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An Integration of local wisdom into a problem-based student book to Empower Students' Conservation Attitudes

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The current state of students' knowledge regarding species diversity, particularly when it comes to endangered local species, is a cause for concern. This problem has resulted in a decline in students' attitudes towards conserving these species. To address these issues, providing students with reading resources that incorporate local wisdom is crucial. This research aims to develop a student book centered around real-world problems and incorporate Papuan local wisdom to enhance students' conservation attitudes. The ADDIE model has been employed to guide the product development process, including trials conducted with junior high school students. The effectiveness of the book was evaluated through questionnaires measuring conservation attitudes, expert validation using validation sheets, and student response questionnaires to assess practicality. The research findings indicate that the student book has been deemed valid by experts. Positive responses from students and teachers regarding the book's ability to optimize conservation attitudes suggest that it meets practical criteria. Moreover, statistically significant differences ($p < 0.05$) in pre and post attitudes demonstrate that problem-based books integrated with local wisdom effectively empower students' conservation attitudes. The inclusion of information on local wisdom, emphasizing the importance of preserving species, has greatly benefited

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students by enhancing their knowledge and positively impacting their conservation attitudes. Science teachers can utilize problem-based student books that integrate local wisdom as a powerful tool to enhance their students' conservation attitudes.

Introduction

Conservation is a widely discussed topic that aims to safeguard natural resources, including the organisms that inhabit them. Education plays a crucial role in this endeavor, serving to instill conservation principles. From a young age, children are introduced to education by their parents and subsequently attend school to gain and enhance knowledge, skills, and attitudes. It is essential not only for students to acquire knowledge but also for their attitudes to be nurtured. Thus, to ensure the effectiveness of natural resource conservation, it is important to foster an understanding of perceptions and attitudes towards nature (Al Balushi & Ambusaidi, 2023; Rampheri & Dube, 2021).

Lack of understanding importance of nature as well as how to conserve natural resources can lead to activities that harm and impact nature for today and future generation. For instance, Johnson et al. (2016) conducted research highlighting how lack of knowledge about protective measures has led to a decline in populations of animals like wild tigers at Lao. Other studies have shown that poaching has resulted in a significant loss of abundance and diversity in natural forests, putting various animal species at the risk of extinction (Gray et al., 2018; Nittu et al., 2023). The effectiveness of conserving living organisms does not solely rely on prohibitions or regulations imposed by authorities or local communities. It is crucial to examine the attitudes of individuals who interact with these vulnerable species to ensure sustainable utilization (Badola et al., 2012). The growing human population has played a role in the reduction of biodiversity (Kopnina et al., 2022). Understanding the levels of conservation awareness and attitudes is believed to provide valuable insights that can contribute to species preservation efforts (Ariya & Momanyi, 2015).

The lack of knowledge among students regarding environmental conservation poses a challenge to their sense of responsibility towards conserving natural resources (Ryan et al., 2020). In the research accomplished by Lee and Tanusia (2016), students' attitudes towards energy conservation at home were investigated. The findings revealed that when students are able to save energy both at home and at school, it indirectly influences their intention to adopt energy-efficient behaviors. Saving energy fosters a positive attitude towards energy conservation among students, thereby instilling a necessary conservation mindset. It is essential to introduce conservation attitudes to students from an early age, and schools play a crucial role in this process (Dimopoulos et al., 2008). The learning experience at school has a positive impact on shaping students' conservation attitudes. Attitude serves as one of the initial variables in a chain of factors that influence societal behavior towards species protection (Allendorf, 2020). Individuals may continue to engage in illegal resource extraction from protected areas because they either fail to recognize the negative impact of their actions or do not perceive viable alternatives (Karki & Hubacek, 2015).

Educators need to be mindful of attitudes towards organisms in order to support their protection through a focus on the affective domain. Schönfelder and Bogner (2017) emphasize the importance of teaching methods that help students identify species and provide scientifically accurate content to foster conservation efforts. Cruz and Grozinger (2023) conducted a study on student mapping for the conservation of pollinators, specifically bees. Their research confirmed that a crucial concept for students to engage in conservation is

understanding the importance of these organisms, their benefits, and the threats they pose to human life. However, this study did not explore conservation attitudes, indicating the need for further research to measure conservation attitudes. Dimopoulos et al. (2008) researched utilizing a conservation module to improve students' knowledge and attitudes regarding the protection of endangered turtles. Their research showed significant changes in students' knowledge when using the conservation module but not in their attitudes. Additionally, Sumberartha et al. (2021) developed teaching materials with a conservation focus to protect organisms. This research has revealed increased students' environmental literacy, where conservation knowledge is one aspect measured. Unfortunately, using this learning resource product does not reveal students' conservation attitudes.

