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Guided Inquiry Model to Enhance Science Literacy of Fifth Graders on the Circulatory System

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ABSTRACT

Research Objective: This study aims to describe the science literacy offifth-grade students at Madrasah Ibtidaiyah Swasta Darussalam Pontianak and the application and influence of the guided inquiry model on improving science literacy in the subject of the human circulatory system, including its quantitative influence.

Methodology: This study applied a quantitative approach with an experimental method using a nonequivalent control group design. Classes VA and VB were selected as samples through total sampling technique. The instruments included multiple-choice tests, observation sheets, and documentation. Data analysis was performed through descriptive statistical tests, prerequisite tests, and hypothesis testing to examine the effectiveness of the model.

General Findings: The results showed that the application of the guided inquiry model had a positive impact on improving the science literacy of fifth-grade students at Madrasah Ibtidaiyah Swasta Darussalam Pontianak. This was indicated by an increase in posttest scores compared to pretest scores, as well as significant paired t-test results (0.000 < 0.05). Although the average N-Gain score was only 40.03% (less effective category), this model still contributed to helping students understand science concepts more actively and structurally.

Novelty/Originality of this Research: This study is unique because it examines the effectiveness of the guided inquiry model specifically on science literacy at the madrasah ibtidaiyah level, which has rarely been studied. The focus on the human circulatory system and the application of a quantitative approach in a local context makes this research valuable as an empirical contribution to the development of relevant and contextual science learning models.

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1. INTRODUCTION

International studies such as the Programme for International Student Assessment (PISA) show that Indonesia still ranks low in terms of science literacy. This indicates that many students are unable to understand scientific concepts in depth or apply this knowledge to solve real-life problems. Science literacy is one of the important competencies that students must have in the 21st century [1]. Amidst the rapid development of science and technology, students' ability to understand scientific concepts, think critically, and make evidence based decisions has become increasingly crucial. Organizations such as the OECD, through the PISA program, have

shown that the level of science literacy among students in Indonesia is still relatively low, especially in terms of the ability to apply scientific concepts in everyday life.

Although science literacy is very important in shaping students who think critically and are competitive in the 21st century, the reality is that students' learning outcomes and scientific thinking skills are still low [2]. This is thought to be due to the dominance of teacher-centered learning approaches, where student active involvement is still very limited. This type of learning model tends to cause passive understanding and hinders students' ability to formulate, test, and solve problems based on scientific evidence. Therefore, replacing it with a guided inquiry approach is very important [3].

Recent research conducted by Anggraini [4] shows that the application of a guided inquiry model in science learning with the help of simple experiments significantly, improves students' science literacy, encourages active engagement, provides concrete experiences, and strengthens students' scientific thinking skills. This research was motivated by the low level of science literacy among students, as evidenced by their difficulty in understanding the concept of human blood circulation, explaining scientific phenomena, and relating science to everyday life, which indicates the urgency of reforming learning strategies [5].

The guided inquiry model, in which teachers act as facilitators who guide students through exploration, experimentation, and structured discussions, is a promising alternative learning strategy to improve students' conceptual understanding and critical thinking skills. Various recent studies support the effectiveness of this model showing that experiment-based guided inquiry significantly improves students' conceptual understanding and critical thinking with an increase in N-gain in the moderate category ($p < 0,05$) [6].

Furthermore, the application of guided inquiry with PhET simulations on wave material improves students' scientific literacy, with indicators of content, context, and science process increasing by 68.7%, 63.7%, and 65.5%, respectively [7]. Research on Guided Inquiry shows that students' critical thinking skills improved in every aspect of interpretation, analysis, evaluation, inference, explanation, and self regulation after two cycles of guided inquiry learning [8]. Despite this growing body of evidence, research on the application of guided inquiry to topics that are inherently abstract and complex, such as the human circulatory system, remains limited at the elementary school level. The circulatory system, which involves interconnected organs and physiological processes, often poses learning challenges for younger students. Exploring how guided inquiry can be integrated into this content area provides an opportunity to strengthen students' conceptual understanding while simultaneously fostering their science literacy.

