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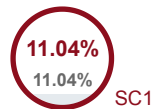
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Vol. xx, No. xx, 20xx, 000-000

<https://doi.org/10.56916/jirpe.vxix.xxxx>

Journal of Innovation and Research in Primary Education | 1(1), 2022 | 1-6

Journal of Innovation and Research in Primary Education | 1(1), 2022 | 1-6

Effect of Guided Inquiry Learning on Elementary Students' Science Competencies

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Keywords Guided Inquiry, Science Competencies, SDGs13 **Article History** Received yyyy-mm-dd Accepted yyyy-mm-dd  
 Copyright © 20xx by Author(s). **This is an open access article under the CC BY-SA license.** **Abstract** Climate change education and scientific competencies are important components of 21st-century learning, particularly in addressing sustainable development challenges. This study aims to examine the effect of guided inquiry learning on elementary students' scientific competence in the topic of alternative energy, and how it supports the UN SDG 13 climate change mitigation program. The research was conducted at SD Negeri Ketajen I. The research involved a pretest on the same day for both the control class (Class 6A, 20 students) and the experimental class (Class 6B, 18 students). The following day, the experimental class received three sessions of guided inquiry learning. Data were analyzed using the Mann-Whitney U test. The results showed a significant difference between the two groups ( $p = 0.011$ ), with the experimental group showing greater improvement in explaining, evaluating, and interpreting scientific phenomena. These findings that guided inquiry learning have a positive effect on students' scientific competence and awareness of climate change, while also providing a practical framework for educators to implement effective teaching strategies that align with sustainable development goals in science education.

### INTRODUCTION

The Sustainable Development Goals (SDGs) are a sustainable development program under the auspices of the United Nations (UN) that is a continuation of the Millennium Development Goals (MDGs) which ended in 2015. The SDGs program has 17 global goals set by member countries, one of which is Indonesia. Indonesia's commitment to achieving these goals aligns with Presidential Regulation No. 59 of 2017, which emphasizes the importance of aligning the implementation of the SDGs with the National Long-Term Development Plan and the National Medium-Term Development Plan.

These 17 global goals encompass various interconnected aspects, namely: (1) No Poverty, (2) No Hunger, (3) Good Health and Well-being, (4) Quality Education, (5) Gender Equality, (6) Clean Water and Sanitation, (7) Affordable and Clean Energy, (8) Decent Work and Economic Growth, (9) Industry, Innovation, and Infrastructure, (10) Reduced Inequalities, (11) Sustainable cities and communities, (12) Responsible consumption and production, (13) Climate action, (14) Life below water, (15) Life on land, (16) Peace, justice, and strong institutions, (17) Partnership for the Goals. One of the objectives that is the focus of this study is SDG 13: climate action, which motivates various countries to take concrete action to address climate change. The increasingly visible impacts of climate change around the world are also being felt in Indonesia, where it is predicted that by 2030, 57% of greenhouse gas emissions will come from fossil fuels. Meanwhile, through SDG 13, Indonesia is striving to achieve a temperature of 1.5°C by 2030.

The High-Level Political Forum (HLPF) established by the United Nations serves as a means of monitoring progress towards achieving the SDGs, particularly SDG 13. The forum reported that the agreed temperature target has been exceeded and that if left unchecked, the world will face

temperatures of 2.5-2.8°C . In light of this alarming situation, it is crucial to recognize the role of education in addressing climate change. In response to this situation, the United Nations is promoting various initiatives, including in the field of education, involving academic experts to target the achievement of SDG 13 in education. These efforts also aim to raise public awareness of climate change issues.

In line with these issues and their urgency, collaboration among communities that understand climate change issues is essential. One effective way to achieve this is by strengthening the role of science. Currently, science is an integral part of people's lives. The involvement of science in daily life includes, for example, the important role of ecosystems in supporting life and issues that are part of public discourse, such as climate change. Regarding climate change, the community needs to have access to detailed scientific information to prevent misinformation and make informed decisions. In this context, the community must understand science so they can gather information related to scientific issues and engage critically .

