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The Influence of Understanding Science Concepts, Critical Thinking Skills, and Scientific Literacy on Scientific Attitudes Class IV Primary School Students

Tunjungsari Sekaringtyas[1], Suyono Suyono[2], Waluyo Hadi[3]

Abstract

Background: This research aims to analyze whether there is a direct or indirect influence between understanding science concepts, critical thinking skills, and scientific literacy on the scientific attitudes of elementary school students. This research is quantitative research with a survey method using path analysis techniques. The research population was elementary school students in the Pisangan Timur area, East Jakarta, totaling 134 students. Data collection was carried out through questionnaires and interviews. The results of the path coefficient calculation show that Py1 = 0.221, Py2 = 0.305, Py3 = 0.422, P21 = 0.249, P31 = 0.405, P32 = 0.305. This value is smaller than the significance level of 0.05, so H0 is rejected. Based on these results, it can be concluded that there is a direct influence between understanding science concepts, critical thinking, and scientific literacy on the scientific attitudes of elementary school students. The better the scientific attitude that students have, the better their achievements will be because they are equipped with a good understanding of concepts, critical thinking, and scientific literacy. Objective: In general, this research aims to obtain information about the influence of Understanding Natural Science Concepts, Critical Thinking, and Scientific Literacy on the Scientific Attitudes of Class IV Elementary School Students. The specific objectives to be achieved are to obtain data about 1) conceptual understanding, 2) critical thinking, 3) scientific literacy, and 4) scientific attitudes of class IV elementary school students. Based on these data, this research aims to analyze the extent to which: (1) The Direct Influence of Understanding Concepts on the Scientific Attitudes of Class IV Elementary School Students, (2) this research study, the aim is to obtain information about the influence of understanding science concepts, critical thinking, and scientific literacy on the scientific attitudes of Class IV Elementary School students. The specific objectives to be achieved are to develop data regarding 1) understanding of concepts, 2) critical thinking, 3) scientific literacy, and 4) scientific attitudes of students in class IV Elementary School. Based on the preliminary data, this research aims to analyze the following: (1) Direct influence of Concept Understanding on the Scientific Attitudes of students in class IV Elementary School, (2) Direct influence of Critical Thinking Skills on the Scientific Attitudes of students in class IV Elementary School, (3) Direct influence of Science Literacy on the Scientific Attitudes of Class IV Elementary School students, (4) Direct influence of Understanding of Concepts on Critical Thinking Ability, (5) Direct influence of Understanding of Concepts on Scientific Literacy, (6) Direct influence of Critical Thinking Ability on Scientific Literacy. Theoretical Framework: A scientific attitude is very important for students who are in the process of studying science, and who are also expected to be able to develop science in the future. A scientific attitude is also important for students because it will influence student learning achievement. Facts show that the scientific attitude of students in Indonesia is still low. One global indicator is that the average PISA score for Indonesian students in 2022 is only 383, below the international average score. Therefore, it is important to improve students' scientific attitudes. One effort to improve students' scientific attitudes is to look for factors that can significantly improve scientific attitudes. Data will be collected using valid and reliable instruments. The data analysis technique that will be used is path analysis. It is hoped that the results of this research will be useful for teachers and other stakeholders as a basis for improving the scientific attitudes of Indonesian students. The target outputs of this research are 1) scientific articles to be published in reputable international journals, and 2) intellectual property rights from the research instruments developed. Method: This research uses a quantitative approach, survey methods, and path analysis techniques. Variables in path analysis consist of exogenous variables (independent variables) and endogenous variables (dependent variables). The three independent variables are Conceptual Understanding (X1), Critical Thinking (X2), and Scientific Literacy (X3), while the dependent variable is Scientific Attitude (Y). The participants in this research were 134 students. By the research problem, research objectives, and research variables, there are four data required in this research, namely data related to Understanding Science Concepts, Critical Thinking Skills, Scientific Literacy, and Scientific Attitudes in class IV elementary school students. Data on Understanding Science Concepts, Critical Thinking, and Scientific Literacy were collected using multiple choice objective tests and essays, and data on Scientific Attitudes were collected using a questionnaire using a Likert scale. Statistical analysis in this research was carried out to understand the direct and indirect effects of variable X (Understanding of Science Concepts, Critical Thinking, and Scientific Literacy) on variable Y (Scientific Attitude) using path analysis.

[1] Universitas Negeri Jakarta, Jakarta, Indonesia. E-mail: tunjungsariSekaringtyas_9919921016@mhs.unj.ac.id.
[2] Universitas Negeri Jakarta, Jakarta, Indonesia. E-mail: suyono@unj.ac.id.
[3] Universitas Negeri Jakarta, Jakarta, Indonesia. E-mail: waluyohadi@unj.ac.id.

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Results and Discussion: It is known that there are three causal relationship structures, namely: (a) The first relationship structure, namely the variable causing Understanding of Science Concepts, Critical Thinking, and Scientific Literacy to the variable resulting from Scientific Attitude. This first relationship structure answers the first, second, and third research hypotheses, namely 1) the direct influence of Understanding Science Concepts on Scientific Attitudes, 2) the direct influence of Critical Thinking on Scientific Attitudes, 3) the direct influence of Scientific Literacy on Scientific Attitudes, (b) Structure the second relationship, namely the variable causing Understanding of Science Concepts and Critical Thinking to the variable resulting from Scientific Literacy. This second relationship structure can answer the fifth and sixth hypotheses, namely 1) the direct influence of Understanding Natural Science Concepts on Scientific Literacy, 2) The direct influence of Critical Thinking on Scientific Literacy, (c) The third relationship structure, namely the causal variable of Understanding Natural Science Concepts on the Thinking variable. Critical. This third relationship structure can answer the fourth hypothesis, namely the influence of Understanding Science Concepts on Critical Thinking. It is important to know that this research has limitations, namely that educators still pay attention to the aspects of students in their learning process at school. Research Implications: Found a direct influence on understanding science concepts, critical thinking, and scientific literacy on scientific attitudes. Therefore, there are research implications that are explained, such as the influence of the independent variables, namely Understanding Science Concepts, Critical Thinking, and Scientific Literacy, which have been proven to be true. Each of these three variables can be used as a determinant of Scientific Attitude. The three determining factors, namely Understanding Natural Science Concepts, Critical Thinking, and Scientific Literacy, are the determining factors in Scientific Attitude and have been tested in this research. It is hoped that the results of this research can be used as a reference for relevant research in the future, especially those related to the formation of students' scientific attitudes in elementary schools. Originality/Value: Students who have a good understanding of science concepts can form good scientific attitudes as well. Students are also required to have good critical thinking skills to be able to form a good scientific attitude because one of the characteristics of someone who has a good scientific attitude is when that person has good critical thinking skills too, critical thinking skills will stimulate Students' cognitive reasoning in acquiring knowledge, critical thinking is also an aspect that needs to be developed in 21st-century learning. Good critical thinking skills will develop a good scientific attitude, students are expected to be able to be sensitive to the environment around them. Next, it is important to see how much scientific literacy students have. The ability of students to recognize appropriate and related knowledge, the breadth of information related to the knowledge in question, and the teaching and reading materials used by students in learning. This situation will greatly influence the formation of students' scientific attitudes.

