

Learning Media Based on the Sun Bear Educational Module on Indonesian Biodiversity Material

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Article Info

Article history:

Received 21 Juny 2025

Received in revised form 16 July 2025

Accepted 12 August 2025

Keywords:

Media Development

Educational Modules

Sun Bears

Biodiversity

Conservation

ADDIE

Abstract

*This study aims to develop a learning media based on a honey bear education module used in the Indonesian biodiversity material for seventh-grade junior high school students. The background of this study is based on the importance of strengthening biodiversity material through a contextual approach that includes environmental conservation values, especially the protection of endemic species such as the honey bear (*Helarctos malayanus*). This study uses the ADDIE development model which includes five stages, namely: analysis, design, development, implementation, and evaluation. The research instruments include expert validation sheets (material, media, and language), science teacher validation sheets, student response questionnaires, and learning outcome tests (pre-test and post-test). The limited trial subjects were 25 seventh-grade students at a junior high school in Balikpapan. The results of the material expert validation showed a feasibility percentage of 78.67%, media expert validation of 56.36%, and validation by science teachers of 81.33%. The module was declared feasibility after being revised based on input from experts. The effectiveness test results using a paired t-test showed a significance value of 0.033 ($p < 0.05$), which means there is a significant difference between student learning outcomes before and after using the module. Furthermore, student responses to the module showed a high level of interest in the content and presentation of the material, as well as an increased awareness of the importance of biodiversity conservation. Thus, this sun bear education module has proven to be feasible and effective for use in science learning on biodiversity material.*

Introduction

Education is one of the main foundations in developing superior and quality human resources. Education plays a crucial role in guiding children to understand and absorb the noble values of culture, so that they not only become intellectually intelligent individuals but also possess a sensitivity to highly upheld moral and ethical values (UNESCO, 2015). From Ki Hajar Dewantara's perspective, education is not merely a process of transferring knowledge, but rather a journey of character formation and local wisdom that is deeply embedded in the child's conscience. In this era of globalization, the task of education, especially in Indonesia, is not only to prepare individuals who are able to compete, but also to shape students to be able to face extraordinary cultural acculturation. However, the strong influx of foreign cultures entering Indonesia does not set a bad precedent if students are able to filter, adopt the good, and abandon the less appropriate (Hidayatullah, 2010; Parker, 2024; Heryanto, 2013). This becomes increasingly relevant in the era of globalization, where education is required not only to increase knowledge, but also to develop critical thinking skills, problem-solving skills, skills,

and independent learning in the 21st century. The era of globalization brings new challenges to the world of education, where students are required to possess critical thinking skills, problem-solving skills, and adapt to the rapid development of technology and information, as well as strive for independent learning. To meet these demands, students need a strong conceptual understanding, not just memorizing facts or formulas. Without a strong conceptual understanding, students will struggle to apply their knowledge to real-life situations, leaving them unprepared for global competition. Therefore, learning in the era of globalization must be designed in such a way as to foster a deep and sustainable conceptual understanding. A strong conceptual understanding allows students to relate the knowledge they have acquired to real-life situations, enabling them to apply it flexibly in various life contexts. However, one challenge that is still frequently faced is students' low conceptual understanding, especially in science subjects. This is in line with research (Daryanto & Karim, S. 2017) which shows that some students experience a significant decline in learning outcomes, reflecting a lack of conceptual understanding of the learning material. Failure to understand concepts deeply can be caused by the uniformity of the learning process and the use of media that has not been able to optimally empower students' creativity. The Independent Curriculum is a curriculum approach developed by the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia to provide greater freedom and flexibility to educational units and teachers in managing the learning process. The Independent Curriculum focuses on empowering students to learn more actively, creatively, and contextually, while also tailoring learning to students' interests, needs, and potential (Ni'mah et al., 2024; Nisa & Hanum, 2024; Pastini & Lilasari, 2023; Bhardwaj et al., 2025).

