

Integrating Indigenous Knowledge of Papuan in Biology Education: Teaching Conservation of The Numfor Paradise Kingfisher

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Abstract. This study developed conservation teaching materials integrating indigenous knowledge using the Numfor Paradise Kingfisher (*Tanysiptera carolinae*) as a contextual model. The study applied a research and development approach based on the ADDIE model and involved 24 students from the Biology Education Department of Papua University. Data were collected through expert validation, classroom implementation in the New Guinea Biota Conservation course, interviews, student questionnaires, pre-test and post-test assessments. The developed materials achieved high validity (88,68%) and excellent practicality (93,22%). Effectiveness testing showed a significant improvement in students' conservation literacy, indicated by a high N-gain score (0,84) and a significant difference between pre-test and post-test results ($p = 0,001$). The results demonstrate that integrating indigenous knowledge of Papuan into New Guinea Biota Conservation learning materials effectively enhances students' conservation literacy. This study provides an applicable instructional model for culturally contextualized biodiversity education and supports the development of sustainable conservation learning in biodiversity-rich regions.

1 Introduction

In biology education, contextual teaching materials are essential for improving students' understanding of ecological concepts and their applications in real-world situations. However, many existing resources are not directly relevant to local environmental contexts. This limitation reduces their effectiveness in developing student awareness of conservation issues. This problem is particularly evident in Papua, a region known for its remarkable biodiversity and deep cultural connections with nature. However, teaching materials that integrate indigenous ecological knowledge with biodiversity conservation are lacking. This absence makes it difficult to provide locally grounded and meaningful learning experiences for students.

Strengthening biological education through context-based materials that reflect Papua's unique ecological and cultural characteristics is crucial for promoting conservation literacy. Developing contextual teaching materials can make biological education more relevant and transformative. In Papua, integrating traditional ecological knowledge with formal science education can bridge local and scientific worldviews, helping students appreciate biodiversity while nurturing conservation-oriented values [1–3].

Papua is one of the world's most biologically diverse regions and is home to approximately 15,000 plant species, 700 bird species, and 200 mammal species,

many of which are endemic to New Guinea [4]. The Numfor Paradise Kingfisher (*Tanysiptera carolinae*), an endemic bird on Numfor Island in the Biak–Numfor Archipelago, represents the region's ecological uniqueness. According to the IUCN Red List, this species is classified as Near Threatened because of its restricted range and ongoing habitat degradation [5]. Although it is relatively common within its limited distribution, there are currently no published estimates of its total population size in terms of mature individuals. Instead, the population trend is believed to decline as forest habitats continue to decline.

Despite its ecological and cultural significance, there remains a lack of educational materials that highlight the conservation importance of this bird species or incorporate indigenous ecological perspectives [6]. To address this gap, the present study designed and validated teaching materials that integrated community-based ecological insights into biodiversity conservation learning. This approach represents a novel contribution to biology education by fostering a culturally responsive pedagogy that strengthens both scientific understanding and ecological stewardship. Several studies have explored the integration of cultural values and indigenous knowledge into environmental education in order to strengthen conservation literacy and awareness [7,8].

Responding to these challenges, the present study developed and validated the Biota New Guinea

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Conservation teaching materials that incorporated the ecological knowledge and cultural perspectives of the Manggari community. This initiative provides a concrete educational model that integrates indigenous ecological insights into formal biological education. Unlike previous studies that broadly included local wisdom as thematic content, this study focused specifically on the conservation of the Numfor Paradise Kingfisher (*Tanysiptera carolinae*), an endemic species representing Papua's unique biodiversity.

Adopting a Research and Development framework [9]. This study produced teaching materials that were empirically tested for validity, practicality, and effectiveness in improving conservation-oriented literacy among university students. The strategic role of this study lies in its ability to translate local ecological knowledge into structured learning experiences, thereby supporting both conservation education and community-based biodiversity protection. The novelty of this study is its integration of cultural identity, scientific learning, and species-focused conservation into a single pedagogical model, offering a new pathway for context-based biological education in ecologically diverse regions.

