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Effectiveness of Ecotourism-Based Field Practicum Model in Improving Scientific Literacy of Prospective Biology Teacher Students

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Abstract: Scientific literacy is an essential competency for prospective science educators in understanding scientific concepts, applying scientific methods, and making decisions based on scientific evidence. This study aims to test the effectiveness of the Ecotourism-Based Field Practicum Model (MPLBE) in improving the scientific literacy of prospective biology teacher students. The subjects of the study were students of the Biology Education study program, FKIP, Mataram University, who took the vertebrate Zoology course. The research design used was a quasi-experiment with a pretest-posttest control group design. The experimental group used the MPLBE model that focused on the study of ecology and conservation of the *M. reinwardt* bird in the Gunung Tunak and Kerandangan Nature Tourism Parks, while the control group followed conventional practicums in the laboratory. The research instrument was a scientific literacy test that had been validated by experts. Quantitative analysis was performed on the effectiveness of the model using N-Gain and the Mann-Whitney Test. The results of the data analysis showed a significant difference in the increase in scientific literacy scores between the experimental and control groups. These findings indicate that the MPLBE model is effective in improving students' scientific literacy. This model not only strengthens the understanding of biological concepts contextually, but also builds environmental awareness and scientific thinking skills of prospective biology teachers. This study recommends the integration of ecotourism in biology learning as an innovative approach based on local potential.

Keywords: *M. reinwardt*; Ecotourism; Field Practice; Science Literacy.

Introduction

Scientific literacy is an essential competency for prospective biology teacher students in understanding and applying science concepts effectively. This ability includes skills in identifying valid scientific opinions, conducting effective literature searches, understanding research design, and interpreting quantitative data. However, various studies show that the level of scientific literacy of prospective biology teacher students is still in the low to moderate category. Students' understanding of conducting effective literature searches only reached 49.14%, while the ability to understand research design elements was 60.92% [1].

One approach that can be applied to improve scientific literacy is through ecotourism-based field practicums. This method integrates practicum activities with the utilization of local ecotourism potential, so that students can learn contextually and applicably. Ecotourism-based science practicums focusing on the *M. reinwardt* bird can improve students' creative thinking skills [2]. This indicates that an ecotourism-based approach not only enriches the learning experience but also encourages the development of high-level thinking skills [3].

The *M. reinwardt* bird, known as the red-footed scrubfowl, is an endemic species that plays an important role in tropical forest ecosystems. The unique existence and behavior of this bird make it an interesting subject to study in the context of biology and conservation education. The study of the nesting microhabitat of this bird on Satonda Island, Moyo Satonda National Park, provides in-depth insight into the interaction of this species with its environment. The use of M. reinwardt birds in ecotourism-based field practicums is expected to improve students' understanding of ecology and conservation, while strengthening their scientific literacy [2].

The Ecotourism-Based Field Practicum Model is designed to combine theoretical learning with practical experience in the field, utilizing local natural resources as a learning media [4-5]. This approach is expected to improve students' observation, data analysis, and problem-solving skills through direct interaction with the objects of study in their natural habitat. In addition, MPLBE also aims to foster awareness and concern for environmental conservation through active involvement in ecotourism activities.

This study aims to evaluate the effectiveness of the implementation of MPLBE in improving the scientific literacy of prospective biology teacher students. The main

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focus of this study is to measure the improvement of students' abilities in understanding and applying scientific concepts, as well as developing critical thinking skills through field practicum activities based on *M. reinwardt*'s bird ecotourism. The results are expected to contribute to the development of innovative learning models that integrate biology education with the utilization of local ecotourism potential.

Research Methods

This study used a quasi-experimental design with a pretest-posttest control group design. This design was chosen to evaluate the effectiveness of the Ecotourism-Based Field Practicum Model (MPLBE) in improving the scientific literacy of prospective biology teacher students. The quasi-experimental approach allows researchers to control and compare the results between the experimental and control groups, although without full random assignment.

Research Subject

The subjects of the study were fifth-semester students of the Biology Education Study Program at the Faculty of Teacher Training and Education, University of Mataram, who were taking the Animal Ecology course. A total of 60 students were selected purposively and divided into two groups: an experimental group consisting of 30 students and a control group consisting of 30 students. The experimental group followed learning with the MPLBE model that focused on the study of ecology and conservation of *M. reinwardt* birds in local ecotourism areas, while the control group followed conventional practicums in the laboratory.