A curriculum integrated with conservation education is fundamental because it increases students' commitment to preventing, protecting, and conserving nature (Christ & Dreesmann, 2023). To facilitate this, the development of student books becomes necessary. Student science books play a significant role in shaping student attitudes (Klop et al., 2010). Introducing students to various species through these books can provide substantial benefits for conservation efforts. Additionally, using species as an examples that are native to students' surroundings makes it easier for them to comprehend and relate to the subject matter. Børresen et al. (2023) recommend the inclusion of conservation biology in the school curriculum, particularly emphasizing the threats to biodiversity and species extinction resulting from the use of local natural resources. By presenting conservation-focused materials, it encourages individuals to foster a sense of responsibility towards conservation (Lewandowski & Oberhauser, 2017).

When a species facing endangerment is not properly introduced to the local community, it leads to a decline in awareness and willingness to protect it (Olive, 2014; Rampheri et al., 2022). Therefore, it is essential to incorporate local wisdom into the efforts of biological conservation and implement effective measures to safeguard living organisms under specific circumstances (Gray et al., 2018). Illegal activities carried out by local residents can undermine conservation objectives and impede progress (Castilho et al., 2018). Research undertaken by Castilho et al. (2018) highlighted the significance of considering human behavior and attitudes towards conservation activities when attempting to bring about change in a particular area. By introducing local environmental and biodiversity concerns to the community, it can inspire them to participate in conservation efforts (Haywood et al., 2016). The conservation attitudes of the community offer a ray of hope for the sustainable utilization of natural resources and preservation of living organisms (Sinthumule, 2021).

The research of Mutisya et al. (2015) focused on the topic of conservation education in Kenya. They discovered that the implementation of conservation education had made pupils conscious that when making judgments, such decisions were based on the information they gathered in their surroundings. Students have the perception that there is a connection between protected species and the activities of humans and that this connection results in a threat to protected creatures. Humans are responsible for their mistakes, leading to conflicts with wildlife. At the end of the article, the authors recommend that educators encourage pupils to adopt conservation attitudes by focusing on local issues. Utilizing local issues is intended to inspire students' thinking and decision-making to preserve the local environment in which they now reside.

Christ et al. (2022) researched to evaluate students' attitudes toward wild bees in the field. After being exposed to wild bees, the researchers discovered that the students' attitudes about

the significance of wild bee populations shifted positively. According to the study results, when children are exposed to the wild bees that are a natural part of their environment, their attitudes on the significance of variety are likely to shift in a favorable direction. Students' anxiety level about wild bees has decreased, which has led to the development of conservative measures to protect varied biodiversity, especially wildlife. The kids spoke about the right steps, such as growing flowers to provide the bees with both rooms to live and food to eat. Students' attitudes toward conservation may shift when they are educated about the need to safeguard certain resources against the risk of deterioration or extinction (Karris et al., 2020).

Knowledge of animal and plant species serves as the foundation for conservation efforts (Härtel et al., 2023). A strong understanding of these species positively influences student attitudes. Student' s lack of conservation knowledge might also contribute to decline in animal and plant species that coexist in their surroundings (Härtel et al., 2023). Introduction of environmental protection in education has proven effective in shaping students' attitudes towards preserving the environment and avoiding harm (Khanzadeh et al., 2021). Gavrilakis et al. (2023) have used wild animals of local endangered species in teaching activities. The research revealed that students displayed limited familiarity with local species and struggled to identify those threatened with extinction. Educating students about local species, particularly endangered ones, becomes a vital approach to combat biodiversity loss and empower students to safeguard these species from future extinction threats.

Sukri et al. (2020) utilized comic books infused with local wisdom as teaching materials. The research revealed no significant difference in students' conservation attitudes. However, they identified that the lack of interaction with the local ecosystem, particularly the absence of direct contact, resulted in a reduction in students' understanding. To address this issue, it is necessary to not only integrate local wisdom but also adopt a problem-based approach in the teaching materials. Interestingly, even indirect contact with nature, such as reading books about it, contributed to an improvement in students' conservation attitudes. For Instance, Xu and Jiang (2022) reported that over 80% of the students occasionally or frequently read books about the nature surrounding them, with less than 3% never engaging in such reading. They highlighted that indirect contact, like reading books about nature, can significantly impact students' conservation awareness and abilities. Through indirect contact via book reading, students gain knowledge about organisms and learn how to protect them.

Local wisdom holds valuable knowledge and strategies for nature conservation (Primayanti & Puspita, 2022). Diab et al. (2022) emphasize the importance of understanding and creating public awareness regarding the local wisdom potential in each region. In recent decades, there has been growing concern about conservation efforts disregarding local wisdom (Chaichana et al., 2019). To enhance conservation awareness, it is crucial to integrate local wisdom into conservation education (Chaichana et al., 2019). Recognizing the significant position of humans and local wisdom becomes imperative in addressing environmental challenges (Yasir et al., 2022).