The urgency of this study is underscored by the need to improve science literacy among elementary students as part of broader educational priorities in the 21st century. Developing students' ability to reason scientifically about health-related topics is not only relevant to academic achievement but also to cultivating lifelong awareness of personal well-being and informed decision-making. Addressing these needs requires instructional models that go beyond rote memorization to promote active engagement and contextual learning.Therefore, the main objective of this research is to investigate the effectiveness of the guided inquiry learning model in improving the science literacy of fifth-grade students in learning the human circulatory system.

2. LIETRATURE REVIEW

2.1. Science Literacy

Science literacy is a combination of two concepts, namely "literacy," which means being literate [9], and "science," which refers to knowledge obtained through scientific methods. Science literacy not only encompasses students' ability to understand facts, build concepts, and recognize principles, but also requires the ability to discover new knowledge through a scientific approach, which is the main characteristic of science literacy itself [10].

Science literacy was officially introduced into education in Indonesia through participation in the PISA program organized by the OECD since 2000 [11]. This program assesses students' abilities in reading, mathematics, and science literacy. Science literacy refers to the ability to use scientific knowledge to identify questions, obtain evidence, and draw conclusions in order to understand the natural world and the changes that occur as a result of human activities [12]. Science literacy not only includes mastery of material, but also scientific thinking and problem-solving skills. Furthermore, science literacy is an important indicator in 21st century learning, which requires students to think critically, creatively, and communicatively [13].

Science literacy includes the ability to understand scientific knowledge, ask questions to obtain new information, explain scientific phenomena, and draw conclusions based on scientific evidence [14]. In addition, science literacy also includes the ability to use this knowledge in making decisions that have an impact on oneself and society in a global context [15]. Science literacy is not only related to mastery of science material, but also includes scientific thinking skills and the ability to solve problems systematically. In a systematic reviewof 15 scientific articles from 2019–2024, they found that learning models such as inquiry-based learning, collaboration, and project-based learning consistently improve students' scientific literacy competencies. This makes science

literacy one of the main indicators in 21st-century learning, which demands critical, creative, communicative, and collaborative thinking skills [16].

Scientific literacy plays a crucial role in shaping students' ability to make wise decisions on environmental, health, and technological issues. However, research by Ayu et al., [17] based on PISA 2022 shows that the science literacy of Indonesian students is at 383 points, still below the average for Mexico (around 399, and only about 34% of students reach Level 2, indicating limitations in their mastery of basic scientific concepts. Science literacy plays an important role in equipping students to deal with various science-based issues in real life. PISA identifies four main components of science literacy, namely context, knowledge, competence, and attitude [18], and establishes three main indicators: explaining scientific phenomena, evaluating and designing investigations, and interpreting scientific data and evidence [12]. These three indicators assess students' ability to understand, apply, and evaluate scientific concepts comprehensively. Research by Febrianty [19] supports the application of these indicators at the elementary school level because they align with 21st-century learning demands and are relevant to the Merdeka Curriculum.

2.2. Guided Inquiry

The guided inquiry learning model is an approach that allows students to actively investigate and build their knowledge with the teacher acting as a facilitator who guides the learning process. This model creates a contextual and in-depth learning environment where students not only receive information but are directly involved in the scientific exploration process. The Guided Inquiry Model is a science learning approach that emphasizes the active role of students in building knowledge through their natural curiosity [20]. In this model, the teacher acts as a guide who provides direction without taking away the students' freedom to ask questions, express opinions, and analyze problems according to their capacity. Although not new, this approach remains relevant because it has been proven to be more effective than traditional learning in encouraging critical thinking and meaningful problem solving.

