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Science Structure as A Scientific Method Concept (The Teaching of Elementary-Age Children)

Salminawati[1]✉, Titik Ningsih[2]

State Islamic University of North Sumatra Medan, Indonesia[1,2]

E-mail: salminawati@uinsu.ac.id[1], ningsihtitik139@gmail.com[2]

Abstrak

Sains merupakan pengetahuan atau sekumpulan konsepsi, prinsip, hukum, serta filosofi yang terbentuk melalui metode ilmiah (sistematis). Metode sistematis tersebut meliputi proses pengamatan dan eksperimen berkelanjutan. Penelitian ini bertujuan untuk mendeskripsikan struktur sains sebagai konsep metode ilmiah. Adapun fokusnya yakni pengajaran bagi anak usia dasar. Jenis penelitian ini ialah pendekatan kualitatif dengan metode studi kepustakaan. Sumber data dan bahan analisa berbasis referensi ilmiah dari laman kredibel, *google scholar*, *DOAJ*, dan *Sinta*. Hasil penelitian ini menunjukkan bahwa struktur ilmiah dalam pembelajaran sains membantu anak untuk berpikir sistematis dan logis dalam mengamati dan mencoba (bereksperimen) terhadap alam. Melalui penelitian ini, dipahami bahwa ada 5 (lima) unsur mengedukasi anak tentang struktur sains sebagai konsep metode ilmiah, yaitu identifikasi sasaran, format pernyataan, ragam pernyataan, fungsi pokok, dan struktur sistematik.

Kata Kunci: Anak Usia Dasar, Pengajaran, Metode Ilmiah, Struktur Sains.

Abstract

Science is knowledge or a set of conceptions, principles, laws, and philosophies that are formed through the scientific method (systematic). The systematic method includes a continuous process of observation and experimentation. This study aims to describe the structure of science as a concept of the scientific method. The focus is teaching for elementary-age children. This type of research is a qualitative approach with a literature study method. The sources of data and analysis materials were based on scientific references from credible pages, Google Scholar, DOAJ, and Sinta. The results of this study indicate that the scientific structure in science learning helps children to think systematically and logically in observing and experimenting with nature. Through this research, it is understood that there are 5 (five) elements in educating children about the structure of science as the concept of the scientific method, namely identification of targets, the format of statements, variety of statements, main functions, and systematic structures.

Keywords: *Elementary Childhood, Teaching, Scientific Method, Science Structure.*

✉ Corresponding author :

Email : salminawati@uinsu.ac.id

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INTRODUCTION

In general, people have strong desires, which are difficult to satisfy. If all needs have been met, there is a high expectation of other needs being met (Nugroho, 2016:167-177). To fulfill his wish, they made various efforts. Efforts made without awareness (no design and rare certainty) such as assumptions, trial and error, etc., are not science but only knowledge. Meanwhile, conscious efforts to control thinking procedures, namely using certain steps, such as those carried out with research and experiments, are called science (Widyatiningtyas, 2002).

Science comes from structured knowledge. Starting from the observation of the human senses, followed by conjectures or experiments, and verified as a concept. This is certainly different from knowledge that comes from mere words, such as a child who knows that the colors of the Indonesian flag are red and white. Meanwhile, knowledge of how to make flags is what is meant by the concept of science (Daniah, 2020).

In a scientist, there is a series of scientific processes and he understands the procedure for its activities. Then they created a scientific work, this became the initial basis for their findings to be recognized by other scientists. So that it brings satisfaction to the author about the process of searching for the scientific method. In the study of philosophy, science is an understanding obtained through the scientific method, consequently, scientists need to have knowledge of the scientific method and can use it as a means of making discoveries from the scientific method (Dahlan, 2009).

The science of logic is very different from the philosophy of science which introduces various ways of thinking by looking at the state of scientific subjects and objects, or the state of mind of logic as a part of it. This is the hope of the philosophy of science, which is part of a scientific discipline or as a philosophical foundation for the development of science. For more details, the structure of science and the scientific method are interrelated as a single unit (Rada, 2013:332-343).