The loss of biodiversity is caused by local wisdom knowledge which has been reduced due to the shift in patterns towards modern culture (Selemani, 2020). Local wisdom can be integrated into problem-based learning (PBL), and the effect is to increase students' knowledge of protecting the environment (Lubis et al., 2022). PBL can enhance students' knowledge of science, promoting problem-solving and critical reasoning skills. PBL is a student-centered approach that involves students in the learning process by involving them in

collaborative activities to solve problems (Kristianto & Gandajaya, 2023). The study suggests that the PBL could be effectively used in courses integrating fundamental understanding into students' skills to analyze, assess, and find solutions to complex actual-life problems. PBL in classrooms involves problem analysis, independent investigation, and sharing results, empowering students to solve problems, think critically, and take initiative in the learning process, ultimately achieving learning objectives (Hidayati et al., 2022). Teachers play a crucial role in implementing PBL, focusing on students' competency goals and ensuring they gain valuable knowledge for their future lives (Suwono et al., 2023). In PBL, the teacher facilitates group understanding by compiling information, directing exploration, strengthening complex concepts, and encouraging reflection on group processes and results (Seibert, 2021). PBL that is implemented well will increase learner satisfaction, is better than traditional learning, can improve social skills, produces very few bad effects, and can improve communication and problem solving abilities (Trullàs et al., 2022). Barrett (2013) explains that the quality of problems in PBL is authentic problems that challenge students, being multidimensional, based in the actual world, and equipping them with the ability to grow skills to comprehend the main concepts and application of problems in the real world. Discussion small-group in problem-based learning provides students with a secure and supportive environment in which to develop the appropriate abilities, Knowledge, and attitudes (Hande et al., 2015). There is a change in students' attitudes when they are involved in a PBL environment (Terashita et al., 2016). PBL can be chosen as a learning program for students' conservation development (Henderson, 2016). Thus the problem of biodiversity conservation attitudes can be solved by implementing PBL.

PBL offers a promising approach to address conservation issues effectively (Lister, 2000). PBL aligns well with teaching methods that focus on the conservation of living things. Widyaningrum et al. (2017) conducted a study utilizing PBL to enhance student learning outcomes in environmental preservation. The research demonstrated an increase in students' knowledge of environmental preservation. However, this particular study did not measure students' conservation attitudes during PBL learning. In another study by Regala (2019) in Manila, a problem-based book was implemented in schools to enhance student achievement regarding ecosystem conservation. His research results indicated positive effects on post-intervention student achievement using problem-based books. However, there was no specific measurement of students' conservation attitudes in this research. On the other hand, Wahyuni et al. (2022) examined a digital booklet based on crustacean local wisdom in the mangrove forest of Sangiang Island to enhance conservation attitudes, with PBL being the chosen learning method. The researchers claimed that the local wisdom booklet had an effect on students' conservation attitudes. However, upon analyzing their findings, it was observed that there was no significant difference in conservation attitudes between students who used the booklet and those who did not. Thus, it can be inferred that the booklet used in PBL did not demonstrate any distinctive impact on students' conservation attitudes compared to those without booklets.

Creating a problem-based book that integrates local wisdom is an ingenious strategy for enhancing students' conservation attitudes. The book can incorporate problems related to the knowledge and local community traditions. Students can learn how to address conservation issues and discover effective solutions by utilizing PBL. Additionally, the inclusion of local wisdom exposes students to valuable information about the local flora and fauna, as well as the community's traditions in safeguarding and preserving endangered species. Since the students are in the Papua region, the focus of the book will be on introducing them to Papuan local wisdom. The primary goal of this research is to develop problem-based student books

that integrate Papuan local wisdom, thereby empowering students to develop positive conservation attitudes.

Method

Research Design

The ADDIE model for research and development encompasses several stages (Branch, 2009), namely analysis, design, develop, implement, and evaluate. Drljača et al. (2017) have used this model to develop a teaching metarial. Likewise, Muruganantham (2015) has developed electronic content and the results show that the product developed meets valid criteria and has a significant effect on students. The ADDIE model is a structured approach to help understand student needs, so that data improves teaching about attitudes, skills and knowledge (Cheung, 2016).

The initial phase is Analysis, which involves conducting a thorough assessment of various factors. In this case, the school curriculum, teacher's tools and devices, the learning process, available learning resources, and student performance regarding their conservation attitudes were examined. Furthermore, researchers explored Papuan local wisdom and successfully integrated it into the student books.

During the Design stage, a meticulous process of creating problem-based teaching materials was undertaken. This involved identifying the problem's context, incorporating local wisdom, and organizing the material within the student's book. The result of this stage is a detailed storyboard for the student book. Student worksheets and lesson plans were designed to align with the junior high school curriculum and incorporate problem-based learning approaches. Additionally, a conservation attitude questionnaire was developed based on indicators such as protection, preservation, and utilization.

