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Enhancing Students' Science Process Skills through Local Wisdom Based Biology Worksheets in Ecology and Biodiversity Learning

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ABSTRACT

The low relevance of biology subject matter to the local context has resulted in students having limited in-depth understanding of concepts. This research focuses on evaluating the implementation of a Student Worksheet rooted in local wisdom in biology learning, specifically on ecology and biodiversity, through the guided inquiry model. The research employed a descriptive approach at the worksheet implementation stage with seventh-grade students as subjects. Data were obtained from the N-gain score of a written test on. Research data were derived from the N-gain score of a written test on SPS and from the evaluation of worksheet implementation over four meetings. The findings show an N-gain score of 0.51, classified into medium, indicating that the worksheet rooted in local wisdom was able to enhance students' SPS, foster active engagement, and facilitate concept comprehension. The evaluation results revealed that almost all biology learning activities were implemented, and reflections showed positive responses as the material was relevant to daily life.The worksheet based on local wisdom is feasible to be used as an alternative biology teaching material employing the guided inquiry model at MTs Nurul Ula Desa Burai.

INTRODUCTION

Biology education is essential for fostering students' scientific reasoning and inquiry skills. Although biology education represents an essential component in fostering scientific reasoning skills, many students still struggle to master scientific concepts. This is also evident at MTs Nurul Ula, based on study preliminary students' abilities in understanding biology subjects remain relatively low. Observations show that most students tend to memorize material without fully grasping the underlying concepts, which often limit students' capacity to to connect theory with real-life applications. In addition, their reasoning and problem solving competencies are still weak, as reflected in their limited ability to formulate questions, conduct simple experiments, and develop evidence based conclusions. These shortcomings are partly due to teacher-centered learning, the predominance of teacher-centered lectures and the restricted opportunities given to students to engage in inquiry-based activities. Inquiry-based learning (IBL) encourages students To actively investigate, experiment, and evaluate evidence, deepening their conceptual understanding (Bioco & Echaure, 2021). As noted, biology education equips students with methods to process facts through experimentation and reasoning, enhancing both cognitive and problem-solving abilities (Lakhvich, 2021; Toma, 2021).

Inquiry also supports reforms in many education systems, improving students' scientific literacy a central goal of biology education (Liu et al., 2020). Studies confirm that IBL fosters deeper understanding while increasing motivation and engagement (Liang et al., 2021; Toma, 2021). Successful implementation, however, requires well-prepared teachers; professional development strengthens their ability and confidence to deliver inquiry-based lessons (Maeng et al., 2020; Seneviratne et al., 2020). Such practices not only build conceptual knowledge but also equip students with critical thinking and reasoning skills vital for future success (Baharom et al., 2020; Rohandi, 2022). Overall, biology education an essential foundation for enhancing students' engagement and scientific capabilities, as shown in various studies and reforms (Liu et al., 2020; Winarno et al., 2020).

Observations along with in-depth interviews were carried out at MTs Nurul Ula, Burai Village indicate that science learning has not systematically assessed students' science process skills (SPS) and remains largely teacher-centered and textbook-based. A needs analysis involving 12 eighth-grade students showed that 66,7% experienced difficulties in understanding ecology and biodiversity, and 83,3% rarely engaged in outdoor learning activities, limiting opportunities to practice SPS through direct observation and investigation. As a result, students' SPS were not optimally facilitated, although their actual level had not been formally measured. To address this gap, the present study employed a pretest–posttest design to obtain initial data on students' SPS and to examine changes after the implementation of a local wisdom–based worksheet. SPS are a core component of scientific literacy, encompassing skills which involve observing, organizing data, interpreting findings, and drawing evidence-based conclusions that enable learners to conduct inquiry-based scientific activities. Previous studies emphasize the importance of these skills, highlighting challenges in evidence-based reasoning (Gozalbo et al., 2022) and the role of analysis and hypothesis formulation in biology learning (Hayden & Eades-Baird, 2020). Similarly, Haryadi & Pujiastuti (2020) defined scientific literacy as using knowledge, identifying questions, and drawing evidence-based conclusions, a view shared by Cahyaningtyas & Desstya (2024) who highlighted problem recognition and systematic analysis as essential to the scientific method. Pedagogical strategies also play a crucial role, with Salchegger et al. (2021) showing that structured inquiry-based environments foster stronger biology achievement than open inquiry. Thus, strengthening SPS through well-designed inquiry-based learning is vital for fostering literacy and preparing students to apply scientific reasoning in real contexts.