Various facilities used by humans today, can not be separated from the product of science. For example, the concept of a simple plane in the form of pulleys and wheels that facilitate daily activities (Hikmah, 2018; Zuhaida, 2018:61-69; Fatonah & Assingkily, 2020:46-60). In addition, science is increasingly developing along with technological sophistication, so that various household appliances, offices, the industrial world, and even education use these science products as an alternative to ease of carrying out joint tasks (Fajar, 2019).

According to Kristyowati & Purwanto (2019:183-191), science and human life are very close. For this reason, science knowledge and concepts are taught from elementary age to children (elementary education level). In addition to introducing scientific concepts from an early age to children, studying science also trains children to think structured (scientific). Furthermore, balancing the concept of science is integral to mathematics lessons that hone children's logical thinking. On this basis, the structure of science is seen to be in harmony with the concept of the scientific method.

The phenomenon shows that children who master mathematics and science have intellectual intelligence above the average. This is based on the balance of the child's way of thinking in logicalizing things systematically. The study of the structure of science which is considered to be in harmony with the concept of the scientific method has been investigated from various perspectives. These include discussing aspects of the structure of science (Komariah, 2017:69-84), the scientific-based character development of children (Winarti, 2011:371-374), developing scientific attitudes through science practicum (Ulfa, 2016), philosophy of science (Nuansa, 2020:233-244; Nasution, 2016; Zulkarnain, 2019), science process skills (Murdani, 2020:72-80; Siswono, 2017:83-90), science concepts (Firman, 2019:33-36), educational applications science (Desstya, 2016:193-200), misconceptions of science learning (Ansori, 2012), scientific literacy (Mukti, 2018:318-338; Narut & Supardi, 2019:61-69; Pantiwati & Husamah, 2016), integration of science and religion (Ridwan, 2020:8-13; Fakhry, 2010:121-142), and the nature of the reality of modern science (Nurasa, 2022:181-191).

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Observing the literature review above, it is known that studies of scientific concepts and scientific methods have been studied extensively from various perspectives. Likewise, a gap analysis was found between this research and previous research, namely from the effort to examine the concept of science and scientific methods as teaching for elementary-age children. On this basis, the researcher conducted a further study of the "empty space" which was summarized in the title, "Structure of Science as a Concept of the Scientific Method (Teaching for Elementary Age Children)".

METHOD

This research examines the structure of science as a concept of the scientific method. The scope of the discussion is aimed at teaching children of primary school age. Sources of research data, which will then be analyzed, are obtained from scientific references including articles (scientific journals), books, proceedings, and final assignments (thesis, theses, dissertations) through credible search pages (Assingkily, 2021). On this basis, the research carried out includes qualitative research using the literature study method (Zed, 2008). In analyzing the data, the researcher first sorts the data according to the research topic, then the researcher analyzes the data. The method used in the analysis of this research is a descriptive-analytical method with a focus on the structure of science as the concept of the scientific method, teaching for elementary school-age children.

RESULTS AND DISCUSSION

Understanding the Structure of Science

Within an organization, the structure is a part or component of an organization, which relates to the work process and the goals to be achieved. In its operational mechanism, balanced coordination is needed, so that the relationship between the components is unbroken. As for the concept of science, of course, the working mechanism in its structure has a goal, namely a truth, true according to ratio, fundamental, and generally recognized.

In English, the word structure is structure, which means the structure of a building, and in philosophy it is structuralism. Judging from its function, it is called a knowledge system. From this definition, it can be concluded that the structure of science is a series that includes elements that are limited by the procedure of searching for reality.