Keywords: *Understanding science concepts, critical thinking, scientific literacy, scientific attitude, elementary school.*

Introduction

A scientific attitude is shown by scientists in developing science. The characteristics of a scientific attitude include having a curious, critical, open, objective attitude, respecting other people's work, having the courage to defend the truth, not easily giving up, being persistent, etc., for example, Gega [1], Harlen [2], AAAS [3], and Ministry of Education and Culture [4]. A scientific attitude needs to be possessed by students who are in the process of studying science, and who in the future are expected to be able to develop science. A scientific attitude is also important for students because it will influence student learning achievement [5]. The scientific attitude possessed by students will encourage them to be more interested and involved in learning, especially science learning so that their understanding of science concepts will also be better [6].

Conditions in the field show that in general, the scientific attitude of students in Indonesia is still low. One macro indicator of students' low scientific attitudes is the PISA (Program for International Student Assessment) score. In 2022 Indonesian students obtained a score of 383, below the international average score, and specifically in the field of science 35% of Indonesian students are still in the level 1a competency group (using general language and procedural knowledge) and 17% are even at a lower level. This fact is in line with micro indicators, for example, based on the results of observations made on State Elementary School students in the East Pisangan area, East Jakarta at the beginning of 2023, that students' enthusiasm for obtaining solutions to problems was low, they were not confident, and they were less able to answer systematically.

Efforts have been and will continue to be made to improve students' scientific attitudes. In terms of policy, the newest curriculum currently being implemented in Indonesia is the Merdeka Curriculum, one of the characteristics of which is that it emphasizes project-based learning [7]. At school, teachers have also made efforts to overcome students' low scientific attitudes, such as using interactive learning media and participating in learning innovation training, but the results have not been significant enough.

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Supporting the efforts made by the Government and teachers to improve students' scientific attitudes, it is important to know the factors that can significantly influence students' scientific attitudes. From the literature review that has been carried out, the following are several research results related to scientific attitudes and related variables. The formation of a scientific attitude begins with students' high curiosity about the subject matter [8]. Science learning trains students' critical thinking skills [9]. Students who have a good scientific attitude will be able to find out what they have discovered and what is not yet known [10]. Scientific attitudes need to be improved through students' internal factors, see for example Rahmat [6], Julimah et al [5], Hatibe [8], and Febryana [11]. Through science learning, students can discover concepts and build them into cognitive structures [12] as stated by Jones [13], Imek [14], Bidegain [15], and Tasdemir [16].

After further studies were carried out by researchers, scientific attitudes also needed to be improved internally among students. Internal factors that need to be observed include whether students have a good understanding of science concepts so they can form a good scientific attitude. Apart from that, from the aspect of students' thinking skills, students are also required to have good critical thinking competencies to be able to form a good scientific attitude too, because one of the characteristics of someone who has a good scientific attitude is when that person has good critical thinking skills. Also, good, critical thinking skills will stimulate students' cognitive reasoning in gaining knowledge, critical thinking is also an aspect that needs to be developed in 21st-century learning. Good critical thinking skills will develop good scientific attitudes, students are expected to be able to be sensitive to the surrounding environment. Next, it is important to see how much scientific literacy students have. The ability of students to recognize appropriate and related knowledge, the breadth of information related to the knowledge in question, and the teaching and reading materials used by students in learning. This situation will greatly influence the formation of students' scientific attitudes.

In line with this, Rahmat (2015) in his research shows that partially there is a significant and positive influence between scientific attitudes on understanding science concepts. This can happen because students who have a good scientific attitude will be more enthusiastic about participating in the learning process, so they can produce a good understanding of learning. The scientific attitude possessed by students can encourage them to be more interested and involved in learning science so that their understanding of science concepts will also be better [6]. Thus, through learning science students can discover concepts and build them into their cognitive structures so that a good understanding of science concepts is formed.

Furthermore, some things can influence the quality of students' internal scientific attitudes, one of which is students' critical thinking abilities. Based on research conducted by Julimah et al, it is said that scientific attitudes can be improved by creating a learning process that enables students to explore and improve their scientific attitudes. Students who have a high scientific attitude will find it easier to master and explain the material to their group friends, teachers, and other groups and tend to have high affective dimension learning achievements and complex thinking abilities such as critical thinking abilities [5].

A Pancasila student is expected to have character and competence, including critical and creative reasoning. Critical reasoning skills are needed for students to solve problems. In schools, critical reasoning skills are an important aspect to be taught, instilled, and developed so that students can face various problems that occur around them well, skillfully, and critically. In the Pancasila Student Profile, the critical reasoning dimension has several benefits, one of which is that it can improve critical thinking skills. Individuals who think critically will be accustomed to analyzing, synthesizing, and making decisions on a logical basis based on all the information they receive. Students who reason critically have the ability to think objectively, logically, and systematically. Students will be better able to identify problems, analyze information, evaluate arguments, and make the right decisions. They will think about everything from various points of view before finally making a decision rationally [17].

Apart from that, the third variable is scientific literacy. Scientific literacy supports students in creating their procedures based on the investigations that students carry out. Scientific literacy emphasizes how students use the knowledge they have in creating new ideas, and new concepts in addressing a problem scientifically [18].

