemistry functions as a way of thinking, a way of investigating, building knowledge, and having links with technology and society.

The progress and development of science in the field of chemistry cannot be separated from the thoughts of experts in the past (Shidiq, 2019). Ancient Greek philosophy of science began with in-depth chemical questions about the basic elements in the universe and about how to give reasons for the finite variety of matter and its amazing changes, such as water turning into solid or gas, wood turning into fire, smoke, and ash, stone turns into metal, food turns into a human body, or certain materials convert a diseased body into a healthy body.

Furthermore, Aristotle focused science on the theory of the elements which then had an influence well into the 18th century and eventually provided the basis for some chemists. Chemists meticulously carried out the desired changes in matter in the laboratory, particularly alchemy and metallurgy who were deeply involved in thinking about metaphysical and methodological problems from not only modern chemistry but also the emergence of experimental methods, such as the emergence of Francis Bacon, a popular influential chemist. . Although the 17th century brought about fundamental divisions in science, mathematics, and experimentation and many famous philosophers were inclined towards the mathematical tradition, philosophical discussions of chemistry did not stop there. This can be seen from chemists such as Hegel, Schelling, and Engels who later sparked a generation of 20th century philosophers in communist countries to reflect on chemistry. Finally, chemists of the 19th and 20th centuries starting from Liebig, Duhem, Ostwald to Polanyi who were very involved in philosophical issues gave major changes to the development of chemistry.

Broadly speaking, the development of chemistry from the desire of experts is to obtain answers to the what and why questions about matter that exists in nature, each of which will produce facts and theoretical knowledge about matter whose truth can be explained by mathematical logic (Caldin, 2002).

Philosophical Studies in Chemistry

Philosophy of science has two objects of study, namely material objects and formal objects. The material object is what is studied and peeled off as material material. Material objects are objects that are targeted for investigation by a science or objects studied by science. The material object of the philosophy of science is knowledge itself, namely *scientific knowledge* that has been systematically compiled with certain scientific methods so that the truth can be accounted for in general (Adib, 2010). Meanwhile, the formal object is the approach used for material objects, so that it characterizes certain fields (Djajadi, 2019).

This material object and formal object then become a reference in the scope of the philosophy of chemistry. Basically the scope of the philosophy of science is a study related to what objects are studied by science (ontology), how the process of acquiring knowledge (epistemology), and how the benefits of science (axiology) (Suriasumantri, 2010). The description of the three scopes of philosophy in chemistry is as follows.

a. Ontology of Chemistry Chemistry

comes from the Arabic language, namely *al-kimiya* which means change of matter, by the Arab scientist Jabir Bin Hayyan. In more detail, chemistry is defined as the study of matter, the composition of matter, the structure of matter, the properties of matter, and the changes in matter and the energy that accompanies these changes (Chang, 2005).

Matter is understood as anything that has mass and can occupy space (Chang, 2005). The composition of the material includes the components that make up the material and the comparison of each of these components. Furthermore, the structure of matter includes the structure of the particles that make up a material or describes how the atoms that make up the material are bonded together. Next, the properties of matter referred to in chemistry are properties that include physical properties (form and appearance) as well as chemical properties which are

influenced by the composition and structure of the material. While material changes include physical changes in the form of changes in form and chemical changes in the form of changes that produce new substances (Caldin, 2002).

Based on this explanation, the ontology aspect of chemistry includes chemical concepts which mean the composition, structure, properties, and changes in matter and the energy that accompanies these changes. While the object of study of chemistry is substances and matter.

Suriasumatri (2010) added that the ontology discusses the nature of what you want to study. In this regard, it is agreed that the nature of chemistry is in the form of material that can change shape, as well as the arrangement of particles into other forms so that deformation occurs, changes in the location of the arrangement, thus affecting properties that are different from the original form (Caldin, 2002). From the time of classical Greek philosophy and alchemy to the development of modern chemistry in the 19th century, the notion of matter, elements, compounds, and their transformations has become a central issue and this issue has become the basis for philosophical systems as well as the target of critical reflection (Borchert, 2006).

b. Epistemology of Chemistry

Scientific phenomena always demand scientific explanations based on existing knowledge. Knowledge has a very broad scope which includes knowledge revealing the source of all knowledge, the science of morality, skills, human relations, and ways to educate and regulate humans. The uniqueness of the human sciences approach lies in their commitment to investigating a phenomenon for practical purposes (Cohen, 2018). The investigation of a phenomenon in acquiring knowledge is closely related to the epistemology of the philosophy of science. Epistemology examines and tries to find the general characteristics and nature of human knowledge, how that knowledge is obtained and tested for truth. The subject matter of epistemology includes the nature and sources of knowledge, methods of obtaining knowledge, and criteria for the validity of knowledge (Mufid, 2013).

The epistemological aspect of chemistry is about how the process of acquiring chemistry is. Chemistry is a science that was originally acquired and developed based on experiments but in subsequent developments chemistry is also obtained and developed based on theory. The development of chemistry begins with answering the question of what is chemistry and why questions about matter in nature. Knowledge born from attempts to answer the question "what" is a fact that the properties of matter observed are the same by everyone will result in descriptive knowledge obtained by designing experiments and conducting experiments. Meanwhile, knowledge that is born to answer the question "why" a material has certain properties will produce theoretical knowledge. This knowledge is obtained through scientific steps so that a theory emerges and is created (Brakel, 2014). The theory that has been found will continue to be proven by other researchers in order to strengthen the theory or perhaps refine the theory (Mufid, 2013).

c. Axiology of Chemistry

Axiology examines how humans use their knowledge (Wattimena, 2007). The axiology of science consists of normative values in giving meaning to the truth or reality in life. Axiology as a science investigates the nature of values from a philosophical point of view (Sinensis, 2017). Aspects of axiology in chemistry, namely chemistry has useful values for human understanding so that humans will be better towards the natural environment and use various natural processes that take place in it in life. Chemistry can also be useful in the fields of health, agriculture, animal husbandry, law, biology, and other fields involving the use of materials in the needs of human life.

• CONCLUSION

Based on the explanation above, conclusions regarding philosophy as the basis of science in the development of chemistry are as follows:

1. Philosophy serves as the basis of science where through philosophy is obtained the truth which is the basis or foundation for every science, including chemistry. Thus learning something related to chemistry through knowledge (philosophy) is a step to get true and objective knowledge about chemistry.
2. Chemists and scientists agree on the basis of the development of chemistry, namely to obtain answers to the what and why questions about matter in nature, each of which will produce facts and theoretical knowledge about matter whose truth can be explained by mathematical logic.
3. The study of chemistry in its development includes aspects of ontology, epistemology, and axiology. The ontology aspect includes the chemical concept which means about the composition, structure, properties, and changes in matter and the energy that accompanies the material change. The epistemological aspect includes an understanding of chemistry which is obtained and developed based on experiments but in subsequent developments chemistry is also obtained and developed based on theory. While the axiological aspect of chemistry includes the usefulness of values for human understanding so that humans will be better at the surrounding nature and use various natural processes that take place in it to meet the needs of human life.

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