In biology learning activities at MTs Nurul Ula, Student Worksheets are still rarely used, as teachers often rely on textbooks as the main teaching material. The limited use of worksheet is also reinforced by the teaching methods applied by teachers, which are still dominated by lectures, discussions, and group presentations. Conventional methods remain the teachers' primary choice in teaching, where teachers explain the material and students passively listen, take notes, and then complete practice questions. Instructional tools such as student worksheets are essential in facilitating the development of scientific skills among students. Student worksheets act as structured guides that foster motivation, critical thinking, and engagement in biology learning through interactive and multimedia-based approaches (Setianingrum et al., 2022).

Worksheets play a vital role in facilitating students' mastery of SPS, as they provide structured opportunities for learners to practice essential abilities such as observation, classification, interpretation, and drawing conclusions. A worksheet is a learning tool in the form of structured tasks or guided activities that help students explore and understand a concept step-by-step. It usually contains questions, prompts, or exercises that lead students to observe, analyze, and apply what they are learning.Through guided tasks and inquiry-based activities, worksheets also foster active participation and promote higher-order thinking, encouraging students to reason critically and develop decisions supported by empirical evidence (Warnida et al., 2023). Moreover, effective implementation of worksheet improves scientific literacy by guiding students to apply scientific methods and equipping them with essential life skills (Setiati & Jumadi, 2023). Thus, well-designed worksheet are crucial for strengthening both teaching effectiveness and students' scientific competencies.

An effective worksheet should be designed to guide learners toward active exploration and concept discovery through hands-on investigation. Worksheet not only present scientific concepts but also engage students through multimedia and practical activities that enhance motivation and understanding (Setianingrum et al., 2022). Emphasizing hands-on investigations, they support inquiry-based learning and significantly improve SPS by helping students explore and construct knowledge (Haerani et al., 2023). Guided prompts within worksheet while fostering students' abilities in critical reasoning and problem resolution, empowering learners to take ownership of their learning (Ernawati & Sujatmika, 2021). Thus, well-designed worksheet are essential for strengthening students' scientific competencies and deepening their understanding of scientific principles.

The swamp ecosystem in Burai Village is characterized by rich biodiversity, dominated by vegetation such as purun (*Lepironia articulata*), cattail (*Typha angustifolia*), reeds (*Phragmites australis*), and water hyacinth (*Eichhornia crassipes*). Local wisdom includes using gelam wood (*Melaleuca leucadendron*) for traditional stilt houses and purun for handicrafts, supporting both household income and the village's role as an ecotourism area. The integration of such local wisdom into worksheet design can provide contextualized and culturally relevant learning experiences for students. To create integration between local contexts and scientific practices, the development of local wisdom-based student worksheets facilitated by a guided inquiry model offers a unique approach. On one hand, worksheet function as learning media that bridge local issues with scientific concepts; on the other, the guided inquiry model provides structure within exploratory learning.

This approach enables students to construct knowledge through authentic, structured, and locally meaningful activities. Integrating local wisdom into worksheet design provides culturally relevant learning that connects curriculum to students' identities, fostering engagement and retention (Pela et al., 2023). Culturally responsive materials improve outcomes and inclusivity (Besonia et al., 2023), while also encouraging student ownership of learning (Levine & Tamburrino, 2024). From an anthropological view, education is shaped by culture and context (Gaurifa, 2024), and embedding local wisdom supports inquiry and deeper understanding, as demonstrated in chemistry learning by Huang (2023). Based on the aforementioned background, it is evident that although worksheets have the potential to foster scientific literacy and SPS, several problems persist in their implementation. Many worksheets are still developed in a predominantly theoretical manner, with limited integration of contextual relevance, local environmental issues, and inquiry-based activities that actively engage students in scientific exploration. As a result, students often experience difficulties in developing SPS meaningfully, and learning activities tend to be less connected to their real-life and cultural contexts. This condition highlights the importance of examining the effectiveness of worksheets that incorporate local wisdom, as such an approach not merely contextualizes biology learning but also enhances students' understanding of science through their interaction with familiar environmental and cultural settings.

