



## Improving students' scientific literacy through inquiry learning at Solo Safari



Wachidatul Linda Yuhanna<sup>1,a,\*</sup>, Raras Setyo Retno<sup>2,b</sup>

<sup>1</sup> Department of Biology Education, Universitas PGRI Madiun, Madiun, Indonesia

<sup>2</sup> Department of Elementary School Education, Universitas PGRI Madiun, Madiun, Indonesia

Email: [linda.yuhanna@unipma.ac.id](mailto:linda.yuhanna@unipma.ac.id)<sup>1,a,\*</sup>, [raras@unipma.ac.id](mailto:raras@unipma.ac.id)<sup>2,b</sup>

\* Corresponding author

Article Information	ABSTRACT
<p><b>Article History:</b> Submitted: 2025-04-24 Revision: 2025-05-31 Accepted: 2025-05-31 Published: 2025-07-01</p> <p><b>Keywords:</b> Inquiry; Solo Safari; science literacy</p>	<p>The scientific literacy of students in the animal diversity course has not met the criteria. Students are less concerned, passive, and do not dare to express their problem-solving comprehensively. The animal diversity course requires learning methods and learning resources to improve scientific literacy. The purpose of this study was to analyze the effect of inquiry learning on improving students' scientific literacy at Solo Safari. This research method is quantitative research with a quasi-experimental method. The research design uses pre and post-test results of students' scientific literacy. The study population was 71 biology education students. The sample was 13 students who took the Animal Diversity course. The data taken is students' scientific literacy. The independent variable is inquiry learning at Solo Safari. The dependent variable is science literacy. The instrument used is a science literacy instrument, resulting in 15 valid statement items. Data analysis techniques were carried out with a paired sample t-test. N-gain score analysis was conducted to determine the effectiveness of science literacy. The results showed that the sig-value (2-tailed) = 0.000. The inquiry learning model affects students' scientific literacy. The inquiry learning model can improve students' scientific literacy. The result of the N-gain score on science literacy is 0.62 with moderate criteria. There is a significant increase in understanding of science literacy after students take part in learning with the inquiry approach. The conclusion of this study is, inquiry affects improving students' scientific literacy at Solo Safari. The application of inquiry in Solo Safari can increase students' scientific literacy in the moderate category. The implications of this study can be used as basic research to choose the right learning model for animal diversity courses. Science literacy instruments can also be used for various biological studies and other materials.</p>
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## INTRODUCTION

Indonesia is a megabiodiverse country that holds many natural resources, especially animals. The abundance of wildlife species places Indonesia as the country with the 3rd highest level of biodiversity in

the world (Sarinastiti & Wicaksono, 2021). Efforts to recognize and study animals can be done by increasing literacy and supporting research. The Animal diversity course is a course that must be taken by Biology Education students. This course is very complex in discussing animal identification, classification, taxonomy, and conservation efforts (Indriwati et al., 2018; Latifa et al., 2022; Rachmawati & Nurwahyunani, 2018). Mastery of the concepts of this animal diversity course will be more meaningful if students find the concepts they learn in real terms.

Mastery of the concept of animal diversity in a complex manner requires science literacy and critical thinking skills. Science literacy is the human ability to learn, apply, and analyze science from various events or science-related substantive (Syofyan & Amir, 2019; Yuliati, 2017). Science literacy includes science knowledge, science context, science competence, and science attitude. Science literacy can hone and encourage students as critical and solution-oriented regarding various natural phenomena. Science literacy also plays a role in understanding and helping to make decisions related to natural phenomena and their changes caused by human activities (Juhji & Mansur, 2020; Muslihasari et al., 2022). Science literacy is very influential on biology learning and also serves as an asset to produce a generation that can be competitive and solve various problems and challenges that they will face in the future, especially on the theme of nature (Muhimmatin & Prasetyo, 2024; Muliani et al., 2021).