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Research conducted by Eka Febryana also found that, according to her, students who have good scientific literacy skills will grow their skills in solving problems, armed with knowledge, understanding, and good thinking skills, and they will respond to problems well and wisely as a form of skill. life [11].

Referring to relevant previous research results, researchers are interested in conducting research on the influence, both direct and indirect, of understanding science concepts, critical thinking skills, and scientific literacy on elementary school students' scientific attitudes. In this research, the relationship between understanding science concepts, critical thinking skills and scientific literacy will also be further analyzed.

Theoretical Framework

Scientific Attitude

Developing students' attitudes towards science is known as scientific attitude. A scientific attitude is an attitude or values that arise from within oneself that encourage a person to behave towards an object which is carried out systematically through scientific steps. Scientific attitudes need to be cultivated since elementary school so that in the future they will become Indonesian people with good attitudes. A scientific attitude is a manifestation of the character values that have been developed in learning. This scientific attitude will directly influence the character concerned [19].

According to the National Curriculum Council (NCC) in Bundu (2016), a scientific attitude is a very important attitude to have at the level of science education, namely the desire to know, appreciate reality, critical attitude, careful attitude, diligence, tenacious, steadfast, creative for discovery. new, open-minded, and collaborative with other people [20].

According to Usman Samatowa (2016), the scientific attitude that needs to be trained in our country is the ability to respect other people and students' courage to answer questions, ask questions, and discuss [12]. Patta Bundhu (2006) suggests that there are at least four types of attitudes that are necessary and relevant to elementary school students, namely: (a) attitudes towards work at school, (b) attitudes towards themselves as students, (c) attitudes towards science, especially science, and (d) attitudes towards objects and events in the surrounding environment. These four attitudes will form a scientific attitude that influences a person's desire to participate in certain activities and the way a person responds to other people, objects, or certain events [20].

Winney Harlen in Sole (2017) states that there are at least nine aspects of scientific attitudes that can be developed in elementary school-age students, including an attitude of curiosity, an attitude of wanting to get something new (originality), and an attitude of cooperation. (cooperation), an attitude of not giving up (perseverance), an attitude of not being prejudiced (open-minded), an introspective attitude (self-criticism), an attitude of responsibility (responsibility), an attitude of free thinking (independence in thinking), an attitude of self-discipline (self-discipline) [21].

Based on studies according to Samatowa and Bundu, the most important scientific attitudes trained in Indonesia are related to respecting other people's opinions and training courage in students, attitudes towards work at school, their attitudes as students, attitudes towards science, especially natural sciences, and attitudes towards objects that occur in the surrounding environment from several aspects, so to measure scientific attitudes in students in this research we will use the attitude scale test created by Barry J. Fraser, namely the Test of Science-Related Attitudes (TOSRA) which was created in 1976. TOSRA is an attitude scale test related to science, namely scientific attitudes. There are seven dimensions of scientific attitude contained in TOSRA and by the opinions of Samatowa and Bundu, namely social implications of science (social implications of science), normality of scientists (normality of teachers), attitude to scientific inquiry (attitude towards inquiry in science), adoption of scientific attitudes (adaptation of scientific attitudes), enjoyment of science lessons (enjoyment in learning science), leisure interest in science (interest in increasing time studying science), and career interest in science (interest in a career in science) [22].

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Marylin in John's book. W. Santrock said, "Conceptual understanding is a key aspect of learning. An important teaching goal is to help students understand the main concepts in a subject rather than just memorize isolated facts. In many cases, conceptual understanding is enhanced when teachers explore a topic in-depth and give appropriate, interesting examples of the concepts involved. As you will see, concepts are the building blocks of thinking. Concepts also aid the process of remembering, making it more efficient" [23].

According to Marylin, understanding concepts is the key to learning. Understanding concepts aims to help students understand the main concepts of what they are studying, not just knowing the facts.

The indicators that show a good understanding of concepts according to Kenneth D. Moore include: restating a concept; classifying objects according to certain properties (according to the concept); providing examples and non-examples of the concept; presenting concepts in various forms of mathematical representation; developing necessary or sufficient conditions for a concept; using, utilizing, and selecting particular procedures or operations; and applying problem-solving concepts or algorithms [24].

Killpatrick and Findell explain that conceptual understanding is the ability of students to receive, absorb and understand material or information obtained through a series of events or occurrences that can be seen directly or heard which are stored in the mind and can later be applied in everyday life [25].

As for the stages of indicators that need to be considered for understanding concepts that are appropriate for fourth-grade elementary school students according to Anderson and Karthwohl, the levels of the cognitive process of understanding based on Bloom's theory are categorized into 7 indicators of concept understanding, namely interpreting, exemplifying, classifying, summarizing, concluding, comparing and explaining [26].

Permendiknas year no. 22 of 2006 is to develop knowledge and scientific concepts that will be useful and can be applied in everyday life. Understanding and using science concepts in everyday life and simple technology is the goal of education [27].

The view above shows that science learning in elementary schools teaches students about scientific understanding of science. Therefore, there are several stages in gaining an understanding of science concepts for class IV students, including interpreting, exemplifying, classifying, summarizing, comparing, and explaining. [28].

The Educational Standards, Curriculum, and Assessment Agency of the Ministry of Education and Culture said that science lessons in elementary schools aim for students to have the following abilities: develop curiosity and a positive attitude towards science, technology, and society, develop process skills to investigate the natural environment, solve problems and make decisions, develop knowledge and understanding of science concepts that will be useful and can be applied in everyday life, develop awareness of the role and importance of science in everyday life, transfer knowledge, skills and understanding to other areas of teaching, participate in maintaining, maintaining and preserving the natural environment, appreciating the various forms of God's creation in this universe for study [29].

Science learning is essentially learning that teaches students facts, concepts, and theories relating to the universe. Understanding science concepts is an important aspect of science learning that every student needs to have because the science concepts are already possessed by understanding the next concept. This is because understanding science concepts is interrelated with each other, both within lesson content and between lesson content [30].

Based on the opinion of several experts, understanding the concept of science is the ability of students to receive, absorb, and understand material or information related to science which is obtained through a series of incidents or incidents that can be seen directly or heard which are stored in the mind which can

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later be applied in life. daily indicators with interpreting, exemplifying, classifying, summarizing, comparing, and explaining.