The guided inquiry learning model also consists of a series of learning activities that emphasize critical and analytical thinking to search for and find answers to the questions asked [21]. Specifically, guided inquiry encourages students to learn through guided scientific investigation, where teachers provide initial questions and general directions, but students are given the freedom to explore, ask questions, and draw conclusions based on their experiences [22]. In addition, according to Wulandari et al., [23] adds that this model is particularly suitable for science subjects because it provides space for students to think critically, ask questions, draw conclusions, and test their ideas through a systematic and structured process.

According to Rahayu [24], the Guided Inquiry Model is a learning approach that encourages students to use all their thinking abilities in a structured, rational, critical, and analytical manner in the investigation process. Through active involvement in finding answers to questions that arise from curiosity, students are guided to build their own knowledge and competence. This approach not only fosters intellectual abilities and thinking skills, but also creates a meaningful learning experience, like solving puzzles that stimulate in-depth problem solving.

2.3. Previous Research

The guided inquiry learning model has been proven to be one of the most effective approaches in improving students' science literacy. This model emphasizes the active involvement of students in discovering concepts through scientific stages such as problem identification, hypothesis formulation, data collection and analysis, and conclusion drawing. According to Ratna et al., [25] applying the guided inquiry model with a scientific approach to ecosystem material was found to be effective in improving students' critical thinking skills. Guided inquiry helps develop students' scientific skills through direct experience in the inquiry process. This is in line with the view of Kissi et al., [7], which states that this approach also encourages the improvement of science literacy through active and contextual exploration.

In addition, learning with guided inquiry is also able to facilitate critical thinking, scientific reflection, and a deeper understanding of concepts [26]. It should be added that the application of this model is more successful when combined with contextual media and the support of a collaborative learning environment. Various previous studies have shown the effectiveness of guided inquiry in improving learning outcomes, critical thinking skills, and science literacy among students, as reported by Fitriana [27].

3. RESEARCH METHOD

3.1. Type and Design of Research

This study uses a quantitative approach according to Muri [28] Quantitative research is a type of research that is systematic and structured with clear stages, concerning a phenomenon or social fact, by describing several variables related to the problem being studied. Data in the form of numbers is collected and processed using statistical techniques. Meanwhile, the Nonequivalent Control Group Design according to Sugiyono [29] involves two groups that are not randomly selected, namely the experimental class that is given treatment in the form of a

guided inquiry learning model, and the control class that is not given treatment. Measurements are carried out through pre-tests and post-tests of science literacy skills.

3.2. Research Location and Time

The research was conducted at Madrasah Ibtidaiyah Swasta Darussalam Pontianak, Jalan Tani, Kelurahan Saigon, Kecamatan Pontianak Timur, Kota Pontianak. The research was conducted from April 2024 to June 2025, covering the preparation, implementation, and report writing stages.

3.3. Population and Sample

The population in this study was all fifth-grade students at Madrasah Ibtidaiyah Swasta Darussalam Pontianak. The sample was taken using total sampling, a sampling technique in which all members of the population are used as samples [29]. The samples in this study were class VA as the control class and class VB as the experimental class, each consisting of 20 students.

3.4. Research Variables

The variables used in this study consisted of two types, namely independent variables and dependent variables. Independent variables are factors that influence or cause changes in other variables, and in this study, they were the guided inquiry learning model [30]. Meanwhile, the dependent variable is a variable that is influenced by the independent variable, namely students' science literacy, which is the result of treatment in the learning process [29].

3.5. Data Collection Techniques and Tools

The data collection technique in this study used test and non-test methods. The test was conducted by giving 15 multiple-choice questions used to measure students' science literacy, both before (pre-test) and after (post-test) the treatment. This test assessed aspects of scientific process skills such as observing, measuring, classifying, predicting, concluding, and communicating, with results categorized into five levels based on percentage scores [31].

In addition to tests, non-test techniques were used through observation and documentation. Observations were made directly on learning activities, classroom conditions, and school facilities and infrastructure [32]. Meanwhile, documentation included the collection of archives in the form of photos of learning activities, student attendance, and other supporting documents such as teaching modules and school profiles [33]. To support data collection, several tools were used, namely test sheets as pretest and posttest evaluation instruments, observation guidelines to record learning activities and learning conditions, and documentation guidelines in the form of a checklist of relevant archives to support the validity of the research data.