Research Instruments

The main instrument used in this study was a scientific literacy test developed and validated based on the PISA 2015 scientific literacy framework. This test measures three core competencies: scientific explanation of phenomena, evaluation and design of scientific investigations, and interpretation of scientific data and evidence. The validity and reliability of the instrument were tested using the Rasch model to ensure the quality of the measurement.

Research Procedures

1. Preparation Stage: Development of MPLBE learning tools, including field practicum modules and observation guides, as well as validation of scientific literacy test instruments by experts.
2. Pretest Implementation: Before the intervention, both groups were given a pretest to measure their initial scientific literacy level.
3. Intervention:
   a) Experimental Group: Participated in ecotourism-based field practicums involving direct observation, data collection, and ecological analysis of the *M. reinwardt* bird in its natural habitat.
   b) Control Group: Undergoing conventional laboratory practicums with the same material without involvement in ecotourism activities.
4. Posttest Implementation: After 4 weeks of intervention, both groups were given the same posttest as the pretest to measure changes in scientific literacy.

Data analysis

The data obtained from this mixed-methods research consists of qualitative and quantitative data. Qualitative data includes: (1) characteristics of the PLBE Model, (2) indicators of scientific literacy and critical thinking skills, (3) student attitudes toward the PLBE Model, (4) student perceptions of bird ecotourism, and (5) student responses to the PLBE Model. Meanwhile, quantitative data consists of: (1) scientific literacy skill scores, and (2) critical thinking skills.

The research data analysis used sequential data analysis techniques, which include: (1) qualitative data analysis, (2) quantitative data analysis, and (3) combined analysis of both types of data. Qualitative data obtained before, during, and after M-PLBE were analyzed using interpretive descriptive analysis, while quantitative data were analyzed using inferential statistical methods. The normalized gain percentage for each student was calculated using the formula developed by Hake (1998) [6].

$$\%g = \frac{\text{S post}}{\text{S max}} - \frac{\text{S pre}}{\text{S post}}\ x100\%$$

Information:
% g = normalized gain percentage, Spost = final test score, Spre = initial test score, and Smax = maximum score.
N-Gain Score Category:
g > 0.7 Height; 0.3 g ≤ 0.7 Medium; and g < 0.3 Low
N-Gain %:
% > 70 g High; 30 < 70 g Medium; and % < 30 g Low.

Statistics were tested using SPSS version 16 at a significance level of 5%. Qualitative data were analyzed using descriptive statistical methods, which include calculating the average response for each item presented in percentage form for each statement.

Results and Discussion

The scientific literacy skills measured include six indicators, namely (1) explaining scientific phenomena scientifically; (2) evaluating and designing scientific investigations; (3) interpreting data and evidence scientifically; (4) applying science in everyday life; (5) showing an attitude of interest in science that plays an important role in decision making; and (6) showing a creative attitude, providing innovative ideas based on logical thinking and scientific knowledge (Appendix 3). The measurement was carried out with a written test before (Pretest) and after (Posttest) the MPLBE activity using 25 multiple-choice questions with five options. In addition to the measurement through a written test, it was also carried out through observation during the MPLBE activity process, assisted by a practicum assistant at each stage of the MPLBE by referring to the KLI observation sheet that had been prepared by the researcher. The

following table presents a summary of the results of the KLI measurement through written tests and observations in the MPLBE activity.

The results of observations on the implementation of MPLBE show variations in the achievement of KLI indicators for prospective biology teacher students. From the four main indicators of observing, classifying, predicting, and communicating, quantitative data were obtained, indicating the dominance of achievement levels at medium to high levels. More details are presented in Table 1.