Critical Thinking Skills

Students need to be encouraged to work to solve problems, find things for themselves, and work hard to realize their ideas. Based on the mandate of the Minister of Education and Culture Regulation, one of the steps that can be taken is to implement appropriate learning models for 21st-century education. One of the thinking skills in the 21st century is critical thinking skills; this is needed by students for the learning process and later to be applied in everyday life.

Critical thinking is the cognitive process of students in systematically and specifically analyzing the problems they face, distinguishing these problems carefully and thoroughly, and identifying and reviewing information to plan problem-solving strategies [31].

Indonesian students' critical thinking skills are still low. The results of the 2018 Trends in International Mathematics and Science Study (TIMSS) show that the mathematics scores of Indonesian students are ranked 45th out of 50 countries. The ability of Indonesian students to work on questions in the reasoning domain also shows that their abilities are still very minimal [32]. Critical thinking ability is one component of life skills that are developed through the learning process. Through the critical thinking process, a student can develop the skills to explore and evaluate information, the ability to consider the decisions and actions he takes, as well as the skills to analyze and solve problems faced in everyday life [33].

The stages of development of critical thinking according to Richard Paul are starting from unreflective thinkers, they are people who do not reflect on their thoughts and their impact on their lives, the opinions they form are still based on prejudice and misunderstanding, while their thinking does not improve. Thinkers at the next level are challenged thinkers, they realize the importance of thinking to their existence and know that deficiencies in thinking can cause big problems, they know that their thinking has blind spots and other problems and then they take steps to overcome them, but in limited capacity. The next stage is the novice thinker, novice thinkers appreciate reason more, become self-aware in their thinking, and can accept criticism of their mental approach. The next thinker is the practicing thinker, this thinker is more experienced and not only appreciates his shortcomings but also has the skills to overcome them. The trait that must be acquired at this stage is intellectual perseverance which provides the impetus to develop realistic plans for systematic practice. The next stage of thinking is advanced thinking, advanced thinkers feel comfortable with self-criticism and do it systematically to improve, the main characteristics are already having intellectual insight to develop new thinking habits, intellectual integrity to recognize areas of inconsistency and contradiction in one's life, intellectual empathy to put oneself in someone else's position to truly understand them and intellectual courage to face ideas and beliefs that they don't necessarily believe in and have negative emotions towards them. The last stage of thinking is the stage of great thinkers, they are super thinkers by controlling their ways. process information and make decisions and can demonstrate superior practical knowledge and insight, always re-examining their assumptions for weaknesses, logic, and bias [34].

According to research conducted by Utama (2020), critical thinking skills are classified as high-order thinking skills, or HOTS for short. HOTS is then used to solve and instill science concepts so that student learning outcomes increase. Embedding the HOTS context within the scope of critical thinking helps students to achieve the science assessment criteria in the form of products, processes, applications, and attitudes in depth. This opinion is reinforced by Stobaugh in primary research which explains that critical thinking is thinking that is deeply reflective in decision-making and problem-solving to analyze situations, evaluate arguments, and draw appropriate conclusions [35].

Azizah stated that critical thinking is very important in the learning process. There are two phases in this process, namely first, students build their minds in the form of basic ideas, principles, and theories inherent in the content. This phase is called internalization. The second phase occurs when students effectively use these ideas, principles, or theories in life as a form of application. Meanwhile, several characteristics of

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students who can think critically are explained as follows: (1) the ability to understand the logical relationship between ideas, (2) able to formulate ideas concisely and precisely, (3) the ability to identify, build and evaluate arguments, (4) able to evaluate decisions, (5) able to evaluate evidence and able to hypothesize, (6) able to detect inconsistencies and common errors in reasoning, (7) able to analyze problems systematically; (8) being able to identify the relevance and importance of ideas, (9) being able to assess a person's beliefs and values, and (10) being able to evaluate a person's thinking abilities [31].

So, from the opinion of experts, what is meant by critical thinking skills for fourth-grade elementary school students is an impression or view of an organized process that allows students to evaluate the evidence, assumptions, logic, and language underlying other people's statements to achieve a deep understanding. The indicators are as follows: (1) being able to identify a problem, (2) having the ability to evaluate, (3) being able to provide a solution based on a problem, (4) being able to conclude, and (5) being able to express an opinion.

Scientific Literacy

The 21st century is marked by the rapid development of science and technology in the fields of life in society, especially information and communication technology. The vision of 21st-century education which is based more on the learning paradigm is learning to think which is oriented towards logical and rational knowledge, learning to act which is oriented towards how to solve problems, learning to be independent which is oriented towards building character, and learning to live together which is oriented towards being tolerant and ready to collaborate [36].

Providing quality science education will have an impact on a country's development achievements. Science education depends on the learning used in each country. Through science education, students can be involved in the impact of science in everyday life and the role of students in society. Students who know how to understand scientific facts and the relationship between science, technology, and society, and can apply their knowledge to solve problems in real life are called scientifically literate citizens [37].

Scientific literacy views the importance of thinking and acting skills which involve reviewing thinking and using scientific thinking in recognizing and responding to social issues. Scientific literacy is important for students to understand the environment, health, economics, modern society, and technology [37].

Paul Dehart Hurd in his book says, "Competencies required by citizens to think rationally about science in terms of personal economic, social, political, and problems that a person may encounter throughout life [38]".

According to Hurd, people are required to think rationally about science in all fields of science and see how society solves problems in their lives. Competencies are necessary for citizens to think rationally about science about personal, social, political, and economic issues and problems that a person may encounter throughout life. The concept of scientific literacy, which began to be developed in 1958, continues to adapt to changes in society, including the emergence of the information age, the birth of the global economy, and the online world [39].

Table 1. ***Indonesian Students' Science Literacy Data 2000-2018 [40]***

Year	2000	2003	2006	2009	2012	2015	2018
Scor	393	395	393	383	382	403	396
Rank	38/41	38/41	50/57	57/65	64/65	62/72	70/78

In PISA 2015, students' scientific literacy scores experienced a slight increase from 382 in 2012 to 403 in 2015 while placing Indonesia at number 62 out of 72 participating countries. Meanwhile, in PISA in 2018, students' scientific literacy scores again decreased to 396, 70th out of 78 participating countries.