Analysis of the initial conditions of Biology Education students at Universitas PGRI Madiun in studying the Animal Diversity course shows the results of science literacy that have not met the criteria classically. The results of observations show that students cannot explore critical thinking and analysis in processing information. The ease of using artificial intelligence and digitalization makes students less accustomed to analyzing their concepts and thoughts. Concept discovery relies heavily on AI explanations and digital information that has not been tested for accuracy. The use of AI for learning on the one hand, can reduce students' sensitivity in critical and rational thinking (Al Darayseh, 2023; Monib et al., 2024). In the aspect of scientific context, students have not analyzed complex classification material, vertebrate animal taxonomy, and solutions to conservation problems. This is not following the aspects of science literacy that encourage students to solve problems comprehensively based on existing facts (Asih & Supriyatin, 2022; Thahir et al., 2021).

Analysis of aspects of students' science literacy is also not optimal. As many as 73% of students are less concerned, passive, and have not dared to reveal comprehensive problem-solving. Students are satisfied with what is obtained from digital sources that have not been proven in reality. Whereas learning biology requires science literacy to find concepts and apply them (Yuhanna et al., 2017). This condition requires alternative learning solutions that are relevant for animal diversity courses that are able to hone students' science literacy skills. Science literacy aims to increase active participation in the basic concepts of biology and is associated with social and environmental fields (Sakti et al., 2021).

The Animal diversity course is an important aspect of biology that includes variations in living things at the genetic, species, and ecosystem levels (Indriwati et al., 2018). Therefore, the Biodiversity course has a strategic role in providing students with a comprehensive understanding of the diversity of living organisms and the importance of preserving natural biological resources (Hernawati et al., 2018). In its learning practices, direct observation of living objects, especially animals, is an essential component to improve students' conceptual understanding and empirical experience.

However, the reality in the field shows that direct observation of animals is not always easy to do. Animals cannot be found freely in just any place due to ecological factors such as specific habitats, seasonal activities, and hidden behavioral traits. This condition is a challenge in itself in implementing practicums and field studies in this course. As an alternative, lecturers often use indirect objects, such as

images, videos, preserved specimens, or other digital materials (Nur, 2013). Although visually helpful, this approach is considered less effective in conveying the real complexity of biological interactions and is unable to completely replace direct experience in nature (Irawati & Idrus, 2020). This gap shows that there are still limitations in the effectiveness of learning methods that are not based on direct observation, especially in the context of animal diversity. There has not been much research that has thoroughly examined the impact of these different methods on student understanding and how innovative solutions can be developed to overcome these limitations. Zoology lectures and practicals have been conducted with the help of multimedia (Nur, 2013), but evaluation results show that students need direct objects to support the lecture process.

The implementation of relevant learning models is needed to hone students' science literacy in studying animal diversity in depth. One of the learning models used to hone science literacy is inquiry. Through the inquiry model, students are trained to analyze concepts systematically to produce problem-solving according to facts (Indriwati et al., 2018; Irawati & Idrus, 2020). Inquiry can form students who are able to think rationally and make decisions based on evidence (Fitriani, 2019; Nanlohy et al., 2023). Inquiry is a model in that involves many students in the scientific process starting from formulating questions, designing focus experiments, collecting and supporting data, analyzing and discuss results, to make conclusions (Swart, 2017).

Various previous studies have shown that inquiry learning is an effective approach in improving science literacy. Inquiry learning is able to train scientific thinking skills through active involvement of students (Depin et al., 2024). However, most of the previous studies still focus on inquiry learning in a classroom or school laboratory environment, while studies linking inquiry learning with outdoor learning activities (outing class) are still relatively limited, especially in higher education (Abidin, 2017). Inquiry can train students to be more independent in the learning process and are responsible for their findings.

The novelty of this study is the animal diversity lecture conducted with an inquiry model and using observation objects at the Solo safari, to improving students' scientific literacy. Research Abidin (2017) and Nur (2013) shows that field lectures conducted by simply observing, without any learning of syntax to produce findings, do not produce maximum results. Research Nuzalifa (2021) shows that learning zoology with a cooperative method has not maximized self-potential, because students depend on groups. Science literacy is the ability of students to use science knowledge to identify problems and explain scientific facts based on conclusions (Subrata & Rai, 2022). This study uses a scientific literacy instrument consisting of science knowledge, context of science, science competence, and science attitude. This instrument has not been found in previous studies. So that inquiry is very promising as an effective method of learning about animal diversity. The observation location at the Solo Safari has also not been widely explored as a learning resource. Observation activities that mostly lead to in-situ objects, and ex-situ animal observation objects, have not been widely reported (Sarinastiti & Wicaksono, 2021). The findings from student activities in studying animal diversity at the Solo safari can be used as a database, information for the community, and the development of various open material products that support education.