Table 1. Observation Results of the Dominant Implementation of KLI in MPLBE on Prospective Science-Biology Teacher Students 2024

No	Scientific Literacy Skills Indicators	S kor			∑ Students	%
		1	2	3		
1	Observing:					
	Using measuring tools	5			5	17.9
	Reading measurement results		3		3	10.7
	Collecting or writing down observation results			20	20	71.4
2	Classifying:					
	Identifying Habitat Components	4			4	14.3
	Tabulating observation results		9		9	32
	Classifying observation results			15	15	53.6
3	Predict:					
	Using the results of observations to predict an object or	3			3	10.7
	phenomenon and stating things that might happen in situations		13		13	46.4
	that have not been observed.			12	12	42.9
4	Communicating					
	Serve,			12	12	42.9
	discussion, and		4		4	14.3
	conclusion from observation results	2			2	7.1

Data source: Researcher's observation results (Appendix 24)
Information:
Observation: 1= collecting incomplete observation results; 2= collecting complete observation results; 3= collecting complete, relevant and clear observation results. Classifying: 1 = Unable to classify the results of his observations; 2 = classification of the results of his observations with the help of a lecturer; 3 = classification of the results of his observations was done independently. Predicting: 1 = cannot use the results of observations to predict what might happen; 2 = can use the results of observations to predict what might happen; 3 If can use the results of observations to predict and state what might happen in conditions that have not been observed. Communicating: 1 = presenting, discussing and concluding the observation results are unclear; 2 = discussing and concluding the observation results are unclear; 3 = presenting, discussing and concluding the results are clear.

The results of observations on the indicators of students' scientific literacy skills during the implementation of MPLBE in Table 1 above, recorded four indicators, namely the skills of observing, classifying and communicating observation results, were carried out well by more than 60% of student practitioners. The KLI indicator "collecting or writing complete and clear observation results was carried out well by 20 students (71%). presenting, discussing, and clearly concluding the results of observations involving as many as 15 people (54%), and the classification of observation results was carried out independently by 18 students (43%). One of the four indicators, namely the indicator of the skill of predicting things that might happen, was carried out well by 12 students (43%). From these data, it can be interpreted that the majority (52.7%) of prospective Biology teacher students at the FKIP University have scientific literacy skills in the good category, 25.9% in the poor category, and 12.5% in the low category. These results are not much different from those reported by another study, which indicates that students' scientific literacy skills are still below the criteria of being lacking, as indicated by students' skills in understanding research methods that lead to scientific knowledge of 59.54%, and skills in organising, analysing, and interpreting quantitative data [7]. In this regard, students' scientific literacy skills in several sub-indicators include 1) Evaluation and useinformationscientific 79 (good), 2) understanding research design elements and predicting their impact on scientific findings 28 (very poor), 3) creating graphs that can represent data 28 (very poor), 6) reading and interpreting data 56 (poor), 7) problem solving using quantitative skills 33 (very poor), 8) understanding and being able to interpret basic statistics 24 (very poor), 9) presenting conclusions, predictionsbased onquantitative data 31 (very lacking) [8]. Students' scientific literacy skills towards basic biological concepts for both competencies are dominated by the nominal category with a percentage range of 62%, in the functional category 34% and in the conceptual category in the range of 4% - 7% (Wibowo, 2019).

In the observation indicator, the majority of students (71.4%) were able to collect complete, relevant, and clear observation data (score 3). This reflects the effectiveness of MPLBE in training observation skills through direct activities in the field, where students use measuring instruments, read measurement results, and record ecological data systematically. These results are in line with the findings, which state that direct involvement in observing nature can improve students' accuracy and data analysis skills in the context of science [9].

The classification indicator shows a fairly varied score distribution, with 53.6% of students at a score of 3 (independent classification), 32% at a score of 2 (with the help of lecturers), and 14.3% at a score of 1 (unable to classify). Although more than half of the students have been able to classify independently, these results indicate the need for strengthening the systematic thinking aspect

in grouping information from observations. Classification is a skill that requires a strong conceptual understanding and repeated practice in real contexts [10].

In the predicting aspect, student achievement is in the medium to high category, with details of 46.4% achieving a score of 2 and 42.9% achieving a score of 3. This shows that most students are able to use observational data to predict phenomena that have not been observed, although there are still 10.7% who have not shown this ability. This indicates that MPLBE is starting to be able to build students' scientific inference skills, in accordance with the statement that predictive skills will develop further in the context of experiential learning and real problems in the surrounding environment [11].