Beyond merely understanding information, the importance of scientific literacy becomes paramount. PISA ( Program for International Student Assessment) defines scientific literacy as the ability to use scientific knowledge to understand and make decisions about the environment and changes related to human actions . An example of scientific literacy is the policy of using alternative energy sources to reduce CO2 levels in the air; if ignored, this could lead to greenhouse gas emissions and air pollution.

The importance of science in education is supported by UNESCO through the integration of SDG 13 on Climate Change into science education in the Merdeka Curriculum, which covers the Learning Objectives domain consisting of Cognitive, Socio-Emotional, and Behavioral aspects. In addition, the Indonesian government has implemented a policy direction to reduce greenhouse gas emissions and emission intensity through the expansion of energy efficiency measures and the provision of new and renewable energy, as well as a policy direction for low-carbon development through the expansion of energy efficiency and EBT implementation and increased use of biofuels

Despite these national efforts and curriculum reforms aimed at improving science education, significant challenges persist at the local level. For instance, the scientific competence ranking in Indonesia, specifically in Ketajen Village, Gedangan District, at Ketajen 1 Public Elementary School, is 30%, while at Kupang 03 Elementary School, Ambarawa District, Semarang Regency, Central Java, it is low at around 44.8% . Given this situation, it is the government's responsibility to continue striving to improve the quality of education to create an interactive and meaningful learning process that can be implemented by teachers in schools, one of which is through the implementation of the Merdeka Curriculum. The main focus of the Merdeka Curriculum is the guided inquiry learning model. Through this model, students can develop skills such as curiosity about various topics, problem-solving abilities, flexibility in thinking, and decision-making based on logical, innovative, and analytical reasoning, accompanied by reflective attitudes or ideas

The concept of guided inquiry learning originated from John Dewey's ideas in the early 20th century, which emphasized the importance of teaching skills centered on learners . John Dewey believed that learners would learn effectively when they were directly involved in solving problems related to everyday life. This idea was later developed by Herron (1971), who categorized inquiry-based learning models into four levels: confirmatory inquiry, guided inquiry, structured inquiry, and open inquiry. In the guided inquiry level, teachers present a problem while students design and seek their own solutions.

Guided inquiry learning is defined as a teaching technique that involves students in teaching and learning activities through questioning, problem solving, and critical thinking . In general, inquiry-based learning takes the form of teamwork, dividing the class into small groups that are given questions or problems to discuss together, and then present their findings. In the context of guided inquiry-based learning, Sanjaya (2006) outlines the following stages or syntax: (1) orientation, where students are presented with a problem, (2) problem formulation, where students formulate questions, (3) hypothesis formulation, where students provide temporary answers to the problem formulation, (4) data collection through experiments or trials, (5) testing hypotheses, which involves testing the data or experiments, (6) formulating conclusions, which involves describing the results of the experiments or trials

Guided inquiry learning contributes to the development of students' science competencies through specific knowledge in scientific investigation. Various studies have consistently demonstrated the effectiveness of guided inquiry learning models in improving various aspects of students' science competence. For example, a study found that Guided Inquiry-Based Learning is much better than ordinary teaching in changing students' thinking from unscientific to scientific . Finally, recent research on elementary school students also confirms that guided inquiry learning is effective in improving students' science process skill and concept mastery .

As such, the results of these studies collectively prove that guided inquiry is a very suitable learning method to help elementary school students develop various important skills in science.

Various studies have confirmed that the guided inquiry model is effective in improving students' science competencies in general (such as science process skills, conceptual understanding, and learning achievement). However, there is still a gap in the literature. Specifically, research that directly examines how the guided inquiry model is effective in elementary students' science competencies related to climate change mitigation (SDG 13) is limited. Many studies focus on general science aspects, but they haven't deeply explored how guided inquiry specifically develops students' abilities to investigate, evaluate information, explain scientific phenomena, and apply them in the context of climate change issues. Given the urgency of climate change and the importance of education as a tool for mitigation, understanding the effectiveness of teaching approaches like guided inquiry in this specific context is crucial. This gap needs to be filled to provide stronger evidence for developing curricula and teaching practices focused on climate action at the elementary level.