The learning process of animal diversity, in addition to requiring relevant learning models, also requires contextual learning resources. Learning resources that can be used are safari parks. The safari park is an ex-situ location that functions as a conservation facility that is outside its natural habitat, similar to artificial (captive conservation). Ex-situ conservation institutions are not only animal conservation institutions but also tourist and educational facilities (Sarinastiti & Wicaksono, 2021). Solo Safari Park, as an educational vehicle based on conservation and biodiversity, offers great potential to become a natural

laboratory in the implementation of inquiry learning. Students' direct experience in observing animal behavior, studying ecosystems, and understanding the relationship between humans and the environment can be a strong context for improving their science literacy more authentically and contextually. The observation study at Solo Safari is expected to hone students' science literacy, especially in the process of data collection, in-depth analysis based on real objects, and linking to problems and solutions in the environment. Inquiry learning at Solo Safari, students can directly explore the study of identification, classification, and conservation of vertebrate animals. The purpose of this study was to analyze the effect of inquiry learning on improving students' scientific literacy at Solo Safari.

## RESEARCH METHODS

This research method is quantitative research with a quasi-experimental method. The research design is as shown in [Table 1](#), using pre and post-test results of students' scientific literacy. The study population was 71 biology education students. The sample was 13 students who took the Animal Diversity course. Sample selection using purposive sampling. The sample was selected based on the limited availability of participants who met the inclusion criteria, namely students taking animal diversity courses. This research was conducted in December 2024. The research site was Solo Safari and Universitas PGRI Madiun. The independent variable is inquiry learning at Solo Safari. The dependent variable is science literacy. The learning model used is inquiry which consists of orientation/stimulation, formulating problems, formulating hypotheses, collecting data and observation, analyzing and discuss data, make conclusions, and communicating results ([Hasnunidah et al., 2019](#)).

**Table 1. Research Design**

Pretest	Treatment	Posttest
O1	M1	O2

Description:

M1: Implementation of inquiry learning at Solo Safari

O1: Science literacy before inquiry learning in Solo Safari

O2: Science literacy after inquiry learning in Solo Safari

The instrument used is a science literacy observation sheet, as shown in [Table 2](#). The instrument has been validated by experts and tested for validity and reliability, resulting in 15 valid statement items to measure scientific literacy. The research procedure carried out was that the researcher conducted observations of students' scientific literacy skills. Students conducted an inquiry flow to observe the characteristics and classification of vertebrate animals in the Solo Safari. The researcher conducted a final observation of students' scientific literacy skills. The data taken is students' scientific literacy. Data collection technique was carried out by means of lecturers implementing inquiry learning at Solo Safari according to the syntax.

**Table 2. Student Science Literacy Observation Sheet**

No	Aspect	Statement observation sheet	Score				
			Very Good (5)	Good (4)	Quite Good (3)	Less Good (2)	Not Good (1)
1	Science Knowledge	Students are able to mention the main classification of vertebrate animals					

No	Aspect	Statement observation sheet	Very Good (5)	Good (4)	Score Quite Good (3)	Less Good (2)	Not Good (1)
2		Students are able to explain the characteristics of each vertebrate class based on observations					
3		Students identify morphological adaptations of animals according to their habitat.					
4		Students use scientific terms correctly when explaining the results of observations					
5		Students are able to relate animal diversity to environmental issues (e.g. conservation)					
6	Context of Science	Students explain the importance of maintaining the natural habitat of vertebrate animals.					
7		Students provide examples of application of animal diversity knowledge in daily life.					
8		Students make direct observations systematically and carefully.					
9		Students are able to record observation data accurately and in an organized manner.					
10	Science competence	Students analyze observation data and relate it to theory					
11		Students make scientific interpretations of phenomena observed in the field.					
12		Students draw conclusions based on evidence of observation data.					
13		Students show curiosity by asking critical questions					
14	Science attitude	Students are open to different data or other friends' observations					
15		Students show responsibility and scientific ethics during observation					