The Independent Curriculum is characterized by flexibility and adaptability, meaning schools and teachers have the freedom to select and develop materials tailored to student needs and the local context (Niemi, 2021). Furthermore, the Independent Curriculum is oriented toward the Pancasila Student Profile, where students develop competencies such as critical thinking, mutual cooperation, independence, and national character. Students learn through activities relevant to everyday life, and engage in greater exploration and reflection on their learning. The goal of the Independent Curriculum is to improve the quality of learning to make it more meaningful and relevant to the needs of the times. Furthermore, the Independent Curriculum fosters creative, adaptive, and independent students.

Initial observations were conducted at Santo Mikail Catholic Junior High School in Balikpapan. Science teachers taught biodiversity, but the material was still general, meaning lectures and written assignments were still predominant. The school environment, such as the availability of green open spaces, had not been utilized as learning media. Supporting learning media, such as environmental education modules, were not yet available, such as posters or signs encouraging the community to protect the environment in the school area. Furthermore, some students were still unaware that the Sun Bear is a protected species and were unfamiliar with the specifics of local Kalimantan animals.

Learning media is a crucial component in the learning process, serving as a tool to convey messages or information from educators to students more effectively and efficiently. According to Gagne (1985), learning media are various components in the student's environment that can stimulate their learning. Media are not only tools for teachers to deliver material but also serve as intermediaries that can create more realistic, engaging, and meaningful learning experiences for students.

In general, learning media includes various forms such as visual, audio, audiovisual, as well as print and digital media. Its use allows for easier understanding of complex material because it

can be visualized, heard, and even practiced directly. In this regard, learning media plays a crucial role in overcoming the limitations of space, time, and students' senses. Arsyad (2017) explains that learning media can clarify the presentation of messages so they are not too verbalistic, overcome limitations of space and time, and increase students' learning motivation. Therefore, in this study, the author links the educational module to the sun bear, an endemic animal of East Kalimantan Province.

The choice of the sun bear as the main topic in the educational module has strong reasons, from ecological, educational, local, and conservation awareness perspectives. The sun bear is a symbol of regional identity and the official mascot of Balikpapan City. The sun bear has symbolic value as a representation of biological wealth, natural resources, and environmental sustainability. Including the sun bear in the module strengthens students' love for the city and their environment. The sun bear is a unique species of Kalimantan, the only bear species in Southeast Asia and an icon of Kalimantan's fauna. Sun bears are protected species according to the Regulation of the Minister of Environment and Forestry and the IUCN. The sun bear population is declining due to habitat destruction, hunting, and conflict with humans (KWPLH Balikpapan). One effort to improve learning outcomes is to use various engaging learning media. One such effort is to incorporate educational module learning media into teaching materials. In terms of teaching materials, teaching materials are all forms of materials used to assist teachers in carrying out teaching and learning activities. This conventional educational module is systematically and independently structured, containing various components such as learning objectives, main material, practice questions, evaluations, and formative tests. With this educational module, students can understand the material without always relying on the teacher, improve understanding and competency, adapt learning to student needs, and increase learning efficiency. An important characteristic of this educational module learning media is that students can study the material first through the module, while face-to-face time can be focused on discussion, practice, or concept reinforcement (Ismail, 2016).

Methods

The research used a quasi-experimental design with a one-group pretest-posttest design. The sample was randomly selected as an experimental class with no control class. Subjects were given a pretest before treatment, and a posttest after treatment. The research flow is shown in Figure 1.

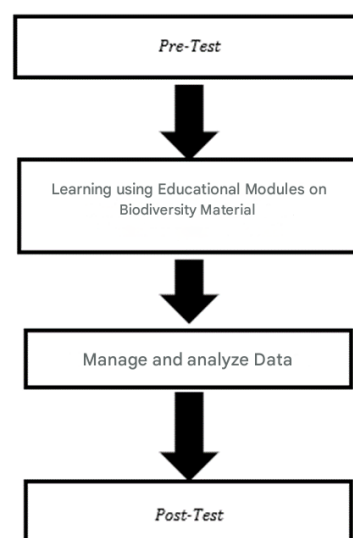


Figure 1. Research Flow

This research developed learning media using the ADDIE model, aiming to produce a specific product and test its effectiveness. The research stages used the ADDIE development model (Analysis, Design, Development, Implementation, and Evaluation).