In response to these challenges, this research concentrates on examining the practice of local wisdom-based worksheets and their contribution to improving students' SPS. Through the integration of inquiry-based activities and contextual content, the worksheets are expected to support more meaningful learning experiences, enhance student engagement, and promote deeper scientific understanding. The findings are anticipated to provide theoretical contributions to the development of contextualized and inquiry-oriented biology learning models, as well as practical insights for teachers in designing effective instructional materials. Consistent with previous studies emphasizing structured inquiry and contextual learning, this study is expected to demonstrate that well-designed worksheets play a crucial role in developing SPS while also preparing students with essential competencies for the 21st century.

The value of this research is demonstrated through the practical implementation of the proposed approach in the real context of MTs Nurul Ula, Burai Village specifically through the exploration of swamp ecosystems as a contextual resource for biology instruction. The novelty of this study is the use of worksheet that emphasize local wisdom (swamp ecosystems) while focusing on guided inquiry to build students' SPS, as well as fostering environmental awareness of the local surroundings. Furthermore, this study provides a significant contribution to the development of biology teaching materials that are not only scientific but also contextual and rooted in local culture. The model enhances teachers' capacity to act as facilitators of active and reflective learning processes., while providing an example of how schools can empower the local environment as an effective learning resource. This investigation seeks to evaluate the implementation of local wisdom-based worksheet in biology learning using a guided inquiry model, with a focus on the extent to which students develop SPS and how teachers and students respond to the learning process The findings of this research are anticipated to provide a reference for the development of biology curricula that are more contextual, creative, and sustainable.

MATERIALS AND METHODS

1. Time and Place of Research

The research activities were conducted at MTs Nurul Ula, Burai Village, during the 2023/2024 academic year. The implementation phase of the local wisdom–based Student Worksheet took place throughout the biology learning sessions covering ecology (swamp ecosystem) and biodiversity.

2. Research Method

This research was carried out through a quantitative approach, implemented after the development of Student Worksheet grounded in local wisdom using a research and development (R&D) model. The quantitative stage focused on assessing the efficacy of the worksheet in enhancing students' Science Process Skills (SPS). A one-group pretest–posttest design was applied in this study to measure students' science process skills before and after the intervention of the worksheet, as detailed in Table 1.

Table 1. Research Design of the One-Group Pretest–Posttest Model

Group	Pretest	Observation	Posttest
Experimental Class	O1	X1 X2 X3 X4	O2

Note: O1 = Pretest (initial measurement of students' SPS); X1–X4 = Learning stages using the local wisdom–based worksheet; O2 = Posttest (final measurement of students' SPS)

3. Population and Sample

The population consisted of all seventh-grade students at MTs Nurul Ula. A total of 20 students were selected as the sample using purposive sampling, based on their relevance to the implementation of swamp ecosystem–based local wisdom in the ecology and biodiversity topics.

4. Research Prosedure

The procedure of this study involved a number of sequential phases designed to ensure systematic implementation and evaluation of the local wisdom based Student Worksheet:

a. The process began with the development of the worksheet through a R&D model, proceeded by its application in guided inquiry based learning. Before the learning intervention, students completed a pretest to measure their initial Science Process Skills (SPS).
b. The worksheet was then integrated into ecology and biodiversity lessons, accompanied by observations to monitor students' activities and skill development throughout the learning stages.
c. After the intervention, students completed a posttest to assess changes in their SPS. The resulting data were processed using N-gain, through the Mann–Whitney test and subsequent effect size analysis calculations to determine the effectiveness of the worksheet and the magnitude of improvement in students' scientific skills.