In the development stage, the creation of digital files for the student books is accomplished using Canva software. The detailed storyboard designed during the previous stage is transformed into an actual student book that incorporates local wisdom. Within the book, Papuan local wisdom is featured, focusing on topics such as "Sasi Laut" (a traditional marine conservation practice), the native butterfly species found in the Arfak mountains (Manihuruk et al., 2020)**,** indigenous flora and fauna like the Bird of Paradise and a newly discovered dragonfly species called *Oreaeschna dictatrix*, the illegal hunting of small birds of paradise, and the traditional utilization of black fruit by the Wandamen people (Ungirwalu et al., 2018). The final version of the student books undergoes a validation process by experts, and based on the feedback received, revisions are made to ensure a validated and improved product. Subsequently, the validated product goes through the phase I testing, also known as the pilot study.

The products that meet the necessary criteria from trial I move forward to the subsequent stage of ADDIE, which is product implementation. During the implementation phase, a pretest-posttest design is utilized. Students are provided with same questionnaires at different times. The first questionnaire is administered before the distribution and instruction on using the product (problem-based student books) take place. The second questionnaire is given at the conclusion of the product implementation process.

Evaluation stages are integrated into each ADDIE stage (Branch, 2009). In the analysis stage, an evaluation is performed regarding the curriculum used by the school, the availability of learning resources, students' conservation attitudes, and the learning process that the teacher has implemented. In the design stage, an evaluation is carried out regarding local wisdom that will be included in the book, learning objectives with the tasks given to students, and determining the appropriate design for the book. At the development stage, an evaluation is carried out for the suitability of the book based on experts, student responses, and teacher responses. At the implementation stage, an evaluation is performed to see the effectiveness of the developed book's implementation. An overall evaluation was performed to determine the feasibility based on the validity (based on experts), practicality (student and teacher responses), and effectiveness (t-test results) of the book being developed.

Participants

The research involved various participants, including experts, students, and science teachers. The experts encompassed learning specialists and science material experts, who played a crucial role in validating the designed and developed learning tools. Three science teachers were responsible for implementing the developed products, and one teacher for the pilot study. They supported the researchers by teaching science subjects to junior high school students and utilizing problem-based book products that integrated Papuan local wisdom into their teaching. In the pilot study, a total of 18 junior high school students participated. During the implementation stage, the learning process involved 51 students. The total number of students in the pilot study and implementation stage was 69. The age distribution of students was 11 years old = 4 (5.80%), 12 years old = 32 (46.38%), 13 years old = 9 (13.04%), 14 years old = 11 (15.94%), aged 15 years = 7 (10.14%), and each aged 16 - 19 = 1 (1.45%). The gender distribution is 37 (53.62%) males and 32 (46.38%) females. They are in grade 7 at Junior High School in the West Papua Region. Students come from urban and rural areas. This is also the basis for taking the participants using purposive sampling. The participants must come from Papuan and non-Papuan ethnic and represent urban and rural areas. Apart from that, the purposive basis is also due to the school's willingness to carry out research.

Instruments and Data Collection

The instruments used in this study consisted of a validation sheet and two questionnaires: a conservation attitude questionnaire and a student response questionnaire. The conservation questionnaire was utilized to measure students' conservation attitudes. The response questionnaire was adopted to measure student responses after learning is implemented. The validation sheet was provided to experts to validate the compiled learning tools, including the conservation attitude questionnaire and the questionnaire regarding student responses. The conservation attitude questionnaire was designed based on the principles outlined in the Law on the Conservation of Biological Resources and their Ecosystems (No. 5 of 1990), which includes the protection of life support systems, preservation of plant and animal species diversity and their ecosystems, and sustainable use of biological natural resources and their ecosystems. Seventeen statements in the conservation questionnaire. Each statement has five answer options: strongly agree - strongly disagree. Before implementing the developed products in actual classroom settings, they underwent a pilot study to assess their effectiveness. During the pilot study, students engaged in problem-based learning facilitated by a problem-based student book that integrated Papuan local wisdom. The students' responses and conservation attitudes were measured at the end of the lesson. The trial results from the development stage served as an evaluation basis for the subsequent implementation stage. In the implementation stage, at the beginning of the lesson,

students were administered the conservation attitude questionnaire. After completing the lesson, students were given the questionnaire again to determine any changes in their conservation attitude. Additionally, both students and teachers were provided with a response questionnaire to gather their feedback. The data collected from the implementation in actual classroom settings were used to determine the effectiveness of the problem-based student books integrated with Papuan local wisdom.

Table 1. Validity and Reliability of The Conservation Attitude Questionnaire

No	Validity			Reliability	
	r	sig.	Decision	Cronbach's Alpha	Decision
1	0.359	0.001	V		
2	0.432	0.000	V		
3	0.388	0.000	V		
4	0.385	0.000	V		
5	0.416	0.000	V		
6	0.51	0.000	V		
7	0.436	0.000	V		
8	0.558	0.000	V		
9	0.508	0.000	V	0.747	R
10	0.484	0.000	V		
11	0.287	0.006	V		
12	0.58	0.000	V		
13	0.338	0.001	V		
14	0.436	0.000	V		
15	0.578	0.000	V		
16	0.465	0.000	V		
17	0.353	0.001	V		

Note: R = Reliable, V= Valid

Analyzing of Data

The analysis involves examining student books created and verified by experts, using established validation standards (see Akbar, 2013). The achievement of each indicator of conservation attitude is calculated and categorized accordingly. These categories are outlined in Table 2. To determine the variance between students' initial and final conservation attitudes, paired t-test (using IBM Statistic 20) is utilized as a part of the final analysis.