Data analysis techniques were carried out with a paired sample t-test to determine whether or not there were differences in science literacy variables before and after the use of inquiry learning at Solo Safari. N-gain score analysis was conducted to determine the effectiveness of science literacy before and after inquiry learning at Solo Safari Park. The N-gain score formula is as follows, and the N-gain score categories as shown in [Table 3](#).

$$\text{N-Gain Score} = \frac{\text{Score after treatment} - \text{Score before treatment}}{\text{Maximum Score} - \text{Score before treatment}} \quad (1)$$

**Table 3. N-gain score categories**

N-gain score	Categories
$g > 0.7$	High
$0.3 \leq g \leq 0.7$	Medium
$g < 0.3$	Low

## FINDING AND DISCUSSION

Science literacy is one of the essential competencies of the 21st century that reflects an individual's ability to understand scientific concepts, evaluate evidence-based information, and apply scientific knowledge in everyday life. The results of the research on students' scientific literacy are as shown in [Table 4](#). The paired sample test computation yielded a sig value (2-tailed) = 0.000. According to this data in [Table 4](#), the sig value is less than 0.005, indicating that  $H_1$  is accepted and  $H_0$  is rejected. The inquiry

learning model has an effect on students' scientific literacy. There is a difference in students' scientific literacy abilities before and after the application of the inquiry method in Solo Safari. The use of the inquiry method based on direct observation of animals at Solo Safari has strong potential in improving students' scientific literacy because it presents a contextual, active, and meaningful learning experience. The inquiry method tensions the active involvement of students in formulating questions, collecting data, analyzing information, and drawing conclusions through the scientific process. When applied in a real environment such as Solo Safari, students not only learn theories about animal diversity, but can also directly observe morphological characteristics, behavior, habitat, and ecological relationships between organisms. Inquiry learning is implemented in line with constructivist theory, which supports students developing concepts/knowledge with contextual activities.

**Table 4. Table of T-Test Results**

		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Science literacy <b>after</b> using the inquiry model at Solo Safari - Science literacy <b>before</b> using the inquiry model at Solo Safari	52,0	7,785	1.406	32,813	27.224	29,79	12	0,000

Biology learning is closely related to factual and contextual information following life. Currently, society continues to deal with issues related to climate change, nature conservation, health, new technologies, and environmental sustainability (Juhji & Mansur, 2020). Students, as part of society, need skills in capturing environmental and social issues to produce critical thinking. One of the competencies that must be possessed is science literacy. Science literacy means that a person can think scientifically, understand the principles of science, and apply them for personal and community welfare (Sumanik et al., 2021). At the higher education level, science literacy plays an important role in forming students who are critical, reflective, and responsible for science and environmental issues (Adriadi et al., 2025)

This research reveals student science literacy data from the implementation of inquiry learning at Solo Safari Park to improve science literacy in studying vertebrate animal diversity. At the first meeting, students understood the concepts of identification, classification, and animal diversity through various digital learning resources. Learning is done by direct instruction without any structured learning model. In the second meeting, students were trained in an inquiry learning model with direct learning resources, including real objects of vertebrate animals at the Solo Safari Park. One of the models that works well for applying the constructivism approach is the inquiry learning model (Fitriani, 2019). According to Andriani (2016), inquiry is the process of gathering data via experimentation or observation in order to use critical and logical thinking abilities to solve a problem.

Inquiry learning begins with orientation by lecturing on the topic of vertebrate diversity, the process of identification and classification, and conservation. The second step is that the lecturer guides students to formulate problems that will be solved at the Solo Safari Park. The third step is that the lecturer guides students to formulate hypotheses or temporary answers to the problems of vertebrate animal diversity.

The fourth step is for students to collect data with vertebrate observation studies at the Solo Safari Park to find answers to problems. The fifth step is to test the hypothesis; students determine the answer that is considered acceptable in accordance with the data or information obtained based on observation and data collection. Students also analyze the answer and provide a complete explanation. The sixth step is concluding and presenting results. Because they are actively involved in "doing" the investigation, students will gain a better understanding of vertebrate diversity thanks to inquiry-based learning (Yuhanna et al., 2017; Yuhanna & Retno, 2016).