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According to Pertiwi (2018), scientific literacy is categorized into three dimensions, namely content (science knowledge), process (science competency), and context (science application). Science content refers to the key concepts from science that are necessary to understand natural phenomena and the changes made to nature through human activities. The process dimension includes the science competency component. There are three focuses of assessment in the dimensions of the scientific literacy process, namely including activities to identify scientific questions, explain phenomena scientifically and use scientific evidence, while context is the application area of scientific concepts [41].

Scientific literacy assessment assesses students' understanding of science content (functional literacy/application of concepts), science processes (civic literacy), and the context of science application (cultural literacy). Content in scientific literacy includes material contained in the curriculum and material that is cross-curricular with an emphasis on understanding concepts and the ability to use them in life. The scientific process refers to the mental processes involved when students solve problems. In another case, context is the application area of scientific concepts. According to this view, scientific assessment is not merely a measurement of the level of understanding of scientific knowledge but also an understanding of various aspects of the scientific process and the ability to apply scientific knowledge and processes in real situations. students, this means that scientific literacy assessment is not only oriented toward mastering science material but also towards mastering life skills, thinking abilities, and the ability to carry out scientific processes in students' real lives [42].

After explaining several related theories above, it can be concluded that scientific literacy is the ability of students to think scientifically by using knowledge and scientific processes to understand the world. The indicators used are explaining scientific phenomena, evaluating and designing scientific investigations, and interpreting data and evidence scientifically.

Class IV Primary School Students

Several characteristics of the development of elementary school-age children must be known to develop learning that suits the needs of elementary school students. Elementary school students are children who often experience drastic changes both physically and mentally. In general, elementary school-age children range in age from 6-12 years. So, various forms of development occur. However, there are three main developments, namely physical development, cognitive development, and psychosocial development.

In general, elementary school-age children are in phase; 1) enjoy playing, and a lot of lesson material is designed in the form of games, especially for lower grade ages (1-3) which are found in the play zone. 2) Elementary school-aged children like to move, 3) Elementary school-aged children enjoy group activities, 4) Elementary school-aged children enjoy doing direct practice, according to their stage of development elementary school-aged children enjoy doing new things, especially in experimental or practicum activities, because it is when conducting experiments that elementary school age children gain direct learning experience, so classical learning does not need to be given during evaluation [43].

Elementary school students' cognitive development can include changes that occur in elementary school students' thinking patterns. The cognitive expert, Piaget in Zulherma stated that there are four cognitive phases experienced by humans, namely: the sensory phase. This phase is in the range of 0-2 years. In this phase, newborn babies have several innate reflexes that encourage them to explore their world. Pre-operational phase. This phase is in the range of 2-7 years. In this phase, students learn to be able to represent and use objects through words or pictures of things. Concrete operational phase. This phase is in the age range of 7-11 years. In this phase, students can use logic. At this stage, students learn to understand things logically using the help of concrete objects. It is in this phase that elementary school students are. So, a learning process using logic through concrete objects is needed. Formal operational phase. This phase is in the age range of 12-15 years. In this phase the ability to think abstractly. Apart from that, students at this time can reason logically and can conclude from the information presented [44].

The next stage is psychosocial development which is closely related to the development and changes in students' emotions [45]. J. Havighurst (1953) stated that the development of student aspects must be in

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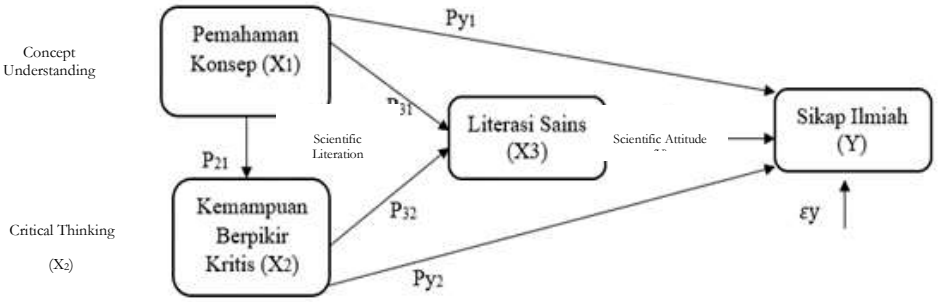
line, including psychological, social, and moral aspects. Students before entering school have been able to develop the ability to think in action and social influence. In the early days of school, students are still egocentric towards themselves and their environment. This means that students at this time are still focused on themselves, and things related to their environment such as their family, home, and kindergarten. After students enter the lower classes in elementary school, students begin to show self-confidence, and some can show low self-esteem. In this phase, students will show that they are mature people. Students will feel that they will be able to do the assignments themselves. So, this stage is also known as the "I can do it myself" stage.

Methodology

In general, this research aims to obtain information about the influence of understanding science concepts, critical thinking, and scientific literacy on the scientific attitudes of Class IV elementary school students. The specific objectives to be achieved are to obtain data about 1) conceptual understanding, 2) critical thinking, 3) scientific literacy, and 4) scientific attitudes of class IV elementary school students. This research was conducted at SDN Pisangan Timur 11 and Pisangan Timur 18, East Jakarta in November 2024.

This research uses a quantitative approach, survey methods, and path analysis techniques. Variables in path analysis consist of exogenous variables (independent variables) and endogenous variables (dependent variables). The three independent variables are Conceptual Understanding (X_1), Critical Thinking (X_2), and Scientific Literacy (X_3), while the dependent variable is Scientific Attitude (Y). Based on theory, the relationship pattern between variables is presented as follows:

Picture 1. ***Theoretical Framework for Path Analysis of Research Variables***



The population in this study were Class IV elementary school students for the 2023/2024 academic year at SDN Pisangan Timur. Student samples were taken using cluster random sampling, which is a population divided by region or cluster with a total sample of 134 students.

By the research problem, research objectives, and research variables, there are four data required in this research, namely data related to Understanding Science Concepts, Critical Thinking Skills, Scientific Literacy, and Scientific Attitudes in class IV elementary school students. Data on Understanding Science Concepts, Critical Thinking, and Scientific Literacy were collected using multiple choice objective tests and essays, and data on Scientific Attitudes were collected using a questionnaire using a Likert scale.