Table 2. The Criteria for the Students' Conservation Attitudes

Score	**Criteria**
0 – 39	Very less attitude (VL)
40 – 59	Less attitude (L)
60 – 69	Moderate attitude (M)
70 – 79	Good attitude (G)
80 – 100	Excellent attitude (E)

Findings

In this study, a problem-based student book that incorporates Papuan local wisdom has been created. The research findings are presented in three parts: initial analysis results,

development and validation outcomes, and real classroom implementation results. The viability of the problem-based student book, which integrates Papuan local wisdom, is assessed through expert validation, which indicates that the product is valid. The practicality is evaluated based on the feedback received from students and teachers, and the effectiveness is determined by examining the implementation results.

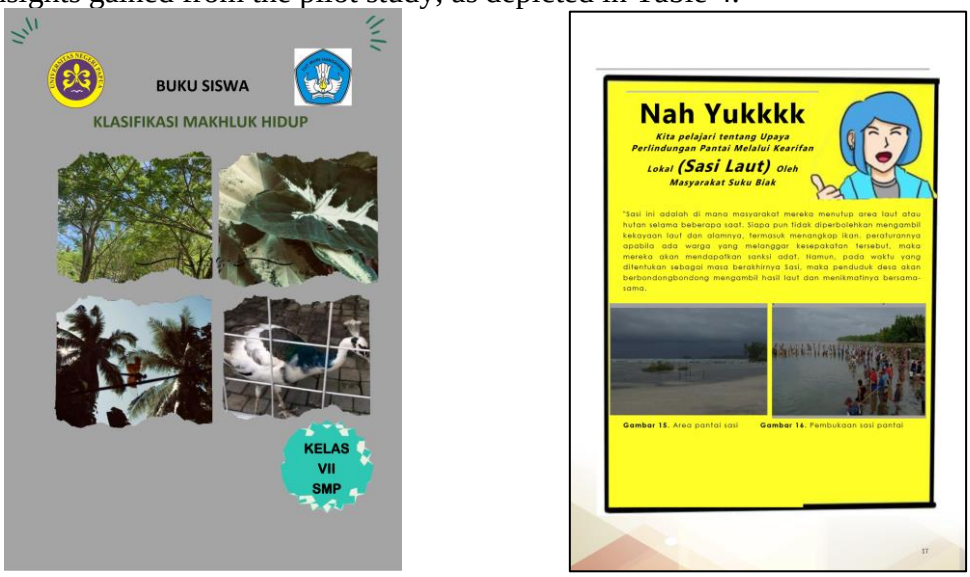
The initial analysis reveals that the student books currently used in schools have a general approach. These books, provided by the government for classroom use, do not incorporate problem-based learning or integrate local wisdom. It is also observed that teachers have not focused on cultivating students' conservation attitudes during their learning process. In light of these findings, a problem-based student book design was developed, incorporating Papuan local wisdom. To support implementation in the classroom, student worksheets and lesson plans were also prepared. The effectiveness of these learning tools was subsequently validated, as shown in Table 3.

Table 3. The Information Regarding the Learning Tools' Validity Assessment

Learning Tools	Score	Criteria
Worksheet of student	92.50	V
Lesson plan	92.50	V
Student book	93.75	V
Conservation attitude questionnaire	97.14	V

*V-Valid

The data presented in Table 3 demonstrates that the learning tools meet the criteria for validity. Specifically, the student book, which is the primary product, satisfies the requirements set by the experts. These findings indicate that the developed student books adhere to a problem-based learning approach and successfully integrate Papuan local wisdom. Subsequently, a pilot study was conducted, and the implementation phase followed based on the insights gained from the pilot study, as depicted in Table 4.



Cover of book

Local wisdom "Sasi Laut" integrated into the book

Figure 1. The examples of the Book Sections that have been Developed

Table 4. The Results of the Pilot Study and Implementation

Pilot study	Score	Criteria

Student conservation attitudes	72.96	G
Student response	78.48	G
Teacher Response	87.50	E
Implementation		
Pre-Student conservation attitudes	70.13	G
Post student conservation attitudes	76.21	G
Student response	79.60	G
Teacher Response	78.70	G

*G-Good, E-Excellent

The data presented in Table 4 reveals positive findings from the pilot study. During the test, students' conservation attitudes achieved a good rating, indicating their positive response to the utilization of problem-based teaching materials that integrate Papuan local wisdom. Similarly, teachers also responded excellently to the materials. These pilot study results served as the basis for progressing to the implementation stage of the problem-based student book, which integrates Papuan local wisdom in real classrooms. According to Table 3, the implementation of these problem-based student books in the classroom led to a significant increase of 6.08 points in students' conservation attitudes. Both students and teachers expressed favorable responses, demonstrating that the problem-based student books, incorporating Papuan local wisdom, successfully met the practical criteria.