The effectiveness of inquiry on science literacy can be seen from the N-gain score (Table 5). The result of the N-gain score on science literacy is 0.62 with moderate criteria. The N-gain score of science literacy is presented in Table 5. The N-gain score on the science knowledge aspect is 0.59 with medium criteria, the science context is 0.43 with medium criteria, science competence is 0.79 with high criteria, and science attitude is 0.68 with medium criteria.

**Table 5. N-Gain Score of Science Literacy of Students**

Aspects of science literacy	N Gain score	Criteria
Science knowledge	0,59	Medium
Science context	0,43	Medium
Science competence	0,79	High
Science attitude	0,68	Medium
Average	0,62	Medium

The results of the N-gain score according to Table 5 show that there is a significant increase in understanding of science literacy after students take part in learning with the inquiry approach. This experience encourages students to think critically and reflectively, and develop scientific skills such as observation, classification, and data interpretation. Direct interaction with real objects also increases students' motivation and curiosity, which are the main foundations in building scientific literacy. Scientific literacy itself includes an understanding of scientific concepts, the ability to solve science-based problems, and responsible decision-making on environmental and social issues. The increase in science literacy before and after the implementation of inquiry at Solo Safari shows a positive change in attitude and knowledge in learning about animal diversity. Adi et al. (2017) say that inquiry has a significant effect in improving science literacy, because it emphasizes the skills of investigation, experimentation, and problem solving. Inquiry is also able to link science concepts and social conditions of society (Ariza et al., 2021; Sakti et al., 2021).

This increase is due to the characteristics of the inquiry model, which provides space for students to experience the scientific process directly, from formulating problems to drawing conclusions (Irawati & Idrus, 2020; Marhamah et al., 2016). Inquiry also encourages students to think critically and reflectively through exploration and group discussions (Fitriani, 2019; Yuhanna & Retno, 2016). Inquiry also supports a more concrete and applicable learning context, especially when implemented outdoors such as at Solo Safari Park, where students can directly observe biotic objects and ecosystems related to biological material. The results show that the inquiry model has great potential to be developed further, especially if it is adjusted to the level of student readiness, facilities, and integration with real learning environments.

The measurement of science literacy used an observation sheet consisting of 4 aspects with 15 statements. Science knowledge, context, science competence, and science attitude are the elements that are being observed. The data in Table 5 shows that the N-gain score of the science knowledge aspect is 0.59 with moderate criteria. By the analysis of initial conditions and readiness, students all get knowledge

material about vertebrate animals in class. So that mastery of science literacy only needs to be practiced and integrated in structured and independent learning. A very high degree of curiosity in grasping a new idea using their method of thought is indicative of science literacy. Attitudes and behaviors that constantly aim to gain a broader and deeper understanding of what they see, hear, and learn. This aspect is interpreted as an attitude with a mindset that does not easily believe something without strong evidence. Scientific knowledge is a very good way to be able to analyze an idea based on logical reasoning and clear data (Retno & Yuhanna, 2018). A critical attitude is carried out by seeking as much information as possible, paying attention to data even if it is small, not accepting conclusions without strong evidence, originality, and giving opinions. Students begin to build concepts by collecting facts and sources used (Andrini, 2016; Nanlohy et al., 2023).

The second aspect is the context of science, with an N-gain score of 0.43 with moderate criteria. The context of science is closely related to the ability of students to understand and respond to a phenomenon related to the diversity of vertebrate animals. Open-mindedness will produce different points of view from various aspects (Yuhanna et al., 2017). As biology students, the concept of open-mindedness is needed so that we are not fanatical about one concept, but open to other views in obtaining facts and truths. The observation study at the Solo Safari contextually inspires students' thinking to be more sensitive and open in interpreting animal diversity and daily life (Dewi et al., 2024). Open-mindedness strongly supports the entry of new knowledge, opportunities, adventures, and greater happiness. The existence of a science context in students greatly encourages broad insights related to the material studied.