Statistical analysis in this research was carried out to test the proposed research hypothesis. To determine the direct and indirect influence of variable

Journal of Ecohumanism
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Volume: 3, No: 8, pp. 6230 – 6247
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Results and Discussion

Results

Path Coefficient in the First Relationship

To obtain the path coefficient, a linear regression analysis was carried out with the independent variables Understanding Science Concepts, Critical Thinking, and Science Literacy with the dependent variable being Scientific Attitude. The following are the results of the first relationship structure regression analysis:

Table 2. Results of the First Relationship Structure Regression Analysis

N	Model Constant	Standardized Coefficients Beta	Sig.
1	Concept Understanding	,221	,001
2	Critical Thinking	,305	,000
3	Scientific Literacy	,422	,000

From Table 2, the path coefficients P_{y1}= 0.221, P_{y2}= 0.305, and P_{y3}= 0.422 are obtained. Based on the results of the variance analysis in Table 2 for the first relationship structure regression model, a significant value of 0.000 was obtained, which is smaller than the significance level of 0.05, so it can be concluded that Understanding Science Concepts, Critical Thinking, and Scientific Literacy have a significant effect together on the Scientific Attitude variable.

Path Coefficient in the Second Relationship

The regression model on the second relationship structure is built through the composition of the causal variables, namely Understanding Science Concepts and Critical Thinking, while the resulting variable is Scientific Literacy. The second relationship structure analysis answers the fifth and sixth research hypotheses, namely 1) the direct influence of understanding science concepts on scientific literacy, and 2) the direct influence of critical thinking on scientific literacy. The following are the results of the regression analysis of the second relationship structure:

Table 3. Results of the Second Relationship Structure Regression Analysis

N	Model Constant	Standardized Coefficients Beta	Sig.
1	Concept Understanding	,405	,000
2	Critical Thingking	,305	,000

From Table 3, the path coefficients P_{31} = 0.405 and P_{32} = 0.305 are obtained. Thus, it can be said that there is sufficient evidence to say that the structure of the relationship between the two variables Understanding Science Concepts and Scientific Literacy together has a significant effect on the Science Literacy variable.

Path Coefficient in the Third Relationship

The regression model on the third relationship structure is built through the composition of the causal variable, namely Understanding Science Concepts, while the resulting variable is Scientific Literacy. Analysis of the relationship structure answers the sixth research hypothesis, namely the influence of understanding science concepts on scientific attitudes. The following are the results of the third relationship structure regression analysis:

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 6230 – 6247
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
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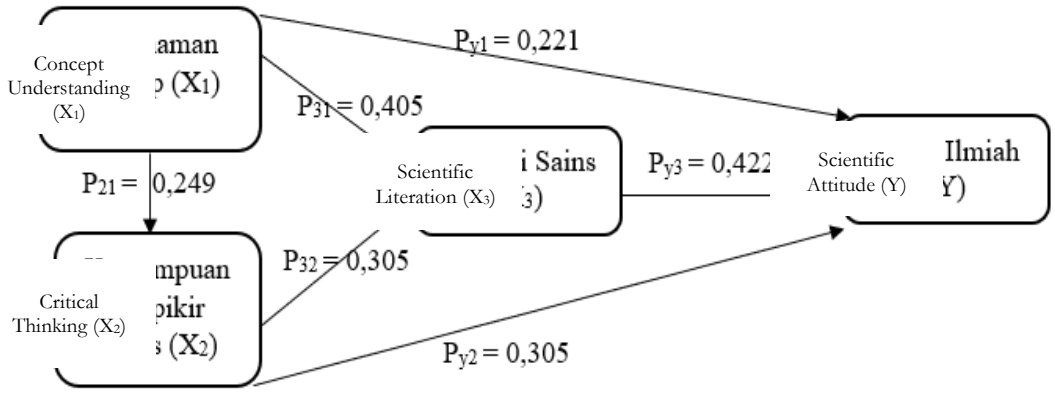
Table 4. Results of the Third Relationship Structure Regression Analysis

N	Model Constant	Standardized Coefficients Beta	Sig.
1	Concept Understanding	,249	,004

From Table 4, the path coefficient P_{21} = 0.249. From Table 4, because the significant value of 0.004 is smaller than the significance level of $\alpha = 0.05$, H_0 is rejected. The conclusion is that there is a direct influence of understanding science concepts on scientific literacy.

After carrying out calculations using path analysis, the results of the path coefficient calculation are presented in the following figure:

Picture 2. ***Correlation Results Between Variables***



Based on the explanation above, below are summarized the six proposed research hypotheses, namely that there is 1) a positive direct influence of Understanding Science Concepts on Scientific Attitudes, 2) a significant negative influence of Critical Thinking on Scientific Attitudes, 3) a positive direct influence of Scientific Literacy on Scientific Attitudes, 4) significant positive influence of understanding science concepts on critical thinking, 5) significant positive influence of scientific literacy on critical thinking, 6) positive direct influence of understanding science concepts on scientific literacy.

Discussion

The results of the correlational analysis show that between the variables, either individually or together, Understanding Science Concepts, Critical Thinking, and Scientific Literacy have a positive influence on Scientific Attitudes. This positive influence means that understanding science concepts, critical thinking and scientific literacy goes hand in hand with scientific attitudes, in other words increasing understanding of science concepts, critical thinking, and scientific literacy is followed by increasing scientific attitudes. This influence also means that scientific attitudes can be traced, explained, or even predicted by understanding scientific concepts, critical thinking, and scientific literacy.

The Influence of Understanding Natural Science Concepts on Scientific Attitudes

The understanding of science concepts possessed by fourth grade elementary school students is a learning process that is obtained by receiving and understanding the information obtained during science learning and can be seen from the ability to behave, think and act as provisions to be applied in everyday life. form a series of scientific attitudes. Several indicators of understanding of science concepts used in this research include interpreting, exemplifying, classifying, summarizing, comparing, and explaining.

Journal of Ecohumanism
2024
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https://ecohumanism.co.uk/joe/ecohumanism
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Science learning is essentially learning that teaches students facts, concepts and theories relating to the universe. Understanding science concepts is an important aspect in science learning that every student needs to have, because the science concepts are already possessed by understanding the next concept. This is because understanding science concepts is interconnected with each other, both within lesson content and between lesson content.