This gap motivates this study to examine the effectiveness of guided inquiry learning models on elementary school students' science competencies, especially those that support SDG 13, namely climate change mitigation. The competencies studied include students' ability to investigate, evaluate information, explain phenomena scientifically, and apply them in daily life related to climate issues.

## METHODS

This type of research is quantitative. Quantitative research is a type of research that uses statistical methods and numerical analysis to collect and analyze data. Based on this opinion, quantitative research is research in which data is collected in the form of numbers, then calculated and analyzed using statistical tools to obtain conclusions. In quantitative research, the results are presented in the form of images, tables, graphs, or other presentations to enhance the information for readers

This study uses a quasi-experimental design with a non-equivalent control. Quasi-experimental is defined as an experiment that has treatment, experimental units, and measured effects Therefore, a quasi-experiment is a type of experiment designed to test cause and effect by providing treatment in the experimental class. This study uses quasi-experimental methods to measure the **effect of guided inquiry learning models on students' science** competencies

This research design uses two classes, namely an experimental class that undergoes guided inquiry learning and a control group that uses conventional learning in the form of lectures. The following is the research design presented in table 1.

Table 1. Research Design

Group	Pretest	Treatment	Posttest
Experiment	O1	X1	O2
Control	O1	X2	O2

Explanation:

O1: Pretest to measure student competence before treatment.

O2: Posttest to measure student competence after treatment.

X1: Treatment using guided inquiry.

X2: Treatment using lecture-based learning.

Population refers to all objects or subjects specified in the study. The population in this study was students at SDN Ketajen I. The population consisted of 38 students, comprising 20 students in class 6A and 18 students in class 6B. This population formed the basis for the research sample. The sample was a portion of the population that became the subject of the study

The researchers used simple random sampling techniques to determine the control class and the experimental class. This sampling method gives everyone an equal chance of being selected as a member of the sample. The samples were determined by conducting a spin-off or lottery witnessed by each class teacher. As a result, the selection process designated Class 6A as the control class and Class 6B as the experimental class. This method was chosen to ensure objectivity and minimize bias in group assignment, thus giving each class an equal opportunity to be either the experimental or control group.

**The data collection technique used in this study was a written test, namely a pre-test and post-test. A test is defined as a series of questions or exercises used to measure the abilities, skills, and talents of an individual or group.** The pre-test and post-test were used to measure scientific competence using instruments containing aspects and indicators adapted from PISA standards to measure scientific competence. These indicators consist of the ability to explain, evaluate, and design investigations, as well as interpret science data and evidence presented in Table 2.

Table 2. Science Competency Indicators

Aspects	Indicator
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Science	<b>Competencies Ability to explain phenomena scientifically: recognize, offer, and evaluate explanations for a variety of natural and technological phenomena Evaluate and design scientific inquiry: describe and asses scientific inquiry and porpose ways of addressing questions scientifically. Interpret data and evidence scientifically: analyze and evaluate data, claims, and arguments in multiple representations and draw appropriate scientific conclusions.</b>
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Validity in quantitative research is defined as its accuracy or truthfulness. Validity is used to measure actual data; in addition, validity determines the quality of a test. The instrument test in this study used two approaches, namely expert judgmental validity testing and construct validation using IBM SPSS 26. In the expert validity test, there were two types of validation, namely science competency tests with a score of 90 from the first expert and a score of 80 from the second expert. Meanwhile, for the expert learning module validity test, expert 1 gave a score of 80, and expert 2 gave a score of 80. The construct test in this study involved the researcher conducting an instrument test on 23 students by distributing test papers. Next, the results of the instrument test were tested for validity using Pearson's product-moment correlation. The validity testing criteria were that if the calculated  $r$  was greater than the table  $r$ , the instrument was considered valid, and if the calculated  $r$  was less than the table  $r$ , the instrument was considered invalid. The validity test results showed that 15 multiple-choice questions out of 25 were valid. The validity test used a confidence level of 0.05, which, when observed in the table, was 0.413. Based on the validity test,  $r_{count} > r_{table}$ , which means that the questions were valid.