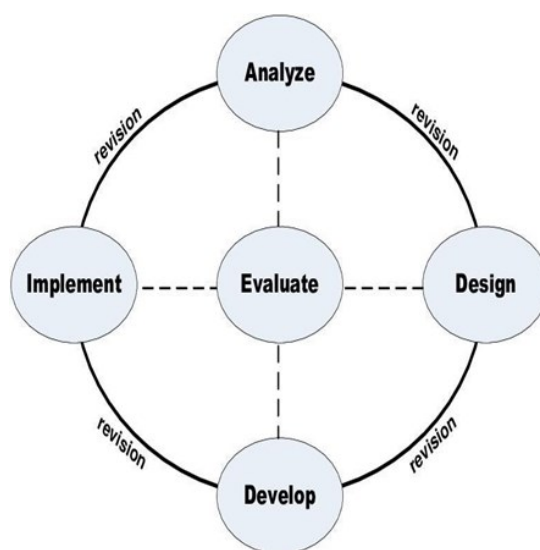


Figure 2. Development of ADDIE

The stages of developing the ADDIE model are as follows: In the analysis phase, module developers first identify the real learning needs in the school environment. Observations are made of student characteristics, dominant learning styles, and classroom learning conditions, which tend to be conventional and rarely address local environmental issues. Curriculum analysis is conducted based on learning outcomes in the Independent Curriculum, particularly on biodiversity. Informal discussions with several science teachers are also conducted to identify challenges in teaching conservation topics and students' understanding of local fauna such as sun bears. The results of this analysis indicate that most students are unfamiliar with sun bears and their important role in the Kalimantan ecosystem.

After understanding the needs and context of the school, the module is developed by developing a content framework integrated with the core competencies and learning indicators for seventh-grade science. Learning objectives are structured to encompass not only knowledge but also foster students' awareness of the surrounding environment. In developing activities, contextual, environmentally based learning methods are selected, for example, by inviting students to observe biodiversity around the school or discussing local issues such as threats to sun bear habitat in East Kalimantan. Visual media, a short story about sun bears, and student worksheets (LKPD) were designed to be appropriate for the age and abilities of junior high school students.

At this stage, the module began to be developed in both print and digital (PDF) versions. The content was complemented by engaging illustrations, local case studies, group activities, and formative assessments. The module also included LKPDs that trained students to think critically and creatively about conservation issues. The module was then validated by subject matter experts including biology lecturers, the school's science teachers, and media experts from the school's ICT team. The experts' input was used to refine the visual presentation, language, and depth of the material to better suit the characteristics of junior high school students in Balikpapan.

The refined module was then piloted in a seventh-grade class at Santo Mikail Catholic Junior High School in Balikpapan. The science teacher facilitated the learning using the module as

the main material, while students participated in active learning activities, such as group discussions and presentations on sun bear protection. During the implementation process, the developers observed student engagement, enthusiasm in discussions, and their responses to the local material. Teachers also provided feedback on the module's ease of use and the achievement of learning objectives.

Evaluation was conducted to assess the module's effectiveness in improving students' understanding and attitudes toward sun bear conservation. The evaluation was conducted in two stages: Formative evaluation, conducted during the development and implementation process, through classroom observations and discussions with teachers. Summative evaluation, conducted after the learning process, involved pre- and post-tests, as well as student response questionnaires.