Table 5. The Students' Conservation Attitude Criteria in Implementation Stage

Criteria	**% students**	
	Pre-conservation attitude	**Post-conservation attitude**
E	13.73	35.29
G	37.25	31.37
M	33.33	29.41
L	15.69	3.92
VL	0.00	0.00

Table 5 provides an overview of the students' conservation attitude criteria during the implementation stage. Prior to using the student book, there were no students with a very low conservation attitude (VL criteria is 0.00% in pre-conservation attitude). The majority of students fell into the good and moderate categories. However, there was a notable shift in these attitudes after the implementation of the problem-based student book, integrating Papuan local wisdom. The findings indicate that the largest percentage of students' conservation attitudes reached the excellent level, followed by good, moderate, and low criteria. Notably, there was a significant increase of 21.56 points in the percentage of students achieving the excellent criteria. This change highlights the positive impact of the lesson on students' conservation attitudes, suggesting a notable shift in their mindset after participating in the activities.

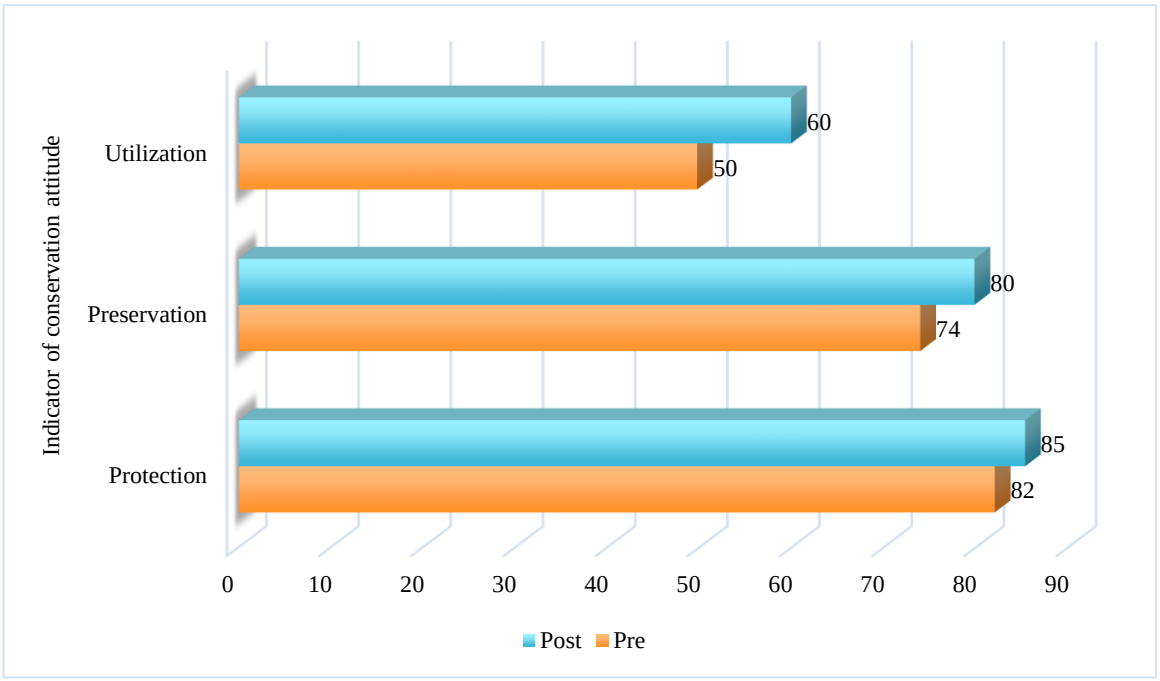


Figure 2. Student Achievement Based on Indicators of Conservation Attitude

Figure 2 shows the student achievement in terms of conservation attitude indicators. The data reveals that students' attitudes towards conservation vary across each indicator. The indicator for protecting life support systems received an additional score of 3. Similarly, the indicator for preserving the diversity of plant and animal species and their ecosystems received an additional score of 6. Furthermore, the indicator for the sustainable use of living natural resources and their ecosystems showed the highest increase with an additional score of 10. However, despite this significant increase, this particular indicator still falls short of the desired level. It remains in the moderate category compared to the other two indicators.