2 Methodology

2.1 Research Design

This study employed a Research and Development using the ADDIE model, which consists of five systematic stages: Analysis, Design, Development, Implementation, and Evaluation. The model was chosen for its effectiveness in producing validated, practical, and measurable learning materials that align with the pedagogical objectives. The process aimed to produce a student book on New Guinea Biota Conservation, with a specific emphasis on the endemic Numfor Paradise Kingfisher (*Tanysiptera carolinae*) as a representative species for contextual Conservation New Guinea learning. This study was conducted through two interrelated stages. In the first stage (research), qualitative data were collected from the Manggari community on Numfor Island, Biak Numfor Regency (Figure 1). Semi-structured interviews were employed to document indigenous people's knowledge.

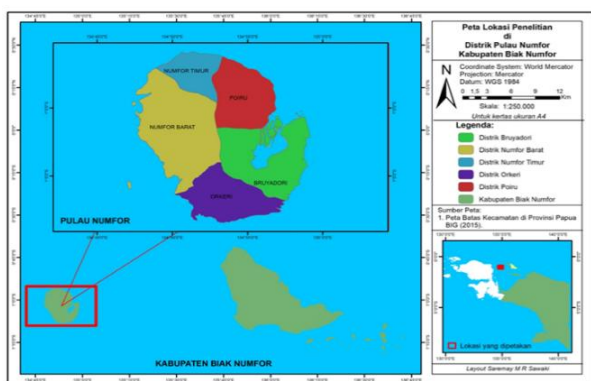


Fig.1. Map of Numfor Island

The second stage (prototype development) involved designing and refining students books based on the field data and pedagogical analysis. This phase engaged students from the Biological Education Department of Papua University, in developing and testing the prototype from December 2023 to August 2024. This process followed the principles of the ADDIE model (Figure 2).

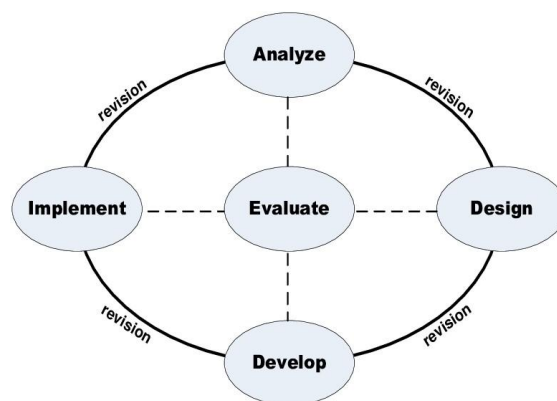


Fig.2. ADDIE development model

2.1.1 Analysis stage

The analysis stage aimed to identify instructional needs and existing gaps in the New Guinea Biota Conservation course. Interviews with course lecturers revealed the absence of teaching resources addressing the conservation of Numfor Paradise Kingfisher (*Tanysiptera carolinae*), an endemic Papuan species. Additional data were obtained through interviews with members of the Manggari Indigenous peoples' ecological knowledge. A literature review was conducted to collect supporting studies related to biodiversity conservation and local ecological perspectives. The findings emphasize the need for teaching materials that integrate ecological science with community-based knowledge to enhance students' understanding of conservation issues.

2.1.2 Design stage (blueprint, content structure, and software used)

A blueprint for the teaching materials was drafted based on the results of the analysis. The content was structured to align with the course's learning objectives, mapping key competencies, concepts, and procedural knowledge relevant to biodiversity conservation. Contextual learning strategies were embedded to connect indigenous people's knowledge. The Canva application was used to design a student learning book, ensuring an engaging visual layout.

2.1.3 Development stage (expert validation)

During the development stage, the prototype of the student learning book and conservation literacy assessment instrument were submitted for validation by subject matter, media, and language experts. The subject experts reviewed the scientific accuracy and

pedagogical alignment of the content. Media experts evaluated the design layout, typography, and visual presentation, whereas language experts assessed clarity, coherence, and academic tone. Feedback from validators and pilot testing sessions with students were used to refine and improve the materials.