The third aspect is science competence with an N-gain score of 0.79, with high criteria. This stage is in accordance with the implementation of inquiry at Solo Safari. Students make direct observations, obtain data, record and analyze, and draw conclusions. This activity has not previously been done in learning about animal diversity. So, the increase in this aspect tends to be high. All of these phases align with the ideas of inquiry-based learning, in which students actively participate in the scientific method as researchers in addition to being information consumers (Ibrahim et al., 2018; Irawati & Idrus, 2020). This learning is carried out in a real environment, Solo Safari, which functions as an "open laboratory". (Sarinastiti & Wicaksono, 2021). Students interact directly with the object of study in the form of animal diversity, observing morphological characteristics, behavior, and habitat. This activity encourages students to develop science process skills naturally, something that has not previously been obtained in conventional classroom learning, especially on the topic of animal diversity, which is usually only conveyed through images or videos.

This high increase in scores can be explained by the fact that students experience contextual and meaningful learning experiences, and students are more motivated and intellectually challenged because they are involved in exploration and solving real problems. High N-Gain scores on aspects of science competence indicate that observation-based inquiry learning at Solo Safari Park not only improves conceptual knowledge but also empowers students to think and work scientifically (Dewantara et al., 2020; Dewi et al., 2024). This is an indication that inquiry learning is very appropriate to be applied in hands-on experience-based biology education.

The fourth aspect is science attitude, with a score of 0.68, with moderate criteria. The attitude of science is seen from the implementation of data collection and the way students communicate the results. A scientific attitude is the main thing in describing data following existing facts. A scientific attitude is also the ability to adjust to concepts that have been tested and easily understand the concept correctly. This scientific attitude is reflected in the ability of students to change opinions based on strong evidence and

be willing to accept different observations. Students are trained to see and analyze different results from other students. If the presentation of other data is deemed appropriate based on facts, students can add these findings to support material that has previously built knowledge (Fitriani, 2019; Retno & Yuhanna, 2018; Yuhanna & Retno, 2016). Scientific attitudes are supported by always wanting to prove the hypotheses they formulate for the development of their field of science.

Inquiry learning conducted through direct observation at Solo Safari has been proven to be able to significantly improve students' science literacy. Direct observation of animals and ecosystems at Solo Safari provides a real and meaningful learning experience. Students not only understand concepts theoretically, but also see and experience scientific phenomena directly, such as animal adaptation behavior, organism interactions, and interrelationships with the environment. This is in line with the science literacy approach (Manampiring et al., 2023), which requires students to be able to relate science concepts to real-world contexts. This process activates various cognitive aspects, including conceptual understanding, logical reasoning and problem-solving skills - all of which are at the core of science literacy. These skills are critical in developing functional scientific abilities, which enable students to use science in everyday life and evidence-based decision-making. Interactive and open learning environments such as Solo Safari Park arouse students' interest in learning and natural curiosity. This fosters scientific attitudes such as openness to data, curiosity, and a critical attitude towards the information obtained - an important part of the affective dimension in science literacy.

Inquiry learning at Solo Safari Park presents ecosystems as a medium for learning about animal diversity (Rachmawati & Nurwahyunani, 2018) where students directly understand the relationship between organisms and the importance of environmental conservation. This forms ecological awareness, one part of science literacy that is not only cognitive, but also ethical and social (Ariza et al., 2021). In addition, Solo Safari Park provides a diversity of animals from various taxonomic classes, making it a rich authentic learning resource to explore concepts such as adaptation, evolution, conservation, and ethics of animal treatment. Therefore, the combination of inquiry methods and natural learning environments such as educational zoos can synergistically improve students' conceptual understanding and scientific thinking skills, which are key indicators of scientific literacy.

## CONCLUSION

This study concludes that there is an effect of the application of the inquiry learning model on improving students' scientific literacy in Solo Safari with a sig-value (2-tailed) = 0.000. The application of inquiry in Solo Safari can increase students' scientific literacy in the moderate category, with an N-gain score of 0.62. This study has limitations in the number of samples and is limited to vertebrate animal material. The implications of this study can be used as basic research to choose the right learning model for animal diversity courses. Science literacy instruments can also be used for various biological studies and other materials. Solo Safari can also be an alternative source of relevant vertebrate animal learning. Recommendations for further research are the addition of relevant student samples, more complex zoology materials, and the development of further learning models.

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