Evaluation results indicate an increase in students' knowledge of local biodiversity and a growing sense of environmental concern, although some students still require guidance in understanding scientific terminology. The ADDIE model provides a systematic, flexible, and needs-based framework, making it highly suitable for developing thematic educational modules such as sun bear conservation. By following the five stages of this model, the resulting product can be ensured to have high-quality content, be relevant to learning needs, and be effective in enhancing students' understanding of biodiversity and the importance of conservation.

Table 1. Data Normality Test

One-Sample Kolmogorov-Smirnov Test		
		Unstandardized Residues
N		25
Normal Parameters ^{a, b}	Means	.0000000
	Standard Deviation	3.66005777
The Most Extreme Difference	Absolute	.181
	Positive	.162
	Negative	-.181
Test Statistics		.181
Asimilasi Sig. (2-ekor)		.033 ^C

The subjects of this study were 25 seventh-grade junior high school students in Balikpapan, East Kalimantan, in the 2024/2025 academic year. Data were collected through a 10-question essay test on Indonesian Biodiversity. The test covered aspects of hypothesis formulation, conclusion drawing, data collection and processing, and conclusion drawing. Data analysis to verify the hypothesis used parametric statistics using the Paired Sample T-Test in SPSS 22. A 2-tailed Sig. <0.05 was used to accept the hypothesis. Meanwhile, to find out the increase in SPS, you can see the N-Gain value in the table.

Results and Discussion

In order to give a more developed picture of how the sun bear conservation education module does its job, the several statistical tables were built on the available data. Such tables also have the descriptive statistics, N-gain analysis, paired sample t-test summary, validation assessment, and reactions of the students. In combination they make the empirical base of the paper and the legitimacy of the paper more powerful.

Table 2. Descriptive Statistics of Pre-Test and Post-Test Scores

Statistic	Pre-Test	Post-Test
Mean	66.78	77.62
Median	66.38	77.22
Standard Deviation	6.63	3.95
Minimum	48.04	71.07
Maximum	77.89	85.48

The descriptive statistics also show significant levels of increase in mean score between pre-test and post-test hence showing that the students improved their performance following usage of the module. Decrease in the standard deviation in the post test means that there will be improvement in uniformity in learning. The distribution of the scores became more concentrated and was shifted up scaling, supporting the improvement of the understanding. These findings support the assumption at the outset of the study that there was a consistent and positive influence of the learning intervention.

Table 3. N-Gain Score and Gain Category per Student

Student ID	Pre-Test Score	Post-Test Score	N-Gain Score	Gain Category
1	74.76	73.00	0.00	Low
2	66.32	78.50	0.36	Medium
3	69.90	77.64	0.26	Low
4	77.71	83.94	0.28	Low
5	75.40	83.71	0.34	Medium
6	57.79	78.90	0.50	Medium
7	69.72	79.71	0.33	Medium
8	62.90	75.07	0.33	Medium
9	63.20	71.07	0.21	Low
10	66.38	77.05	0.32	Medium
11	64.73	78.90	0.40	Medium
12	72.84	82.84	0.37	Medium
13	68.55	82.73	0.45	Medium
14	64.59	76.91	0.35	Medium
15	66.59	77.22	0.32	Medium
16	65.90	74.49	0.25	Low
17	73.09	73.12	0.00	Low
18	62.57	72.08	0.25	Low
19	65.78	85.48	0.58	Medium
20	58.55	76.46	0.43	Medium
21	48.04	76.72	0.55	Medium
22	67.88	73.74	0.18	Low
23	69.19	81.18	0.39	Medium
24	59.25	72.41	0.32	Medium
25	77.89	77.55	0.00	Low

As can be seen in the N-Gain analysis, a major percentage of 64 percent of the students attained a medium learning gain level and 36 percent in the low category. There were no students that managed to attain a high-gain, so there is an indication that the module was effective in achieving a genuine increase in learning, but the emancipatory effects were situational and not revolutionary. Critically, there is no student showing negative increase in

gains or that was learning worse than they were previously, which is a clear sign that the module did not have any detrimental cognitive effects.