2.1.4 Implementation stage (trial for students)

The validated teaching materials were implemented in a classroom setting involving 24 students from the Biology Education Department at the Papua University. A pre-test and post-test design was used to measure changes in conservation literacy. The pre-test, consisting of 15 items, was administered before the learning activities, followed by the use of the developed materials and the post-test. This implementation phase aimed to evaluate the effectiveness of these materials in enhancing students' conservation literacy.

2.1.5 Evaluation stage

The evaluation stage analyze the practicality and effectiveness of the developed materials using statistical measures, such as N-gain and t-tests. The evaluation was conducted continuously across all development phases, integrating both the formative and summative assessments. A formative evaluation was performed during expert validation and pilot testing to ensure continuous quality improvement. In contrast, summative evaluation was implemented after the classroom application, drawing on students' performance data and feedback to determine the overall effectiveness of the student book in enhancing conservation literacy.

2.2 Population and Sample

The research subjects were 24 students in the New Guinea Biota Conservation course. The study population was defined as all students taking the course, from whom the sample was selected for the limited implementation trial.

2.3 Data Collection and Instrument

The instruments used in this study included expert validation sheets for media and content, pre-test-post-test instruments for assessing conservation literacy, and student response questionnaires. Data were collected through a pre-test-post-test design (15 items) that measured conservation literacy in terms of knowledge, attitudes, and participation.

2.4 Data Analysis

The validation instruments used a 5-point Likert scale response format: (1) very poor, (2) poor, (3) fair, (4) good, and (5) excellent. The assessment instrument was validated by content and media experts to ensure its accuracy and relevance (Table 1-2).

$$\text{Percentage (\%)} = \frac{\text{score validation}}{\text{Total score validation}} \times 100\% \quad (1)$$

Table 1. Interval values of teaching materials validity and questionnaire criteria

Interval (%)	Category
81-100	Completely valid/Excellent
61-80	Valid / Good
41-60	Less valid / Fair
21-40	Invalid / Poor
0-20	Completely Invalid / Very poor

Table 2. Interval values for conservation literacy

Interval (%)	Category
85-100	Very High
65-84	High
45-64	Moderate
25-44	Low
< 24	Very Low

The pre-test and post-test data were analyzed to assess the improvement in students' performance before and after the implementation of the research-based teaching materials. This analysis aimed to describe the enhancement of students' conservation literacy following the use of materials that integrated the local wisdom of the Manggari Indigenous community to conserve Numfor Paradise Kingfisher (*Tanysiptera caroliniae*). To determine the extent of improvement, N-gain values were computed using a standard formula [10] (Table 3).

$$\text{N-gain} = \frac{\text{post-test} - \text{pre-test}}{\text{maximal score} - \text{pre-test}} \quad (2)$$

Table 3. Interpretation N-gain

N-gain	Interpretation
N-Gain $\geq 0,70$	High
$0,30 \leq \text{N-Gain} < 0,70$	Moderate
N-Gain $< 0,30$	Low

3 Result and Discussion

The product generated in this research is a set of teaching materials for the course Conservation of New

Guinea Biota, and the ADDIE development model was applied [9].

3.1 Analysis

In the course Conservation of New Guinea Biota, the development of a student book based on research on the local wisdom and conservation of the endemic Numfor Paradise Kingfisher (*Tanysiptera carolinae*) was carried out through needs analysis, curriculum review, and syllabus evaluation of the course. The analysis began by identifying and examining the learning problems that served as key considerations for developing the instructional materials. A student needs analysis was then conducted through the observation of learner characteristics, including their abilities and motivation toward the Conservation of New Guinea Biota course.