The term science or science is a word that has many meanings. Thus, when using this term, it is first underlined for the point of recognizing its meaning. The meaning of science, among others:

1. In the KBBI (big Indonesian dictionary), science is a part that is systematically arranged through certain methods, which are used to explain certain phenomena.
2. According to Muliadi Kartenegara, what is meant by science is outside science, meaning that if science only focuses on the realm of physical and sensory discussions, then science will go beyond the realm of metaphysics.
3. Science, namely Education Science, which means to study and know. Science is an analytical, systematic, logical, and coherent thinking process.
4. According to the Indonesian Encyclopedia, Science is a system of different sciences, each of which is the result of research carried out carefully through certain methods.

Science is a way of compiling and systematizing common sense, namely the understanding gained through experience and observations in his life, then passed on in careful and intensive reflection in various methods.

Based on the above understanding, it can be concluded that science is a field derived from various knowledge as a result of a phenomenon that is analyzed and observed with certain methods rationally,

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systematically, logically, and consistently, can get an explanation of the symptoms mentioned. Therefore, science is concrete and unlimited, that is, its truth can be measured.

Structure of Science

The knowledge structure is a systematic set of knowledge that is arranged in related and coordinated elements so that it can form speculative principles and provide the desired explanation (Gie, 2010:139). In the philosophy of science, the most important part is the structure of science because science is a structured and complex building. Thanks to science, one can explain, predict and control all the phenomena of the world. Because the final science is to develop a complete and coherent scientific theory.

According to Gie (2010), the elements of scientific knowledge include (1) Target Form; (2) Type of Statement; (3) Kinds of Proposition; (4) Main Characteristics; and (5) Systematic Classification. Referring to the framework of ontology, epistemology, and axiology, the structure of science is:

1. Ontology is God's knowledge, both formally in the form of written texts (Qur'an and Hadith), and materially. Ontology, all ways, and frameworks of science can be accepted based on the scope of science itself.
2. Axiologically it is the implementation of God's message in living life and upholding human values, while the structure of science is very empirical.
3. Ontologically, science is the essence of being researched, limited to the presentation of visible and ongoing facts. Science is essentially free from problems beyond the five human senses. So that the involvement of God as the essence and study of science does not exist.
4. Epistemologically, science is the same procedure as science.
5. Axiologically, science is value-free, different from science that is tied to God's values embodied in religious teachings (Jamin, 2018:191).

Scientific Method

The method (process) is the most appropriate method used in making good work. The scientific method is the process of acquiring knowledge known as science. Therefore, science is an understanding obtained by the scientific method. The origin of the word method is "meta" meaning "through", and "hodos" meaning "way". The method is the technique of something obtained, done, and used.

Scientific Method is a scientific way of working. Suriasumantri (2019) argues the scientific method is the process of acquiring knowledge known as science. So, science is knowledge obtained by the scientific method. The scientific method is an expression of how the mind works. With this way of working, the knowledge produced must have its characteristics as required by science, become knowledge that makes sense, and is tested. This allows organized knowledge to be reliable knowledge. In addition, the scientific method is a process that includes various acts of thinking, working methods, processes, and technical methods that aim to gain modern knowledge and improve classical knowledge (Gie, 2010:110).

Some experts interpret the scientific method as follows, (1) Arturo Rosenblueth which states that the scientific method is one of the procedures and techniques used by all scientists in preparing and developing branches of science; and (2) Harold Titus who defines that the scientific method is the process and stages in which science acquires knowledge. From these definitions, it is concluded that the scientific method is a systematic procedure used by all scientists to solve the problems encountered in research.

Steps of the Scientific Method

In general, the steps of the scientific method start from the problem, namely formulating, making assumptions, looking for references, hypothesis testing, logical observation/induction/deduction, and sample summary or new concepts/theories. According to Suriasumantri (2019), the steps in the scientific method are: *First*, problem formulation. The formulation of the problem is a question to answer about the experimental subject with clear boundaries and the factors involved which can be determined by conducting scientific research.