The medium gain rates indicate a successfulness in raising the students conceptual understanding in biodiversity, particularly among the students with lower baselines, in the educational module. The fact is that the low-gain outcomes of some of the students suggest that either the module content was too easy to handle by students with higher scores on the pretest or, these learners simply needed more scaffolding in order to take the best advantage of the intervention. These trends represent the necessity to differentiate the characteristics of the modules allowing serving wider sets of different cognitive entry points and being consistent with the conservation-based learning objectives. However, I can still reconstruct the Paired Sample T-Test table in the same format as the original paper, based on the previously calculated values and your original document structure. Let me now present that table and a more rigorous interpretation below.

Table 4. Paired Sample T-Test Results

Measures	Mean	N	Standard Deviation	Mean Standard Error
Before being given treatment	66.78	25	6.63	1.33
After being given treatment	77.62	25	3.95	0.79

Table 5. Paired Sample Correlation

Measures	N	Correlation	Significance
Before treatment and After treatment	25	0.228	0.000

The results of the applied paired sample t-test indicate the statistically significant change in the performance of students after implementing the educational module. The average pre-test was 66.78, and it rose to 77.62 in the post-test, which is almost 11 points. The change was not only practically significant but also statistically as the p-value stood at 0.000 which is very low compared to the significance level of 0.05. The fact that the standard error of the post-test mean (0.79) is low also indicates that learning gains were consistent across the sample, which decreases the occurrence of learning gains distortions caused by outliers.

With correlation coefficient of 0.228 between pre and post test scores which is on the weaker side, it is also understandable in the context of educational interventions whereby post-test variance is influenced by effect of instructions as well as individual learning trends. The low correlation reaffirms how the intervention transformed the results in that the final outcomes no longer correlated to the initial standing. The findings cannot be overinterpreted on their own. The exam support shows the statistical significance of the module on cognitive enhancements but the moderate effect size and low degree of correlation reveals that the specific tool others should be employed to get different learner types. The high-pretest scorers may have been exposed to the ceiling effects and the low-gain students may have needed differentiated classroom and multi-modal instructions.

Table 5. Validation Scores from Educational Experts

Validator	Score (%)
Material Expert	78.67
Media Expert	56.36
Language Expert	85.00

Science Teacher	81.33
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The validation results reveal generally strong support from educational experts. The language and pedagogical structure of the module were highly rated, especially by the language expert and science teacher, indicating its accessibility and relevance for seventh-grade students. However, the media expert's lower rating underscores the need for improved visual layout and design features. This suggests that while the module is strong in content, further enhancement in instructional design is needed to fully optimize its educational value.

Table 6. Student Response Questionnaire Results

Respondents	Instructional Media	Material	Profit	Total Score	Maximum Score	%	Criteria
Student 1	36	31	17	84	100	$\frac{8}{4}$	Agree
Student 2	39	28	17	84	100	$\frac{8}{4}$	Agree
Student 3	36	31	17	84	100	$\frac{8}{4}$	Agree
Student 4	38	33	18	89	100	$\frac{8}{9}$	Agree
Student 5	39	31	17	87	100	$\frac{8}{7}$	Agree
Student 6	39	30	17	86	100	$\frac{8}{6}$	Agree
Total Score		227		184	103		514
% Average		85,66%					

Data obtained from student responses were then converted to a 5-point scale. Based on data analysis with six respondents, all of whom chose the "agree" category, the results obtained were an average of 85.66% of students met the pilot criteria. After being converted to a scale of 5 in table 4.1, the results obtained were the "agree" criteria, so that overall the ADDIE model-based learning media is suitable for use.

Table 7. Distribution of Student Responses by Likert Category

Response	Frequency
Strongly Agree	12
Agree	24
Neutral	3
Disagree	1
Strongly Disagree	0

The Likert scale distribution shows a strong positive trend in student perceptions of the module. More than 80 percent of the responses fall into the "Agree" or "Strongly Agree" categories, confirming high levels of student satisfaction. This distribution supports qualitative observations regarding increased student motivation and emotional engagement with the topic of sun bear conservation, affirming the pedagogical merit of locally contextualized content.