An analysis of the Merdeka Belajar-Kampus Merdeka curriculum was also undertaken, followed by a review of the course syllabus to determine concepts and materials aligned with the course objectives. The process aimed to define the scope and depth of learning content. A conceptual analysis was integrated into the teaching materials to ensure alignment with the targeted competencies. The proportion of the course syllabus in the developed materials was systematically identified during this process.

3.2 Design

The design stage focused on developing the media and learning content. The design included defining bird diversity and its influencing factors, conservation of the Numfor Paradise Kingfisher (*Tanysiptera carolinae*) based on local wisdom gathered from interviews with the Manggari indigenous people, and instructional content aligned with the course syllabus, particularly related to endemic bird conservation.

Microsoft Word and Canva applications were used for the design process (Figure 3). Key activities included selecting suitable learning media centered on research-based teaching materials to achieve the learning objectives and competencies of the course. Format, layout, cover design, and content structure.



Fig.3. The design teaching materials based on data research

Several significant activities were conducted during the design stage. This included the selection of appropriate learning media that centered on the development of research-based teaching materials. The aim was to achieve the intended learning objectives and

competencies in the Conservation of New Guinea Biota course. The format of the teaching materials was determined, along with the layout design, cover, and content structure to ascertain clarity and aesthetic appeal.

The design stage comprised the development of assessment instruments. These included a set of 15 multiple-choice questions in pre-test and post-tests to assess the students' knowledge, attitudes, and participation. The test items were designed to explore the conservation literacy level of biology education students enrolled in the Conservation of New Guinea Biota course.

3.3 Development

The development stage produced teaching materials for the Conservation of New Guinea Biota course, integrating the local wisdom of the Manggari indigenous people related to the conservation of Numfor Paradise Kingfisher (*Tanysiptera carolinae*). The materials were revised based on feedback from the content and media experts. In the prototype stage, the student book, comprising both learning materials and media, was validated by a panel of expert reviewers Table 4-6.

Table 4. Result of learning material assessment

Indicator	Score
A. Content Feasibility	
The teaching material includes descriptions of the morphology and ecology of the Numfor Paradise Kingfisher (<i>Tanysiptera carolinae</i>)	5
The content is aligned with the course material of Conservation Biology and is relevant to the Papuan context.	5
The material integrates the values and practices of local wisdom from the Manggari Village community in bird conservation.	5
The content corresponds with the Learning Outcomes stated in the Semester Learning Plan.	4
The scope of the material and practice questions is appropriate to the students' level of knowledge.	4
B. Language Appropriateness	
The use of scientific terminology in the teaching material is accurate and consistent.	5
The sentence structure follows the conventions of Indonesian Spelling Guidelines (EYD).	4
The use of capital letters for scientific names, personal names, and place names follows the correct rules.	5
The language used is communicative, clear, and appropriate for the students' academic level.	5
The writing is consistent with established rules of spelling and scientific conventions	4

Indicator	Score
C. Presentation Feasibility	
The presentation of images and illustrations is supported by clear descriptions	5
The sequence of material presentation is logical, systematic, and easy to understand	4
Percentage	91,66%

Table 5. Result of media assessment

Indicator	Score
Alignment of content with learning objectives	5
Attractive design and layout	4
Readability of text and language	4
Clarity of instructions and guidelines	4
Easy of media use	4
Consistency of content presentation	4
Relevance to learning needs	5
Percentage	85,71%

Table 6. Result of media assessment

Validator Expert	Validity value	Validation criteria
Learning material assesment	91,66%	Completely valid
Media assessment	85,71%	Completely valid
Total	88,68%	Completely valid

The validation process evaluated the validity, practicality, and effectiveness of the materials in enhancing students' conservation literacy in the Biology Education Department of Papua University. The mean scores of the expert assessments indicated that subject-matter experts rated the materials as highly valid, confirming the content's accuracy, relevance, and alignment with the course outcomes. Similarly, media experts rated the design as completely valid, noting that layout, readability, and visual design effectively supported learning.