Through science learning, students are provided with a series of processes for solving problems using scientific methods. Science learning is related to how to find out about natural phenomena systematically, so science learning is an experiential process that produces knowledge in the form of understanding concepts. In the context of science learning, it is not much different from the concept of learning in other subjects, only the emphasis must be by the nature of science itself, that science learning must occur in a scientific process, producing scientific products by conducting experiments/experiments and forming a scientific attitude [46].

A scientific attitude is a manifestation of the character values that have been developed in learning. This scientific attitude will directly influence the character of the person concerned. A scientific attitude is an attitude or values that arise from within oneself that encourage a person to behave towards an object which is carried out systematically through scientific steps. A scientific attitude consists of several parts such as an attitude of curiosity, an attitude of discovery, thoroughness, and perseverance. Scientific attitudes relate to a person's disposition towards research or scientific activities and refer to the attitudes required to explore or understand natural phenomena.

Students who have a good understanding of science concepts will be able to give examples, interpret, compare, explain, and draw conclusions, and will also have a good scientific attitude. Because a good understanding of science concepts can help solve the science problems they face. This means that the problem-solving ability possessed is a manifestation of the formation of a good scientific attitude.

The Influence of Critical Thinking on Scientific Attitudes

Science in elementary school is learning that does not require the ability to remember but requires a lot of practice to be able to develop healthy and reasonable thinking skills by scientific methods and to be able to develop curiosity, a positive attitude, thoroughness, and critical thinking. Through science learning, students can find problems from the discovery process, therefore answering questions requires thinking skills, one of which is the ability to think critically. The critical thinking skills possessed by students make them able to make the right decisions because students are used to thinking critically, which means being able to think about and solve problems [47].

Critical thinking skills need to be possessed because they play a role in stimulating students' cognitive reasoning in acquiring knowledge. Critical thinking is very necessary at this time because, during the learning process, students develop ideas for thinking about the problems needed during learning. Moreover, critical thinking skills are one of the aspects that must be developed in 21st-century learning, namely 4C (critical thinking, collaboration, communication, and creativity) [48].

For elementary school students, critical thinking is not as complex as critical thinking contexts for teenagers or adults. This is because elementary school children's thinking abilities are still at the concrete operational stage according to Piaget's theory of development. So, critical thinking for fourth-grade elementary school students is an impression or view of an organized process that allows students to evaluate the evidence, assumptions, logic, and language underlying other people's statements to achieve a deep understanding. The indicators are as follows: (1) being able to identify a problem, (2) having the ability to evaluate, (3) being able to provide solutions based on a problem, (4) being able to conclude, and (5) being able to express opinions.

Of the five indicators, if students are accustomed to solving problems using the stages above, students will be more often involved in finding alternative answers scientifically, able to solve problems using scientific methods, and able to find the right solution to the problem they are facing. given. This will tend to form a

Journal of Ecohumanism
2024
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https://ecohumanism.co.uk/joe/ecohumanism
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good scientific attitude in students because students have been trained on how to solve problems critically, precisely, and correctly based on the scientific stages that have been given. This is the opinion expressed by Husni Mubarok in his research which states that critical thinking is very important in elementary school learning so that students get used to using reasoning skills to solve problems faced by students. Students who are accustomed to using their critical thinking skills will form a deep attitude to face a problem by using experience and evidence from the scientific process so that they will form a mature scientific attitude in students and the scientific attitude they have will become a provision in real life processes [49].

The Influence of Scientific Literacy on Scientific Attitudes

Entering the 21st century, human resources are also needed who have four competencies, namely literacy, innovative thinking, effective communication, and high productivity. This means that from these four competencies, it turns out that students need approximately 16 skills to be able to survive and compete in the 21st century, including basic literacy, competency, and character. Scientific literacy is one of the skills in question. Scientific literacy referred to in this research is the ability of elementary school students when involved with scientific issues and ideas, to understand scientific interactions, and societal technology, which consists of four interrelated aspects, namely context, knowledge, competence, and attitude. Scientific literacy possessed by students is in the form of scientific knowledge and skills to be able to identify questions, obtain new knowledge, explain scientific phenomena, draw conclusions based on facts that occur, be able to understand the characteristics of science, and be aware of how science and technology can shape the natural environment and culture. , intellectual, and the latter cares about issues related to science [50].

Elementary school students need to have scientific literacy because scientific literacy has the function of understanding the environment, health, economics, and other problems faced by modern society which depends on technology and responds to developments in natural science. Scientific literacy plays a role in improving decision-making, at the social and personal level. The scope of scientific literacy is in the form of products (knowledge), process skills (psychomotor), and aspects of scientific attitude (affective).

Students who have good scientific literacy skills will be able to maintain their knowledge when seeking out new knowledge. This means that students who have mastered scientific literacy well are fully aware that when using their knowledge, especially scientific knowledge, it begins with identifying problems, being able to explain scientific phenomena systematically, and being able to draw conclusions based on evidence related to scientific issues. This process will shape someone to have a good scientific attitude, such as from problem identification activities, students will tend to have a high curiosity, be honest, and be open. Then, from the process of explaining scientific phenomena based on the identification results obtained, students will be directed to form an objective, responsible, and diligent attitude. After being able to explain scientific phenomena, students are also able to draw conclusions based on evidence related to scientific issues. Indirectly, this activity of concluding will form an attitude of being careful, careful, not hasty in concluding and not easily giving up [51]. Based on the attitudes that emerge, such as curiosity, honesty, openness, objectiveness, responsibility, perseverance, thoroughness, caution, not being in a hurry and not giving up easily, these are all scientific attitudes that have been formed from a series of learning processes that have been undertaken. Thus, students who have good scientific literacy skills will develop good scientific attitudes as well.