The instrument's consistency was evaluated using Cronbach's Alpha, a statistical method commonly used to assess reliability in educational research. The interpretation of Cronbach's Alpha is as follows: a value of 0.00 indicates no reliability,  $>0.70$  is considered acceptable, and a value  $>0.80$  is categorized as good reliability. A value of 1.00 represents perfect reliability. The reliability test conducted in this study resulted in a Cronbach's Alpha coefficient of 0.85. Based on the classification above, this score falls into the category of good reliability. Which indicated that the instrument is consistent and reliable.

Data analysis includes organizing data based on variables and types. **The data analysis techniques used in this study** were, first, descriptive analysis consisting of averages. Second, a normality test **was conducted to determine whether** the data were **normally distributed or not. In the normality test, the researcher used the Shapiro-Wilk** test because the sample used was  $<50$ . Third, a homogeneity test to show that the groups had the same variance. After that, a test was conducted to determine whether there were differences between unrelated classes. The test used in this study was the Mann-Whitney U test.

## RESULTS AND DISCUSSION

### RESULT

This study was took place at SDN Ketajen I, Gedangan District, involving 20 students in class 6A as the control class and 18 students in class 6B as the experimental class. Class 6A received conventional teaching, consisting only of lectures and assignments. Meanwhile, class 6B used a guided inquiry learning model for three meetings. During each session, Class 6B conducted experiments in groups consisting of 4 to 5 students.

The learning activities in the control class were conducted in one day, which included pre-test questions and material delivery using the lecture model. Before the learning began, the researcher announced the information for the pre-test questions. When explaining the material on alternative energy, the researcher first provided a stimulus by pointing out the lights that were on due to fossil fuel energy sources. The learning process then continued with the formation of small groups of five students to complete the worksheets. Each group then presented the results of their discussions. The pre-test was also conducted in the experimental class 6B to determine the students' initial abilities before the treatment was given.

Guided inquiry learning in the experimental class was conducted after the pre-test activity. The learning activities were carried out over three sessions. The following is the implementation of guided inquiry learning, which consists of several syntaxes designed to enhance science competencies based on PISA indicators.

#### Syntax 1. Problem Orientation

In problem orientation, researchers provide problem videos to trigger stimuli or curiosity in students. This syntax is designed to affect competence in recognizing problem phenomena that will be studied further. Stimuli are not only provided through problem videos, but also through **the mediation of problems that occur in the students' environment. For example, in the first meeting, the mediation used was** a case of water pollution caused by fossil fuel waste. In the second meeting, the mediator was wearing a black shirt that became hot when worn. In the third meeting, the mediation was on the increasing amount of waste pollution, which, if left unchecked, leads to waste pollution.

## Syntax 2. Formulating problems

The videos of problems and mediation presented raise questions or issues, such as "why did this happen," "how does it affect the surrounding environment," and "how can it be resolved." The second syntax is designed to affect the ability to recognize problematic phenomena.

## Syntax 3. Formulating Hypotheses (temporary assumptions/answers)

After formulating questions related to the problem, students continue to formulate temporary answers to those questions. This syntax affects the competence to offer and evaluate explanations for various natural and technological phenomena. At this stage, students use critical thinking skills and prior knowledge on to formulate a Solution to a Problem. Additionally, in this syntax, students are guided to formulate scientific hypotheses by utilizing alternative energy sources.

## Syntax 4. Collecting Data

Learning continues with syntax 4, which is collecting data. This syntax is designed to affect scientific competence in analyzing, evaluating, and interpreting data scientifically. In this syntax, students collect information and data via the internet about the materials they have brought and their relationship to the problems presented. For example, in the first session, students bring charcoal, stones, and pebbles. In the second session, students bring black paper, aluminum foil, and cardboard, which are suspected to be able to absorb heat and thus can be used as a solar stove. In the third session, students bring dry leaves and rice flour, which are suspected to be able to address waste pollution and thus can be used as briquettes

## Syntax 5. Testing Hypotheses

Students enter the syntax for testing hypotheses, which affects their competence in evaluating and designing scientific investigations. In this syntax, students conduct scientific investigations as shown in the image below.