The communication indicator actually shows a less-than-optimal score distribution. Only 7.1% of students are at the highest score (3), while the majority (42.9%) are at a score of 1, and the rest (14.3%) are at a score of 2. This shows that there are still many students who are not able to convey the results of their observations clearly and coherently. Scientific communication skills are a complex aspect, involving logical thinking structures and the ability to construct coherent scientific arguments. Although students are active in field practicums, they still need special guidance to improve their ability to convey results in the form of good scientific reports or presentations [12].

Overall, the observation results show that the MPLBE model is effective in developing scientific literacy skills in the observation, classification, and prediction indicators, but still requires strengthening in the scientific communication aspect. This indicates that ecotourism-based contextual learning is able to provide meaningful learning experiences and form the basis for scientific thinking of prospective teacher students. The integration of this approach into the practicum curriculum is expected to be a strategic step in forming competent, reflective, and environmentally aware science educators.

To measure the effectiveness of MPLBE in improving the scientific literacy skills of prospective biology teacher students, a comparative test was conducted between the experimental class and the control class using pretest, posttest, and N-Gain data. The test results and their analysis are presented in Table 2

Table 2. Results of Pretest and Posttest, KLI, and N-Gain Analysis of Experimental Class and Control Class of Prospective Biology Teacher Students 2024

	Experimental Class					Control Class				
ID	Pretest	Posts	g	N-gain (%)	Category	Pretest	Posts	g	N-gain (%)	Category
1	60	90	30	75	Hig	58	80	32	57	Medium
2	21	54	33	42	Mediur	30	54	24	39	Medium
3	36	53	17	27	Low	24	53	29	27	Low
4	40	73	33	55	Medium	36	63	27	36	Medium
5	35	63	28	43	Medium	42	73	31	63	Medium
6	16	46	30	36	Medium	28	46	18	31	Medium
7	31	41	10	14	Low	22	41	19	29	Low
8	35	40	5	8	Low	17	40	23	20	Low
9	34	77	43	65	Medium	42	75	35	66	Medium
10	41	84	43	73	High	32	54	22	40	Medium
11	28	41	13	18	Low	23	41	18	27	Low
12	49	88	39	76	High	57	72	31	77	High
13	40	94	54	90	High	47	70	47	73	High
14	44	94	50	89	High	55	80	39	86	High
15	38	58	20	32	Medium	29	58	29	14	Low
16	50	95	45	90	High	51	70	44	84	Tall
17	45	68	23	42	Medium	39	68	29	40	Medium
18	56	95	59	92	High	47	70	48	82	High
19	40	86	46	77	High	43	70	43	79	High
20	34	52	18	27	Low	33	52	19	19	Low
21	44	72	28	50	Medium	41	72	31	38	Medium
22	33	80	47	70	Medium	55	81	35	83	High
23	49	92	43	84	High	42	70	50	65	Medium
24	38	81	43	69	Medium	43	71	38	66	Medium
25	18	60	42	51	Medium	44	60	16	26	Low
26	44	91	57	76	High	46	70	45	86	High
27	41	62	21	36	Medium	26	41	15	25	Low
28	61	90	29	74	High	High	-	-	-	-
∑	1082	1999	949	1580	-	1052	1695	837	1378	-
Average	38.6	71.3	34	57	Medium	39	63	31	51	Medium
Mom	62	98	66	92	-	54	85	64	86	-
Min.	18	42	18	18	-	24	41	15	14	-
Mann-Whitney Test Pretest Asymp. Sig. 0.673										
Mann-Whitney Test Post test Asymp. Sig. 0.038										

Source: Results of Researcher Measurement and Analysis.
Description: Decision-making criteria are that if the value: %g > 70 is high, 30 ≤ %g≤70 is medium, and %g < 30 is low (Hake, 1998).

Based on Table 2, the average score of the N-gain pretest *KLI* of the experimental class students was 38, and the average score of the pretest of the control class was 39. Furthermore, to determine the significance of the difference in N-gain *KLI* between the two classes, a difference test was carried out using the Mann-Whitney Test, considering that the two samples were not normally distributed and the numbers were different. The results of the difference test for the average N-gain pretest score of the experimental class and the control class obtained Asymp. Sig. value of 0.673. If the Asymp. Sig. value ≤ 0.05, it means that there is a difference in scientific literacy skills between the experimental class and the control class [13]. Based on the criteria, this means that the initial abilities of students in both experimental and control classes before the MPLBE learning process did not differ significantly (Table 2).