The Influence of Understanding Natural Science Concepts on Critical Thinking

The aim of education that we need to know is to facilitate students to achieve an understanding that can be expressed verbally using a positive thinking framework [52]. Understanding itself can be abstracted as a basis for obtaining ways to solve problems, think creatively and critically, as well as in decision-making. Bloom said the ability to understand is at a higher level than remembering, and all efforts involving brain activity are included in the cognitive domain, and understanding is one part of the cognitive domain [53]. Meanwhile, a concept is a value that is embedded and contained in a material or object. If students master a concept, the results will be better if it is accompanied by understanding. A concept can also be interpreted as an understanding of an assessment whose process has gone through human thought or logic which can

Journal of Ecohumanism
2024
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be gathered using concepts so that it becomes a complete unit of information in forming an understanding [54]. So, it can be interpreted that understanding concepts is a condition that can be seen in students when students can explain the concepts, they have studied using their language, students can provide examples and non-examples of concepts and students can conclude a concept without there being a certain image or symbol.

Understanding concepts has the aim of helping students understand the main concepts of what they are studying, not just knowing the facts. Understanding concepts is the basis for problem-solving. In science learning, the goal cannot be separated from being a reference for pursuing science learning in elementary schools. One of them is science learning which aims to develop knowledge and understanding of science concepts. This is in line with the objectives of science learning in elementary school according to BSNP (2006: 162), including:

"…. develop knowledge and understanding of science concepts that are useful and can be applied in everyday life, increase awareness to participate in maintaining, protect and preserve the natural environment, increase awareness to participate in maintaining, protect and preserve the natural environment, increasing awareness to respect nature and all its order as one of God's creations."

Based on the objectives of BSNP, science learning is directed at developing an understanding of science concepts in everyday life. Understanding is one of the factors that determines the success of learning. Understanding is an advanced level in the cognitive domain of teaching objectives that is higher than knowing or memorizing [55].

Therefore, learning to understand concepts is learning that is used to form high-level thinking abilities, and one of the skills that must be possessed is critical thinking skills. Thinking skills can be interpreted as a form of cognitive ability process that has been broken down into concrete stages which are later used as guidelines and instructions for thinking [56]. Students need to have critical thinking skills because with this ability students become skilled in formulating, analyzing, and selecting the correct strategies for planning problem-solving [57]. The basis for good and appropriate problem-solving abilities, especially in science learning, is having the ability to understand science concepts well.

The Influence of Understanding Natural Science Concepts on Scientific Literacy

Science learning in elementary schools teaches students about scientific understanding of science. Students' understanding of science concepts is formed when students can interpret the concepts being studied and develop their understanding from basic concepts to more complex concepts. In reality, understanding science concepts in elementary schools contains knowledge, ideas, and concepts obtained from knowledge through a series of processes. According to Asyahri (2015), education at this time should emphasize the process of activities that can shape the character of students in facing the era of globalization, environmental problems, advances in information technology, convergence, reading, mathematics, and science, which are things that must be strengthened. and considered. This means that learning activities in schools should not only focus on mastering knowledge but learning activities should be oriented towards the learning process and be able to implement the knowledge that students already have in the form of understanding concepts [58].

The knowledge that students already possess and form an understanding of science concepts can be used in the form of literacy activities. Scientific literacy is the ability possessed by students to use scientific knowledge to solve problems. Students need to master scientific literacy about how students understand the environment, health, economics, and other problems faced by modern society which is highly dependent on the latest technology and the development of science [59].

Understanding science concepts is a form of student learning activity like that of science experts. The learning activities of students who have completed a good understanding of science concepts are the result of the activities of interpreting, exemplifying, classifying, summarizing, comparing, and explaining the knowledge they have understood. Understanding science concepts is the result of a learning process that

Journal of Ecohumanism
2024
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directs students in solving problems through careful planning activities, careful data collection, and appropriate analysis to produce a conclusion.

The impact of students' good understanding of science concepts is proven by the students' good scientific literacy skills. Through the ability to solve problems faced by students, they can develop their scientific literacy skills in the form of the ability to interpret and give examples of scientific issues. This will familiarize students with conveying activities by explaining ideas that might help the problem-solving process. The problems they have studied are then resolved through a series of searches for useful information to obtain solutions to the problems presented. Then the results of classifying, summarizing, and comparing activities can develop scientific literacy competencies in the form of the ability to design and evaluate scientific investigations using scientific evidence that has been obtained from various trusted sources, then interpreted and reduced by students which leads them to solutions to problems. Through scientific evidence and findings, students can also develop their scientific literacy competencies in explaining scientific phenomena through discussion activities when conveying opinions orally based on the interpretation of the scientific evidence they obtain. So, when an optimal understanding of science concepts can be formed in students, the students' scientific literacy competency will also be more fully and optimally formed.

The Influence of Critical Thinking on Scientific Literacy

As stated previously, in 21st century education it is necessary to have one of the thinking skills, namely critical thinking. Critical thinking skills are an important aspect for every student to have, especially when studying science (science). This is because critical thinking is a directed and very clear process that can be used to solve problems, make decisions, analyze assumptions, and conduct research. In science learning, we always develop the concept of deductive and inductive critical thinking skills, being able to explain various events in solving problems quantitatively and qualitatively. According to Cahyana (2017), science learning directs students to become literate in science, from this, students must be equipped with good critical thinking skills so that they can understand and be critical, not only remembering information but also achieving learning goals in a broad sense, namely personality. students who are literate in science [33].

Apart from that, Rustaman in Yelvita (2022) said that scientific literacy is a person's ability to understand science, communicate science both orally and in writing, and apply scientific knowledge to solve problems so that students can form high attitudes and sensitivity towards themselves and their environment in making decisions based on scientific considerations. Thus, students should have good critical thinking skills to be able to understand science. So, it is true that students who have good critical thinking skills will also develop good scientific literacy skills [60]

Conclusion

Based on the results of the path analysis test calculations that have been carried out and the hypothesis testing analysis above. It is known that several conclusions, namely Understanding Natural Science Concepts, Critical Thinking Skills, and Scientific Literacy have a direct influence on Scientific Attitudes.

There are empirical implications and theoretical implications of the research which are explained as follows. Empirically, the influence of the independent variables has been verified. Each of these three variables can be used as a determinant of Scientific Attitude. It is hoped that the results of this research can be used as a reference for relevant research in the future, especially those related to the formation of students' scientific attitudes in elementary schools.

Theoretically, efforts to form a Scientific Attitude can be made by establishing an Understanding of Science Concepts, Critical Thinking, and Scientific Literacy.

Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 6230 – 6247
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https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5228

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