Table 6. Normality and Homogeneity of data of students' conservation attitudes

Data	Shapiro-Wilk				Levene		
	Statistic	df	Sig.	Decision	Statistic	Sig.	Decision
Pre	.987	51	.848	Normal	0.005	0.945	Homogeneous
Post	0.969	51	.198				

Table 7. Results of Paired T-test of Learning Effectiveness

Pair	**n**	**Mean**	**Standard Deviation**	**t**	**df**	**Sig.**	**Cohen's d**
Post – Pre	51	6.08	11.66	3.73	50	0.000	0.52

The results of the paired t-test in Table 7 indicate that problem-based student books integrated with Papuan local wisdom are effective (sig. <0.05) in improving students' conservation attitudes. Table 5 also reveals a moderate effect (Cohen's d = 0.52) from the implemented learning.

Discussion

Integrating local wisdom and problem-based learning into student books has empowered students' conservation attitudes. The outcomes of the initial analysis, which highlighted the need for Learning resources available to students based on local wisdom, have been addressed through the design and development of a problem-based book that incorporates Papuan local wisdom. The product has undergone an expert's assessment and meets the required criteria for validity (Rachmani & Farah, 2023). Once these criteria are fulfilled, the product can proceed to testing (Nusantari et al., 2021). The expert's assessment confirmed that the problem-based student book, integrated with Papuan local wisdom, meets the validity criteria and is ready for the next stage of trials. Experts help improve the quality of books developed by investigating the content in books developed following the ADDIE model (Muruganantham, 2015). Experts assist researchers by analyzing the material's content to ensure there are no conceptual errors, the extent of the material taught, and suitability to student charact Thiss. In this research, it has been fulfilled based on validation analysis from experts with a score of 97.55 so that a pilot study can be carried out.

The pilot study's findings indicated that students' conservation attitudes exhibited a favorable average, accompanied by positive responses from both students and subject teachers. This indicates a successful implementation of the ADDIE framework, with promising results from the pilot study (Damopolii et al., 2022). Both students and teachers responded positively, confirming that the student book, integrated with Papuan local wisdom, meets practical criteria. Students expressed agreement and happiness when using the book for learning, enabling them to enhance their knowledge, especially regarding endangered species. Students respond well to the learning resources used because they get additional information and answer what they want to know (Moghavvemi et al., 2018) . The positive feedback from teachers demonstrated that the developed book is effective in teaching and shaping students' conservation attitudes. Teachers respond that integrating learning resources into the classroom makes the quality of teaching better (Alberola-Mulet et al., 2021). The pilot study through the implementation of problem-based student books integrated with Papuan local wisdom has provided the outcome that students and teachers responded well, and there was an increase in the quality of teaching as indicated by a good conservation attitude score. This becomes the basis for continuing at the next stage.

An examination of the differences between pretest and posttest results during the implementation stage of the ADDIE model reveals a significant change in students' conservation attitudes after being taught using problem-based student books integrated with Papuan local wisdom. The findings indicate a noticeable shift in students' attitudes before and after the intervention. We utilized a problem-based book that incorporates local wisdom, providing students with knowledge on safeguarding living organisms based on local wisdom principles, particularly in Blood Papua. It is crucial to note that knowledge plays a crucial role in shaping conservation attitudes (Bragagnolo et al., 2016) and fostering efforts towards protection (Allendorf, 2020). For instance, during the study, students were introduced to the concept of "Sasi Laut," a local wisdom practice aimed at protecting marine species from extinction by implementing traditions that restrict the large-scale capture of fish. This local wisdom is safeguarded through customary regulations, which prohibit the exploitation of natural resources in customary areas. As a result, marine resources are preserved for a designated period. However, the closure of these areas is not a permanent measure. Once the natural resources have regenerated, the "Sasi Laut" is lifted, and the community is permitted to resume fishing activities. According to Zimmerman and Weible (2017), when students were asked what activities damaged the environment, they answered that fishing was

unnatural. Arias et al. (2015) found that a person's compliance is high in preventing excessive fishing through prohibitions on fishing regulations; fish can be taken but regulated. By teaching the local wisdom "Sasi Laut," students gain knowledge of how to maintain the diversity of living creatures, especially fish, and this makes their protective attitudes well-formed.

The invaluable knowledge derived from this local wisdom serves to educate students on safeguarding marine species and combatting the threat of extinction. The desire to uphold the values embedded in local wisdom instills a sense of awareness and responsibility for the preservation of all living organisms (Yasir et al., 2022). As a result, future generations can witness the continued diversity within their surroundings through various conservation efforts. Armed with this knowledge, students undergo a positive transformation in their conservation attitudes towards living beings. Students' knowledge of environmental protection affects their conservation attitudes (Mohiuddin et al., 2018). When individuals are introduced to the importance of protecting their environment, they tend to exhibit a predominantly positive inclination towards conservation (Allendorf, 2020). This positive shift is evident in the significant increase observed in students' average conservation attitude scores before and after learning. Furthermore, students express their agreement to participate in "Sasi Laut" activities, a preservation practice upheld by the people of Papua, if supported by the government. This endorsement signifies students' support for the ongoing efforts to protect living organisms and ensure their survival for future generations. Their conservation attitude regarding protection has shown an excellent score (85), which indicates that students have an attitude toward protecting biodiversity so that it continues for the next generation.