The average N-gain post-test in the experimental class was 57%, while in the control class it was 51%. The results of the N-gain post-test difference between the two classes using the Mann-Whitney Test showed an Asymp. Sig. value of 0.038 ≤ 0.05. This indicates a significant difference in *KLI* between the experimental class and the control class. In other words, it can be said that there is an increase in ability which is significant to the *KLI* of experimental class students after MPLBE activities. This is in accordance with the results of the study. Half of the students achieved the scientific literacy standard (69.23%), and most (93.7%) of the students agreed that the experimental model was useful and wanted to apply it for the next activities [14].

Of the 28 participants in the experimental class, eight out of 15 people were recorded as participating. The N-gain percentage is classified as ineffective; six out of four people are in the fairly effective category, and eight out of six people are in the effective category. Meanwhile, in the control class of 27 participants, the N-gain is divided into three categories, namely high, five people, medium, 6 people, and low, 16 participants. The increase in the average N-gain percentage score in the experimental class was 57%, which is included in the fairly effective category, while the control class was 51%, which is included in the ineffective category.

Based on Table 2, it is known that the average pretest score of the experimental class was 38.6 and increased to 71.3 in the posttest, with an average N-Gain of 57%, which is in the medium category. In contrast, the control class showed an increase from 39 to 63, with an N-Gain of 51%, also in the medium category. However, if analyzed more deeply, the increase in scores and N-Gain values in the experimental class was more consistent and higher for most students. As many as 10 out of 28 students in the experimental class (35.7%) reached the high category, while in the control class, only 8 out of 27 students (29.6%) were in that category. This indicates that learning with the MPLBE approach contributes more significantly to improving scientific literacy skills. Furthermore, the maximum N-Gain value in the experimental class reached 92%, while in the control class it was only 86%. Even the minimum N-Gain value in the experimental class was higher (18%) compared to the control class (14%). This shows that MPLBE not only has an impact on improving students with high abilities, but also provides support to students with lower initial abilities.

The Mann-Whitney non-parametric statistical test showed that there was no significant difference in the pretest scores between the experimental and control classes (Asymp. Sig. = 0.673 > 0.05), indicating that both groups had equivalent initial abilities. However, the posttest results showed a significant difference (Asymp. Sig. = 0.038 < 0.05), which strengthens the assumption that the difference in increasing scientific literacy was more due to the treatment given in the form of the MPLBE model.

This finding is in line with the results of previous research by Good et al. (2024), who stated that ecotourism-based practicums can provide a real context that encourages students to think scientifically and critically through direct experience in the natural environment. In addition, real-world experience-based learning allows for the integration of theory and practice and forms a deeper conceptual understanding [16].

In general, a more significant increase in the experimental class shows that MPLBE is not only an alternative method of practicum but also an effective means of developing the scientific literacy skills of prospective biology teachers. By directly observing the ecosystem and conducting real measurements in the field, students are actively involved in the real scientific process. This gives them greater ability to observe, classify, predict, and communicate scientific results in a structured manner.

Conclusion

Based on the results of the research and discussion that have been conducted, it can be concluded that: 1) The Ecotourism-Based Field Practicum Model is effective in improving the scientific literacy skills of prospective biology teacher students. This can be seen from the increase in posttest scores and N-Gain values in the experimental class which are higher than the control class; 2) The implementation of MPLBE provides a meaningful, contextual, and applicable direct learning experience in the field. This encourages students to be active in scientific processes such as observing, classifying, predicting, and communicating results scientifically; 3) Statistically, there is a significant difference in the posttest results between the experimental class and the control class (p = 0.038), which indicates that this model has a real impact on improving students' scientific literacy skills; and 4) Observation data shows that the most dominant indicators of scientific literacy skills developed through MPLBE are the ability to observe and classify, while the ability to communicate scientific results still needs to be further improved.

Author's Contribution

M. Yamin: responsible for conceptualization of the research, development of ecotourism-based field practice models, and implementation of the research. A. Wahab Jufri: played a role in academic supervision and review of the contents of the manuscript. Aliefman Hakim: contributed to data processing and analysis. Gunawan:

supported in validation of research design and data visualization.

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