3.6. Data Analysis Techniques

Before conducting the research, the test instruments and learning tools were validated by two experts using the Gregory technique, whereby the validators evaluated each item in a test using a four-point scale on a validation sheet, and then the combined assessments of the two validators were entered into an agreement table[34]. The validity results of the test instruments and learning tools were in the very high category.

Data analysis was performed through descriptive statistical tests, prerequisite tests, and hypothesis testing to examine the effectiveness of the model. Descriptive statistics is basically the process of converting research data into a form that is easier to understand and interpret. Tabulation presents a summary, arrangement, and compilation of data in the form of numbers and graphs [35]. Meanwhile the independent t-test is applied when the two groups of data being compared are unrelated or not paired. In this study, the posttest participants in the experimental class differed from those in the control class, in accordance with the research problem. Therefore, the appropriate statistical analysis employed was the independent t-test.

3.7. Research Procedure

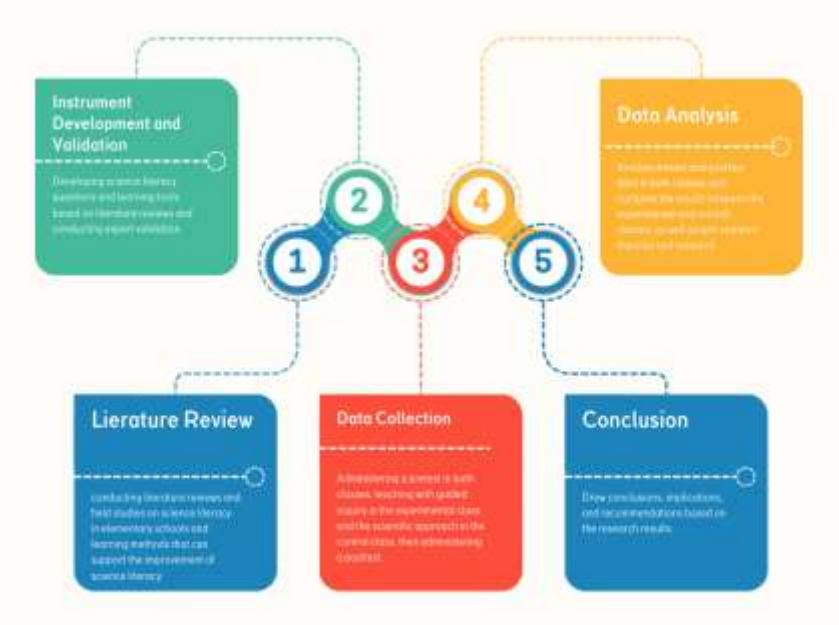

Figure 1. Research Flowchart

4. RESULTS AND DISCUSSION

This study aimed to examine the effect of the guided inquiry learning model on improving the science literacy of fifth-grade students at Madrasah Ibtidaiyah Swasta Darussalam Pontianak. Based on the results of the pretest and posttest, there was an increase in the average science literacy score in the experimental class compared to the control class.

4.1. Results

This study aimed to determine the effect of the guided inquiry learning model on improving the science literacy of fifth-grade students. The science literacy result showed below.

Table 1. Science Literacy Test Results

Class	Pretest Average	Postest Average
Experimetal	42,45	65,00
Control	40,20	59,65

Based on the data analysis results, the pretest and posttest scores showed a significant increase in the experimental class compared to the control class. Before the treatment, the average pretest scores of both classes were relatively the same, namely 52.40 for the experimental class and 53.10 for the control class. After the treatment, there was an increase in the average posttest scores, namely 65.00 for the experimental class and only 59.65 for the control class.