**Figure SEQ Figure \\* ARABIC 1.** A simple water filter

**Figure SEQ Figure \\* ARABIC 2.** Solar cookers

**Figure SEQ Figure \\* ARABIC 3.** Dry leaf briquettes

Based on the picture above, the inquiry-based learning process is carried out for three meetings with different activities each day.

On the first day, learners investigated making a simple water filter. This activity is motivated by the condition of the environment where they live, especially the river, which is polluted by fossil fuel waste from industrial activities. On the second day, learners design and make solar cookers as a solution to the problem of extreme hot weather. Through this activity, learners are expected to understand the importance of utilizing alternative energy, namely sunlight, to reduce dependence on fossil energy fuels.

On the third day, learners test hypotheses related to the problem of waste pollution. Learners identify that waste is often burned or left to rot. As a solution, learners recycle organic waste by processing it into briquettes or charcoal as an environmentally friendly fuel.

## Syntax 6. Draw Conclusions

The last phase in this learning is phase 6, concluding, after students conduct experiments and work on LKPD, students convey ideas and results of discussions with groups with spin-off techniques as a presentation queue. The syntax is designed to affect the competence of assessing claims about the effectiveness of alternative energy in reducing climate change and drawing scientific conclusions to understand the benefits of renewable energy to support SDGs, Mitigating Climate Change. After phase 6 ended, the researcher distributed post-test questions to determine the extent of the effectiveness of guided inquiry for students' science competence. After conducting research in both control and experimental classes, the following are the results of the pretest and posttest of the two classes, along with the descriptive statistics of the scientific competence of the two classes.

Table 3. Descriptive Statistics of Scientific Competencies

Group	Pretest Average	Post-test Average
Control	59.80	73.50
Experiment	63.05	82.28

Based on descriptive statistics, it shows that the average result of the control class using the lecture learning model is 59.80, and the average post-test value is 73.50. Meanwhile, in the experimental class, namely class 6B, the average pre-test score was 63.06 and the average post-test score was 82.28. The average science competency on each indicator can be seen in the table below

**Table 4.** Average Scientific Competencies in Control Class

Indicators	Pretest Average	Post-test Average
Ability to explain phenomena scientifically	12.1	14.8
Evaluate and design scientific inquiry	12	16
<b>Interpret data and evidence scientifically</b>	10.5	14.7

Based on the table above it shows that the ability to explain the indicator has increased from the pretest average of 12.1 to an average of 14.8 in the posttest. So the ability to explain the indicator has increased by 2.7. The average for the indicator of interpreting data is 10.5 in the pretest and an average of 14.7 in the post-test, which means an increase of 4.2. Furthermore, the average for each indicator in the experimental class can be seen in the table below.

Table 5. Average Scientific Competence in Experimental Class

Indicators	Pretest Average	Post-test Average
Ability to <b>explain phenomena scientifically</b>	12.2	14.5
<b>Evaluate and design scientific</b> inquiry	11	18
<b>Interpret data and evidence scientifically</b>	10.2	15.4

The average on each indicator in the experimental class is divided into 2 stages, the same as the control class, namely pretest and posttest, and each indicator has increased. In the ability to explain the indicator in the pretest stage, with an average of 12.2, and in the posttest stage 14.5. Furthermore, in the evaluation and design indicators, **at the pre-test stage, with** the average of 11, and at the post-test stage, 18. The indicator of interpreting data at the pretest stage is 10.2, and posttest 15.4. So that each indicator has increased by 4.2, 5, and 5.2, respectively.

This study, in addition to measuring aspects of science competence, researchers gave quizzes about SDGs 13. Guided inquiry learning in this study was also used to support the 13th Sustainable Goal (SDGs), namely, Mitigation of climate change. The support was applied through experiments on

alternative energy sources as an effort to reduce the impact of climate change due to excessive use of fossil energy, and through quizzes conducted in experimental classes on climate change which were adjusted to indicators by UNESCO, namely Cognitive Learning, Socio-Emotional, and Behavioural. Each aspect has an average presented in the table below.