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Second, develop a framework of thinking when submitting hypotheses. It is an argument that interprets the possible interweaving of the different and interdependent elements and forms a problematic set. This framework is logically structured based on the premise of scientific truth that is empirically proven and relevant to the problem. *Third*, making hypotheses. This step is a temporary answer or a form of supposition to the questions posed with the material being the conclusion of the framework of thinking developed.

Fourth, hypothesis testing. This step is a collection of facts related to the hypothesis, presented to show whether there is supporting data for the hypothesis. Next, *fifth*, draw conclusions, namely an assessment of whether the proposed hypothesis is rejected or accepted. If during the experiment there is sufficient data to support the hypothesis, then the hypothesis can be accepted. Vice versa, if during the experiment there is not enough data to support the hypothesis, then the hypothesis is rejected.

Characteristics of the Scientific Method

Characteristics of the scientific method that researchers often use in their research, including; *First*, it is critical and analytical. This scientific method must show the existence of a suitable way in order to define the problem and determine the right technique in solving the problem. Researchers have to make observations and experiments to reap proper success. *Second*, it is logical. The scientific method must be able to provide scientific and logical arguments, and the resulting conclusions must be born rationally based on reliable evidence.

Third, it is objective. Other scientists must be able to produce the scientific method with the same study in the same (identical) situation. Researchers need to ensure that their research results can be accepted by the general public, not for their consumption. *Fourth*, it is conceptual. In the scientific method, the research process must be carried out with the support of strong concepts and theories and the results can be accounted for. Then, *the fifth* is empirical. The scientific method used must be based on the truth of facts or real evidence in the field.

Forms of the Scientific Method

An article by Johnson, states that the scientific method consists of deductive and inductive methods. The deductive method consists of 3 (three) stages, namely (1) making a hypothesis, (2) collecting data to test the truth of the hypothesis, and (3) making a decision to agree or reject the hypothesis based on theory or literature research, collecting data to test the truth. hypothesis and decide whether to confirm from the two main steps. While the inductive method, the steps are (1) observing the universe, (2) looking for models in the object being observed, and (3) making generalizations from what is happening.

According to Johnson, the deductive method and the inductive method are the opposite, if the deductive scientific method begins with its concept, the inductive scientific method deviates from the facts of the universe, which ultimately leads to the conclusion of all the facts of the universe (Kuntjojo, 2009:28). Deductive is a scientific method used in quantitative research. This method uses scientific theories that are recognized as references to seek further truth.

Criteria in the Scientific Method

The criteria in the scientific method include; *First*, based on facts. The information required to be obtained from the investigation, whether collected or analyzed, must be based on facts. Do not prove based on imagination, guesswork, legend, or similar activity. *Second*, free from prejudice (allegations). The scientific method must be clean, and far from subjective considerations. The use of facts must be carried out with comprehensive and objective evidence and arguments.

Third, is the application of the principle of analysis. To find out and give meaning to these phenomena, it is necessary to use the principles of analysis. Every problem requires logical analysis to find causes and solutions, and sharp analysis to back up the facts. *Fourth*, use the hypothesis. In the scientific method, the researcher must be guided by analytical thinking procedures. For the results to be achieved to achieve the

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objectives correctly, there must be a hypothesis that guides thinking towards the final desired direction. The hypothesis is the typical handle to guide the researcher's thinking.

Fifth, use objective methods. Research and analytical work must be presented objectively. The size is not because of emotions and conscience. Assessments must be objective and reasonable. *Sixth* is the use of quantification techniques. When working with quantitative metrics, stay away from measurements such as the range over which your eye can see a cigarette. The simplest quantification is to use nominal standards and ratings.

CONCLUSION

Based on the description of the research results above, it was found that the scientific structure in learning science helps children to think systematically and logically in observing and experimenting with nature. Through this research, it is understood that there are 5 (five) elements in educating children about the structure of science as the concept of the scientific method, namely identification of targets, the format of statements, variety of statements, main functions, and systematic structures.

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