Table 2. Paired ttest

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	PretestControl PostestControl	-19.45000	9.90202	2.21416	-24.08429	-14.81571	-8.784	19	.000
Pair 2	PretestExp Postest Exp	-22.55000	9.02905	2.01896	-26.77572	-18.32428	-11.169	19	.000

Meanwhile, the paired sample t-test conducted on the pretest and posttest results of the experimental class showed a significance value of 0.000 (smaller than 0.05), which means that there was a significant difference

between before and after the treatment. This shows that the application of the guided inquiry model has a positive effect on improving students' science literacy.

Tabel 3. N-Gain score Test Result

Descriptives				
		Class	Statistic	Std. Error
N Gain_Persen	Experiment	Mean	40.0342	3.27208
		95% Confidence Interval for Mean Lower Bound	33.1857	
		95% Confidence Interval for Mean Upper Bound	46.8828	
		5% Trimmed Mean	39.2235	
		Median	38.3925	
		Variance	214.131	
		Std. Deviation	14.63320	
		Minimum	20.59	
		Maximum	74.07	
		Range	53.49	
		Interquartile Range	22.79	
		Skewness	.735	.512
		Kurtosis	-.138	.992

However, the average N-Gain score obtained was only 40.03%, which is classified as ineffective (N-Gain categories: low ≤ 0.3; moderate 0.3–0.7; high ≥ 0.7). In contrast, the control class, which used a conventional learning approach, showed lower improvement in terms of both posttest scores and N-Gain. A comparison of the posttest results between the control and experimental classes showed that the experimental class had a higher average score, although the statistical test results showed a significance value of 0.227, which means that there was no statistically significant difference (Ho accepted). These results indicate that the application of the guided inquiry model can contribute to improving students' science literacy, although the improvement is not yet optimal. The improvement occurred because this model provides space for students to be actively involved in the learning process through exploration, observation, and scientific discussion, in accordance with the characteristics of guided inquiry, which emphasizes direct experience and guided independent discovery of concepts.

4.2. Discussion

This study aims to determine the effect of the Guided Inquiry learning model on the science literacy of fifth-grade students at Madrasah Ibtidaiyah Swasta Darussalam Pontianak on the subject of the human circulatory system. This model was applied as an effort to improve science literacy, which is an important competency in science learning in elementary schools. Science literacy in this study was measured through three main indicators: the ability to identify scientific phenomena, conclude investigation results, and describe scientific data and evidence. This study used a quantitative method with a non-equivalent control group design, involving two groups, namely a control class and an experimental class, each consisting of 20 students. The control class used a conventional learning model, while the experimental class used the Guided Inquiry model. Both groups were given pre-tests and post-tests to measure the development of science literacy, and the data obtained was analyzed to determine the effect of the Guided Inquiry model on improving students' science literacy. The results showed that the application of the Guided Inquiry learning model had a significant effect on improving the science literacy of fifth-grade students. Based on the data analysis, an N-Gain value of 0.40.3% was obtained in the experimental class (less effective category) and 60% was influenced by other variables such as the classroom and school environment, teacher scaffolding and instructional quality, students' initial cognitive readiness, and the availability of learning media and facilities. This model remains potential for use in learning because it encourages active involvement and critical thinking among students. This shows that the application of the guided inquiry model is more effective than conventional learning. This is align with Faizin et al., [36] and Kahar et al., [37] who found that the learning process utilizing the guided inquiry model effectively enhances science literacy.

According to Husnul et al., [38], the level of science literacy among students in Indonesia is still low, partly due to the inappropriate selection of learning resources. Learning resources that are relevant to students' lives play a significant role in the development of science literacy [39]. In Indonesia, science learning still relies heavily on textbooks, while approaches based on direct experience and exploration are still rarely used. Therefore, the guided inquiry model was chosen because it is able to provide more meaningful learning through the direct involvement of students in the exploration process, thereby effectively improving science literacy.