Table 6. Average of Quiz on SDGs 13 (Climate Change)

Domain	Average
Cognitive	17.3
Socio-emotional	14
Behavioural	15

Berdasarkan tabel di atas, terlihat bahwa terdapat tiga domain yang diukur: Kognitif, Sosio-emosional, dan Behavioral. Dari ketiga domain tersebut, domain Kognitif memiliki rata-rata tertinggi dengan nilai 17.3, menunjukkan pemahaman yang baik dalam aspek kognitif. Sementara itu, domain Sosio-emosional dan Behavioral memiliki rata-rata yang lebih rendah, masing-masing 14 dan 15.

The next technique is the data analysis test, researchers conduct prerequisite tests before testing the results, namely, normality and homogeneity tests. Normality test is defined as a test where data is normally distributed. There are two types of normality tests, namely parametric and non-parametric statistical analysis. Parametric statistics are analytical techniques that require normality of distribution and homogeneity of data, while non-parametric statistics are analytical techniques that do not require normality of distribution and homogeneity of data. This study used the Shapiro-Wilk normality test because the sample used was  $n < 100$ , and the total sample of both was 38 students, following the results of the normality test.

Tabel 7. Normality Test

	Kolmogorov-Smirnov	Shapiro-Wilk	Statistic	df	Sig.
Result	.18176	.000	.91376	.000	
Groups	.18176	.000	.85576	.000	

The output of the table above can be concluded through the Shapiro-Wilk normality test, namely **if the Sig. value  $> 0.05$ , the data is normally distributed; if the data Sig. value  $\leq 0.05$ , the data is said to be not normally distributed.** Based on these data in the class row shows a Sig value of **0.000  $\leq 0.05$ ; it can be concluded that the data above is not normally distributed.** Furthermore, the homogeneity test is presented in Table 8.

Table 8. Test of Homogeneity of Variance

	Lavene	Statistic	Df1	Df2	Sig.	Result	Based on Mean	4.505	3	72	.006
Based on Medium	3.120	3	72	.031							
<b>Based on Median and with adjusted df</b>	3.120	3	48.904	.034							
Based on trimmed mean	4.233	3	72	.008							

The table presented shows that **the data is said to be** homogeneous if the Levene Statistic value  $> 0.05$ ; the table above shows a value of  $0.006 \leq 0.05$ . This means that the two classes are different, and it is said that the two classes are homogeneous. Because the data above shows that the data is not normally distributed and the data is not homogeneous, the hypothesis test uses Mann-Whitney U, besides This test is used to determine whether **there is a difference between** unrelated classes. The test results are presented in the table below.

Table 9. Mann-Whitney U test Result

Test Statisticsa

Hasil	
<b>Mann-Whitney U</b>	94.500
<b>Wilcoxon W</b>	304.500
<b>Z</b>	-2.557
<b>Asymp. Sig. (2-tailed)</b>	.011
<b>Exact Sig. [2*(1-tailed Sig.)]</b>	.011
<b>a. Grouping Variable: Kelas b. Not corrected for ties.</b>	

Based on the statistical table above, the researcher compared the results in the control class and the experimental class regarding science competence. This test is said to be significant if the p-value  $\leq 0.05$  ( **$H_0$  is rejected**), **which means there is** significance then if the p-value  $> 0.05$  ( $H_0$  is accepted), **which means it is not significant.** **Based on the data above, it can be seen that the** value of Asymp. **Sig. value is  $0.011 \leq 0.05$ , then reject  $H_0$ , so it can be seen that there is a significant difference between the** control class using lecture learning and the experimental class using **guided inquiry learning on the material of** alternative energy sources.

## DISCUSSION

**The results of this study** clearly show that guided inquiry learning has a positive effect on students' scientific competence. This positive effect is consistent with the core principles of inquiry-based learning, which not only motivates students to think critically and solve problems but also actively encourages their participation in the learning process. Specifically, the structured yet open-ended approach of guided inquiry is effective in developing crucial 3 indicators of scientific competencies.