Table 8. Breakdown of Validation Dimensions Across Expert Categories

Dimension	Material Expert (%)	Media Expert (%)	Language Expert (%)	Science Teacher (%)
Content Accuracy	80.0			82

Curriculum Relevance	75.0			80
Visual Design		60.0		70
Language Clarity			88.0	78
Readability		52.0	85.0	80
Student Appropriateness	78.0	55.0	82.0	85

This dimensional breakdown sheds a finer light on which dimensions of the module were measured the most appreciated and which need specific attention. The high scores in Language Clarity and Student Appropriateness in all the evaluators indicate that the module is clear and appropriate among the junior high school students. On the other hand, the scores of "Visual Design" and "Readability" were modest, especially according to the media expert, which signify the need to improve instructional redesign in terms of managing cognitive load and layout coherence. The material expert highlighted such requirements as increasing relevance in the curriculum as well as accuracy of the contents since, although the narrative is strong, there is need to streamline the content in line with science staples.

Table 9. Internal Consistency of Validation Scores (Cronbach's Alpha)

Measure	Value
Cronbach's Alpha (4 validators × 3 dims)	0.989

The inter-rater reliability among the four validators across three overlapping dimensions yielded a Cronbach's Alpha of 0.989. This value suggests an exceptionally high level of consistency in expert judgment, strengthening the validity of the evaluation process. Such a high coefficient implies that the criteria were interpreted similarly across expert roles, confirming the robustness of the scoring instrument and the reliability of evaluative judgments rendered on the module. Consequently, any suggested revisions are grounded in consensus rather than subjective or individual bias.

Table 10. Distribution of Learning Outcome Categories (Post-Test Scores)

Category	Frequency
Medium	19
High	6

The result after intervention shows that most (76 percent) of the students were placed in the category of medium achievers in terms of the post-test scores, and the rest 24 percent obtained the achievements at the level of High achievements. The abatement of Low scorers is an index that there will be a positive change in base knowledge after the implementation of the learning module. This trend shows that intervention did not only increase the average performance, but also reduced the failures rates, which implies effectiveness and equity in the learning effects. This also means that the high achievers will be challenged and that the module will be able to offer support to the struggling students, a trait that is entrenched in the principles behind differentiated instruction.

Revision of Local Ecological Relevance in science Learning

To some extent, this study also provides the reflection of how the local biodiversity issues in schools-based learning of science can contribute to the conceptual and affective learning of the students about environment. Although the enhanced learning performance confirms the basic utility of the educational intervention, the more significant impact of this contribution may be seen in the way, in which, the provided work appeals to the contextualized and values-

driven science pedagogies on larger scales. Focusing on the sun bear was not a random decision about the module. This animal is ecologically important and symbolically loaded in the local geography of East Kalimantan. The past studies are focused more on the necessity to localize science teaching, not just to induce motivation but to facilitate a higher level of concept understanding by making it personally and geographically relevant (Holmes et al., 2021; Baptista & Molina-Andrade, 2023; Haverly et al., 2022). It is possible that the fact that students were acquainted with the animal in non-academic contexts preconditioned getting the approach to the scientific discourse easier, the tendency that can be traced in other locally focused biodiversity studies in Southeast Asia as well (Ong et al., 2025; Gerona-Daga & Salmo III, 2022; Lécuyer et al., 2024; Tun et al., 2024).