Validation of the pre-test and post-test instruments (Table 9) showed that all items were appropriate for assessing students' conservation literacy. Expert evaluation confirmed the clarity and relevance of the items, which effectively measured knowledge, attitudes, and participation in biodiversity conservation. The student response questionnaire was rated as completely valid, confirming that the instrument reliably assessed the readability, comprehension, and practicality of the materials.

Table 7. Result of validation instruments

Instrument	Validity value	Criteria
Pre-test and post-test instruments	84,30	Completely valid
Students' response questionnaire	81,54	Completely valid

The study found that teaching materials developed using the ADDIE model (Analysis, Design,

Development, Implementation, and Evaluation) achieved media validation (85,71%), content validation (91,66%), and student practicality (93,22%). These results confirm that the materials were pedagogically sound, contextually relevant, and user-friendly, which essential for high-quality instructional resources in science education.

3.4 Implementation

A trial implementation of the developed teaching materials was conducted in actual classroom conditions. The participants consisted of 24 students in the New Guinea Biota Conservation course (Table 8, Table 9).

Table 8. Indicators of conservation literacy

Aspect	Indicator
Cognitive Literacy	<ol style="list-style-type: none"> Knowing that <i>Tanysiptera carolinae</i> is an endemic bird species of Papua. Understanding the main morphological characteristics of the Numfor Paradise kingfisher. Recognizing the natural habitat of the species on Numfor Island. Identifying the major threats to its population, including hunting and habitat loss. Understanding the bird's conservation status according to the IUCN and Indonesian regulations.
Affective Literacy	<ol style="list-style-type: none"> Demonstrating concern for efforts to protect the Numfor Paradise Kingfisher (<i>Tanysiptera carolinae</i>) Rejecting hunting and trade activities involving endemic species. Supporting collaboration between communities and the government in conserving habitats. Feeling proud of Indonesia's rich endemic biodiversity. Supporting the integration of conservation issues into biology education.
Behavioral Literacy	<ol style="list-style-type: none"> Being able to educate others about the importance of conserving endemic birds. Willing to participate in research and field activities. Actively seeking scientific information about the Numfor Paradise kingfisher. Using social media or scientific works to promote conservation campaigns. Being directly involved in community-based conservation activities.

Table 9. Result of students' conservation literacy

Interval Value	Criteria	Pre-test		Post-test	
		Frequency	Relative Frequency (%)	Frequency	Relative Frequency (%)
85-100	Very High	0	0,00	22	91,67
65-84	High	11	45,83	2	8,33
45-64	Moderate	12	50,00	0	0,00
25-44	Low	1	4,17	0	0,00
< 24	Very Low	0	0	0	0,00
Total		24	100	24	100

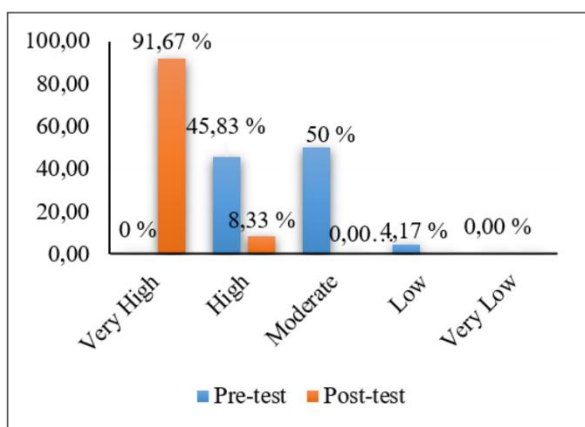


Fig. 4. Graph of students' relative frequencies of conservation literacy

Table 10. Results of N-gain Effectiveness

Partisipant	Pre-test	Post-test	N-Gain
Mean	61,94	93,61	0,84 High criteria
Maximum	80	100	
Minimum	33,33	80	

The findings (Table 10) show a high N-gain score (0,84), indicating substantial learning gains. Based on statistical analysis using SPSS version 29 (Table 11-12), the results confirmed that the research-based teaching materials integrating the local wisdom of the Manggari Indigenous people in conserving the Numfor Paradise Kingfisher (*Tanysiptera carolinae*) effectively enhanced students' conservation literacy.