Guided inquiry effectively builds students' ability to explain phenomena scientifically through its hands-on and problem-solving nature, as students actively construct understanding from their investigations. This approach also proves effective in training students to evaluate and design scientific inquiry, enabling them to plan and assess their investigations. Furthermore, guided inquiry significantly improves students' capacity to interpret data and evidence scientifically. This skill is honed through direct engagement with collected information and conclusions. Such active engagement helps students to apply scientific concepts effectively in real-world contexts.

The observed effectiveness of guided inquiry model in fostering these scientific competencies is firmly rooted in the pedagogical philosophy of John Dewey, as developed by scholars like Sanjaya. Dewey **emphasized that learning is an active process** of inquiry, where students **construct knowledge through direct experience and** interaction with real-world problems. Guided inquiry, with its emphasis on student-led investigation and problem-solving, directly embodies Dewey's principles by engaging learners in authentic scientific processes rather than passive reception of information. This active engagement, central to inquiry-based learning, further aligns strongly with constructivist theories of learning, particularly Jean Piaget's

emphasis on active knowledge construction . According to Piaget, learners do not passively absorb information but rather build their own cognitive structures through direct interaction with their environment and hands-on experimentation. This process, where students actively engage in real actions and investigations to develop understanding, is precisely reflected in the guided inquiry model, providing a theoretical foundation for its positive impact on scientific competencies.

The findings of this study, which show a significant positive impact of guided inquiry on elementary students' science competencies, are strongly consistent with results from other similar research. For example, research by .It also shows that guided inquiry learning provides a balanced collaboration between learners and teachers that encourages cognitive abilities, critical thinking, and problem-solving skills. These consistent findings underscore the robust nature of guided inquiry as an effective pedagogical approach for developing essential scientific competence in elementary students.

The positive effect of guided inquiry learning on students' science competencies carries important practical implications for elementary science education. These findings suggest that integrating guided inquiry learning into the curriculum can be an effective pedagogical strategy for teachers to not only improve students' foundational scientific understanding but also to cultivate critical thinking and problem-solving skills essential for 21st-century learners. Furthermore, by actively engaging students in topics such as alternative energy sources through inquiry-based approaches, this study demonstrates a tangible method to support SDGs 13, climate change mitigation, from an early age. It encourages educators to design learning experiences that foster environmental awareness and empower students to become proactive in addressing global climate challenges through scientific literacy and practical application.

#### CONCLUSION

The results of the show a significant difference between the control group, which received lecture-based instruction, and the experimental group, which experienced guided inquiry-based learning, based on the Mann-Whitney U test (Asymp. Sig = 0.011 &lt; 0.05). Students in the experimental group achieved higher average scores in scientific competence: 14.5 for explaining, 18 for evaluating and designing, and 15.4 for interpreting data. These results confirm that guided inquiry learning had a positive effect on students' science competence. In addition, the learning activities also supported SDG 13 on climate change mitigation through simple experiments on alternative energy and a climate-themed quiz aligned with UNESCO's cognitive, socio-emotional, and behavioral indicators.

These three indicators each showed an average of 17.3 for cognitive, 14 for socio-emotional, and 15 for behavioral. The results of this study indicate that guided inquiry learning is also effective in instilling awareness and responsibility among students, as the younger generation is concerned about the environment and climate change to achieve SDG 13.

Further research could focus on the application of guided inquiry learning in other science topics related to sustainable development and climate change mitigation. This would provide deeper insights into how guided inquiry can enhance students' scientific competence and environmental awareness, especially in support of SDG 13.

#### ACKNOWLEDGMENT (optional)

With all humility, **I would like to express my gratitude to all parties involved in the** writing of this article, namely Muhammadiyah University of Sidoarjo, which always provides opportunities for its students to learn, develop, and grow. Thank you to my university for providing facilities and support to its students to become good individuals. I would also like to thank the students of SD Negeri Ketajen 1 for being part of and participating in my research.