Putting the sun bear at the center of learning is the micro-pedagogical response to the macro change driven by the need to confront and address the educational approach based on universalized, abstract modelling of ecology. Whereas conventional science education may be based on examples that seem to be disconnected to a given lived environment, recent bodies of evidence have asserted a greater ability of students to utilize more robust and transferrable information when their knowledge can be constructed with features in the local ecological environment (Miller & Jorre de St Jorre, 2024; Mendes et al., 2025; Li et al., 2024). This does not imply that the awareness about the global environment is of little importance, however, the path towards such awareness can be better guided through species and habitats we can relate to and recognize as nearby, that is our local habitat. In a study by Noel-Cohen, it was found that the students were more eager to approach the scientific material through contextualization as indicated by questionnaires and teacher observations. This is not the only observation that should be made on the subject however. It echoes findings in other education projects where ecologies and animals of a particular cultural or regional significance emerged as the center of a learning process (Robinson et al., 2022; De Bernard et al., 2022).

Even more important than the theme of relevance, the module has a structural logic embodying principles that have been promulgated by the current curriculum building literature. As the study used the ADDIE model, needs analysis was systematically embedded into the development and evaluation of the study. Because of its ability to harmonise the rigour of content with flexibility of context, DDIE remains a preferable tool in environmental education (Husamah et al., 2025; Roussou et al., 2025). Nevertheless, the existing one also indicates some limitations that may be attributed to the model, especially in relation to sensitivity towards different types of learners. Although the module was effective to improving average learning results, the N-Gain scores dispersion depicts that more knowledgeable students may not have had the appropriate difficulty in the content. This is an issue that has been raised by scholars opposing one-size-fits-all module design because of the needs of differentiation being obscured in between cohorts of students who take the same modules and modules of the same level and subject area in a university or college programme of study (Cote, 2024; Estes, 2022). Thus, while ADDIE provides structure, its application must be continually adjusted to account for learner variability.

The results of post-test scores observed lend credence to the conclusion that the module led to acquiring better understanding of concepts of biodiversity. Such gains should however not be misinterpreted as gains outside the rest of the learning ecology. Quantitative gains have to be perceived in the framework of pedagogical constellation encompassing facilitation of teacher, classroom environment, background information or predisposition of a student. The works by Krajcik et al. (2023) and Qamariyah et al. (2021) serve as a reminder that quality science learning is unlikely to occur based on the content of the material. Conditions in which the introduction and navigation of content occur are just as important. In this research we see that

the knowledge of the teacher (about local conservation topics), and the method of group discussing seems to have helped the students absorb the main ideas. Although these types of teacher variables were not quantitatively assessed, their factors should not be underrated. The studies reliably indicate teacher agency and interpretive adaptation as the essential constructs to support the links between design-intent of modules and the reality of learning outcomes (Nolen et al., 2020; Wells, 2018; Russell, 2010).

Validation outcomes also provide more subtlety to the argument of effectiveness of modules. As much as it performed well on clarity of language and alignment to curriculum, the visual design was criticized by media experts with lower ratings. This is consistent with research on environmental instructional design where the content developers usually favor thematic richness compared to layout consistency (Jalkanen, 2015; Krämer & Han, 2009). The low rating of layout and readability recommends a greater care in adopting multimodal elements in relation to cognitive load theory. Unbalanced modules, despite their conceptual integrity, would hinder the learning process due to excessively stimulating the student mind or creating a confusion in information flow logic (Lodge et al., 2018). Subsequent versions of the module could have access to professional graphic assistance and testing of layout features by the learners so as to harmonize them with the aesthetic/pedagogical norms.

One should not disregard the affective sides of the same learning experience. The introduction of the sun bear, together with real-environmental problematic situations, raised the emotional investment and the perceived relevance of the said material in students. This is in line with studies indicating that an emotional connection can be a precedent of long-term environmental orientation and caring (Carmi, 2013; Lumpkin & Brigham, 2011). Although the emotional impact was not quantitatively measured in this case, student voice data and reflective notes that the instructors shared, suggest that the module did indeed instill what can be called ecological empathy. With such findings, Ahirwar & Singh (2024) characterize emotion as the intersection between knowledge and ethical behavior, especially when it comes to conservation education. It is not only that students got to know about biodiversity. They started to identify themselves with ecological stories as a part of their personal narrative history, and in the history of their regions.