The problems highlighted in the student book, such as species extinction, the life cycle of species, and even poaching, have served as catalysts, motivating students to take action toward protecting them. The inclusion of information on local wisdom, emphasizing the importance of preserving species, has greatly benefited students by enhancing their knowledge and positively impacting their conservation attitudes. PBL has proven to be instrumental in addressing students' conservation weaknesses during the learning process. For instance, students are presented with a problem concerning species extinction, prompting them to identify the causes of endangered species and devise solutions by referring to the local wisdom information provided in the student book. Through this process, they become aware of the necessity of protecting these species. Consistently engaging in such activities, which involve problem-solving related to conservation, fosters a conservation-minded attitude among students. This approach is further supported by reviews conducted by Ardoin et al. (2020), and Demirel and Dağyar (2016), which emphasize that the utilization of PBL, particularly when centered around environmental issues, contributes to conservation efforts and enhances environmental quality.

Being familiar with local species demonstrates an awareness of and connection to one's immediate environment, making it highly valuable as local communities serve as custodians and play a crucial role in in restoring and conserving local biodiversity (Ghosh & Basu, 2022). Introducing featured species for conservation to students not only helps correct any misinformation but also fosters their interest in protecting these species (Schönfelder & Bogner, 2017). The integrated problem-based book focuses on animals and plants endemic to Papua, providing information on how to preserve and manage them to prevent extinction. For example, we highlight the black fruit processing practices of the Wandamen Papua tribe, wherein local communities can harvest and utilize the fruit from natural forests, but with certain restrictions in place to ensure its sustainability. One of the learning topics revolves

around the challenge of classifying living organisms, particularly when faced with the issue of extinction, which hinders the classification of related species. To address this, students are taught how to tackle the problem of organism extinction by applying local wisdom. The integration of local information in the problem-based book not only facilitates easier problem-solving for students but also ensures that the provided information resonates with their daily lives. Furthermore, introducing endemic species and local information in the book enables students to identify and classify these species effectively in future learning scenarios. The issue of species extinction, particularly that of endemic species in a specific area, raises significant concerns. The development of the problem-based book has been instrumental in enhancing students' conservation attitudes. It is crucial to acknowledge that students' lack of awareness about a particular species prevents them from envisioning opportunities to conserve that species (Sieg et al., 2018). Additionally, students' attitudes towards specific species greatly influence their willingness to support conservation efforts (Martín-López et al., 2007). While research indicates problem-based student books integrated with Papuan local wisdom effectively empower students' conservation attitudes, a subset of students (approximately 3.92%) still require further improvement.

The research findings highlight that students' conservation attitudes regarding utilization have not yet reached an optimal level. Students exhibit a lacking attitude when it comes to supporting the sale of endemic animals, primarily due to the challenges associated with meeting their basic human needs. While they express the belief that endemic animals like the Cockatoos should be protected, they sometimes find themselves compelled to sell certain endemic species due to economic constraints. These economic needs drive them to legally hunt protected animals for personal use and sale (Olalekan et al., 2019; Rakhmanov & Turgunov, 2022). However, it is worth noting that other studies suggest a weak influence of economic factors on shaping an individual's conservation attitude (Khan et al., 2023). The results of our research align with the finding that respondents do not exhibit a positive attitude towards conservation when their livelihoods are disrupted, despite the majority expressing a positive attitude towards protection (Abdullah et al., 2019). To address the issue of students' attitudes towards utilization, it is crucial to introduce them to a wider range of endemic and step species. Although this research indicates that students' conservation attitudes regarding utilization were not optimal, implementing of problem-based student books integrated with Papuan local wisdom has effectively contributed to positive attitude changes among students. This is evident from the fact that the utilization indicator experienced a greater increase compared to the other two indicators measured in this research.

Conclusion and Recommendations

The problem-based student book, which incorporates Papuan local wisdom, has successfully met the validity criteria based on expert assessment. The positive responses from both teachers and students highlight the practicality and usability of this book. Furthermore, the noticeable difference observed in students' conservation attitudes before and after utilizing the book demonstrates the integration of problem-based learning with local wisdom effectively in empowering students' conservation attitudes.

Science teachers can utilize problem-based student books that integrate local wisdom as a powerful tool to enhance their students' conservation attitudes. By incorporating local wisdom, these books can effectively increase students' knowledge regarding endangered species and foster positive conservation attitudes. Problem-based learning approaches equip students with the necessary skills to analyze and solve real-world problems that resonate with

their daily lives. For future research, it is recommended to explore how indicators related to the utilization of conservation attitudes can be optimized through the provision of comprehensive information on local wisdom, including responsible usage and sustainable management of natural resources.

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Conflict of Interest

No conflicts to be declared.

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