a. Analyzing Scientific Phenomena

   This aspect assesses students' ability to understand cause-and-effect relationships, compare data, formulate hypotheses, and explain scientific phenomena. Sample questions included explaining the circulatory system and predicting changes in organs. The results showed an increase in scores from 50% to 60% (a 10% increase),

indicating progress in analytical thinking. This improvement is supported by the relevance of the material to the students' real-life experiences, which helps them understand the concepts in a more contextual way [40].

b. Evaluating and Designing Investigations
Students were asked to evaluate experiments, design scientific methods, and assess arguments based on evidence. The questions included exploring questions about the heart and the effects of physical activity. Scores increased from 43% to 51% (an 8% increase). However, students' abilities in this aspect are still relatively low because teachers often have difficulty developing evaluation instruments and adapting them to students' development [41].

c. Interpreting Data and Scientific Evidence
This competency includes the ability to read, transform, and evaluate scientific data in various forms (text, graphs, tables). Sample questions include interpreting experimental results, distinguishing evidence based arguments, and evaluating scientific assumptions. The score increased from 40% to 53% (up 13%). Despite the highest increase, this competency still faces challenges such as a low understanding of basic concepts and an undeveloped culture of literacy [42].

Overall, although the improvement in all three aspects was not significant, the use of the guided inquiry model proved to be effective in promoting improvements in students' science literacy skills. The guided inquiry model encourages students to actively engage in the process of discovering concepts, analyzing data, and drawing conclusions. This process helps students develop critical thinking and problem-solving skills, as well as deepen their understanding of scientific concepts [43].

The guided inquiry learning model was developed based on Jean Piaget's theory of child cognitive development [44]. This model encourages students to actively observe, investigate, and solve problems prepared by the teacher, with the teacher acting as a facilitator. This model was chosen based on a learner-centered learning approach, which trains openness, critical thinking, and problem-solving skills. In addition, through group work, students are also trained to share information and work together. Furthermore, this approach allows students to investigate real phenomena and relate them to the concepts being studied, making learning more meaningful. This is in line with the results of research by Putri et al., [45] which states that guided inquiry is effective in improving critical thinking and science literacy skills in science learning in elementary schools.

In line with this, the activeness or work process of guided inquiry in following the learning process requires the teacher as a facilitator of students in understanding the material being studied [46]. The application of this model can improve students' science literacy skills through the stages of exploration, information gathering, data analysis, and group discussion [47]. In other words, inquiry-based learning encourages students to actively construct their own knowledge. The results of this study are also reinforced by Setiawan et al., [48] , which states that guided inquiry contributes positively to improving science learning outcomes and students' critical thinking skills. Similarly to Aiman et al., [49] confirms that the guided inquiry-based learning model combined with a science literacy context has been proven effective in improving concept understanding and learning outcomes of elementary school students. Furthermore, the findings of Warmadewi [50], show that the guided inquiry model can improve students' science literacy. Through this approach, students become more active in discovering concepts independently, developing problem-solving skills, and providing scientific explanations. This is supported by Deti & Elih [51], which states that science literacy includes the ability to identify questions, acquire knowledge, explain scientific phenomena, and make decisions based on data and scientific evidence.

5. CONCLUSION

This study found that the guided inquiry learning model positively impacts the science literacy of fifth-grade students at Madrasah Ibtidaiyah Swasta Darussalam Pontianak, especially in learning about the human circulatory system. Despite the N-Gain score being categorized as ineffective (40.03%), statistical tests showed a significant improvement between pretest and posttest results ($p < 0.05$). Students demonstrated growth in analyzing scientific phenomena, designing and evaluating investigations, and interpreting data and evidence. These findings highlight that guided inquiry can foster critical thinking, problem-solving, and collaboration—skills essential for 21st-century learning. The effectiveness of guided inquiry, however, depends on several factors, including student readiness, the teacher's role as a facilitator, the learning environment, and the availability of appropriate media and facilities. To maximize its impact, careful lesson planning, teacher professional development, and adequate resources are crucial. It is therefore recommended that guided inquiry be applied more widely in elementary science education as a means to strengthen active student engagement and enhance science literacy in responding to current educational demands.

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