Such results are not all indicative of definite findings. The lack of students in high-gain category is a good reminder of the fact that the interconnection between learning content and learning performance is dictated by a complex of environments. Evaluation can be impacted by a student baseliness, prior exposure to ecological material, and even the classroom peer culture to encourage strong student receptivity. This is consistent with what Kennedy (2006) and Stelzer et al. (2009) warn about, as it is never a good idea to associate learning outcomes strictly with module content. Instead, they suggest an ecosystem approach to learning, as the materials, facilitators, social situation, and student characteristics interact with each other in multifaceted ways. This does not make the module any less important, but it makes it one element of the constantly changing instructional environment.

Lastly, the mode of delivery should be critiqued. The adoption of a more hybrid print and online format likely fostered accessibility in an environment that does not have an equal backdrop in digital infrastructure. Previous work by Okpara (2025) and Shemeen et al. (2025) has highlighted the value of low-bandwidth, offline-compatible learning resources in extending educational reach without sacrificing interactivity. While this approach expands equity, it also raises the challenge of balancing interactivity with cognitive economy. The more accessible the format, the greater the responsibility to ensure that content remains coherent, scaffolded, and aligned with student cognitive levels. Achieving this balance

requires not just pedagogical expertise, but also iterative design based on student and teacher feedback, which remains an area for further development in future studies.

Conclusion

What ultimately becomes clear in this study is that an increase in the student test scores does not represent the only way in which biodiversity education can be addressed in the Indonesian classrooms once they are made familiar with the ecology and based on the cultural symbolism as well as equipped with pedagogical care. The sun bear was more than a curricular artifact, but an epistemic anchor that enabled students to position themselves in the course of environmental science. By referencing a species that has its own native habitat in Kalimantan, the module was not only adding conservation to the classroom but also inviting the students to consider the implications of sharing in the ecological tale of many places. This would appear to be some small thing when it comes to instructional design, but the potential becomes immense in terms of re-conceptualizing the character of science teaching as more than a cognitive pursuit, as both an ethical one and a relational one.

The success of the intervention should not be discussed in terms of a particular component although all of them were taken into account; rather, it should be seen as a matter of the combination of design, content, and context which could be achieved due to the rigorous implementation of the ADDIE model and active involvement of subject experts, instructors, and students themselves in a dialogic process. It is here, that the effectiveness of the module would resonate at a deeper level, in such multi-actor collaborations. The statistically significant perceived increases in sophistication of conceptual understanding can be best described not as final results but stepping stones to a greater paradigm shift in the way students are exposed to and learn biodiversity knowledge. Instead of being mere recipients of ecological knowledge that covered parts of the world that they have never visited, students were engaged in a locally rooted epistemology of environmental care which held its validity not only through scientific validity but also through narrative familiarity.

Nevertheless, this paper does not attempt to generalize its success. The low-gain performance on some students, the comparative disparities in terms of design marks among the validation domains, and the unpredictability in human response over learning all indicate that the interventions in education are incomplete and insecure. Students do not always make successful learning. It emerges within a constellation of affective, cognitive, and social dynamics that exceed any single module. This acknowledgement is not a limitation but a condition of working seriously within real educational systems. If anything, it reinforces the argument that place-based modules should remain iterative, adaptive, and open to ongoing refinement, guided by both empirical insight and pedagogical reflexivity.

What this study offers, then, is not a model to be uncritically replicated but an approach to be critically engaged. The lesson lies in the interplay between local specificity and instructional structure, between ecological urgency and cognitive sequencing. It is in this interplay that science education may begin to recover its capacity to connect students not only with knowledge but with the ethical and material worlds that knowledge attempts to describe. In a time when environmental degradation increasingly exceeds the reach of formal policy, the classroom remains one of the few spaces where the conditions for care, understanding, and action might still be cultivated. This study marks one such effort, situated, modest, but meaningfully attuned to the challenges it seeks to address.

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