Table 11. Test of Normality (Shapiro-Wilk)

	Shapiro-Wilk			Interpretation
	Statistic	Df	Sig.	
Before the students' used of the teaching materials (pre-test)	0,929	24	0,095	Normally

After the student used of the teaching materials (pos-test)	0,979	24	0,880	Normally
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As shown in Table 11, p-values greater than 0,05 in both measurements indicate that the data were normally distributed. Since the assumption of normality was satisfied, a paired-sample t-test was conducted to examine the differences in conservation literacy before and after the implementation of the teaching materials (Table 12).

Table 12. Paired Sample t-Test

Paired sample	Mean Difference	t	df	Sig. (2-tailed)
Before and after the implementation of the teaching materials.	61,92	25,957	24	0,001

The trial implementation of the Student Book on New Guinea Biota Conservation demonstrated strong effectiveness in enhancing students' conservation literacy, as indicated by the results of the pre-test and post-test supporting the assumption of normality (Shapiro-Wilk, pre-test = 0,929; post-test = 0,979; $p > 0,05$). N-gain score (0,84, high category) and significant learning improvement ($p = 0,001$). These outcomes are consistent with previous findings that integrating cultural and ecological contexts can significantly enhance environmental literacy and sustainability-oriented learning outcomes [11].

Pedagogically, an intervention's effectiveness can be attributed to its contextual and problem-based learning (PBL) design [1,12,13]. By engaging students with authentic ecological issues and linking scientific concepts with local conservation practices, the model fostered both cognitive and affective dimensions of learning-. Contextualized learning promotes active knowledge construction and ecological empathy, which are essential for cultivating environmentally responsible behaviors [14,15].

3.5 Evaluation

The practicality of the teaching materials was evaluated using a student response questionnaire based on a 15-item Likert-type scale. The questionnaire was administered to 24 students in the New Guinea Biota Conservation course to assess their perceptions of materials' clarity, relevance, and usability (Table 13).

Table 13. Result of students' responses to teaching material

Aspect	Percentage (%)	Category
A. Readability	92,83	Excellent
B. Content understanding and relevance	93,33	Excellent

Aspect	Percentage (%)	Category
C. Conservation Literacy Strengthening	93,5	Excellent
Total	93,22	Excellent

Among the 24 respondents, the average percentage score for teaching materials was 93,22% in the excellent or highly practical category as evaluated by the users of the teaching materials in the New Guinea Biota Conservation course. Practically, the developed materials present a replicable model for embedding indigenous people's knowledge into biology education, particularly in the conservation of biodiversity-rich regions, such as Papua. Nonetheless, this study's single-institution scope, and limited implementation period constrain generalizability. Future research should employ longitudinal, multi-site studies to evaluate long-term behavioral impacts and explore digital or interdisciplinary adaptations to broaden accessibility and impact.

4 Conclusion

In conclusion, research-based teaching materials integrating the local wisdom of the Manggari community into the conservation of the Numfor Paradise Kingfisher (*Tanysiptera carolinae*) proved to be valid, practical, and effective. High validation scores from the media (85,71%) and content experts (91,66%), excellent practicality ratings from students (93,22%), and a strong learning gain (N-gain = 0,84; p = 0,001) confirmed their quality and educational impact. These results indicate that incorporating community-based ecological knowledge into biology education effectively enhances students' conservation literacy, contextual understanding, and pro-environmental values.

However, this study was limited by its small sample size, single-institution focus, and short implementation duration, which may restrict the generalizability of the results. Future studies should involve larger and more diverse student populations, extend the intervention across multiple educational settings, and explore long-term behavioral impacts on conservation practices. Additionally, further research could examine how integrating digital media, interdisciplinary content, or cross-cultural ecological knowledge strengthens the scalability and sustainability of contextualized conservation education.

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