5. Data Collection

Data were collected using two instruments:

a. SPS Test (pretest and posttest) to determine students' SPS at the beginning and at the end of the worksheet usage.
b. Observation Sheet to record the implementation of learning based on guided inquiry stages and students' engagement during the activities.

6. Data Analysis

a. N-Gain Analysis

Improvement in students' SPS was calculated using the normalized gain (N-gain):

$$\text{N-gain} = \frac{\text{Posttest} - \text{Pretest}}{\text{Maximum score} - \text{Pretest}}$$

The interpretation of N-gain referred to Hake & Reece (1999) :

Table 2. Interpretation of N-gain in Quantitative Analysis

Gain Value	Interpretation
$g \geq 0,7$	High
$0,3 > g > 0,7$	Medium
$g < 0,3$	Low

Hake (1999)

b. Mann-Whitney

The study utilized the Mann–Whitney test as a non-parametric option in place of the Independent Sample T-Test, given that the data failed to meet parametric assumptions. The hypotheses were formulated as follows: H_0: no statistically significant difference was observed between the pretest and posttest SPS, and H_1: a significant difference exists. Decisions were based on the p-value, with H_0 were considered supported if $p > 0.05$ and considered invalid if $p < 0.05$.

c. Effect size

Effect size (r) was determined by means of the following formula (Sheskin, 2003), with classification based on Cohen et al. (2007): $0.2 \leq r < 0.5$ (small), $0.5 \leq r < 0.8$ (medium), and $r \geq 0.8$ (large):

$$r = \frac{|Z|}{\sqrt{N}}$$

Note:

r = Mann-Whitney's effect size
Z = Mann–Whitney U test-derived statistic
N = Overall sample size

RESULTS AND DISCUSSION

The results of this study highlight gains in students' SPS enhanced after learning with the local wisdom based worksheet. The noted enhancement is apparent from the increase in scores between the pretest and subsequent posttest, which was then measured using the N-gain analysis. Before further testing, the pretest and posttest data were initially examined to determine whether they meet the necessary statistical assumptions. The analysis results indicate a clear difference between students' abilities before and after the learning activities. In general, these findings show that the worksheet was effective in supporting students' learning and skill development.

a) N-gain Results

The average N-gain test score shows an improvement in the students' SPS scores measured before and after the intervention. Table 3 provides a detailed view of the average N-gain test results for the pretest and posttest.

Table 3. N-gain Test on Each SPS Indicators

No.	SPS Indicators	Max Score	*Pretest*		*Posttest*		*Gain*	
			$\bar{x}$	*Std*	$\bar{x}$	*Std*	*Gain*	Note.
1.	Formulating Hypotheses	4	1,40	0,88	2,95	1,00	0,60	Medium
2.	Defining Operationally	3	2,00	0,97	2,30	0,86	0,30	Medium
3.	Identifying Variables	3	1,25	0,57	2,20	1,11	0,54	Medium
4.	Conducting Experiments	5	1,95	1,10	3,30	1,78	0,44	Medium
5.	Interpreting Data	3	0,75	0,79	2,20	1,15	0,64	Medium
6.	Drawing Conclusions	2	0,90	0,62	1,50	0,76	0,55	Medium
	Mean		1,38	0,82	2,41	1,11	0,51	Medium

Insights from Table 3 demonstrate that the average N-gain score for the indicators of formulating hypotheses, identifying variables, conducting experiments, interpreting data, and drawing conclusions is greater than 0.30 and less than 0.70, thus classified in the medium category. Meanwhile, the indicator of defining operationally shows a score of 0.30, which is classified in the low category. The highest N-gain score is found in the indicator of interpreting data (0.64), since students practiced extensively in observing and analyzing experimental results through guided inquiry-based worksheets, thereby developing this skill more optimally. Conversely, the indicator that exhibits the lowest score is of defining operationally (0.30), because students had already obtained relatively high scores at the beginning of the sessions, as they were accustomed to defining and understanding concepts theoretically in previous learning activities.

The effectiveness of the student worksheet on swamp vegetation biodiversity was examined through field trials in class VII MTs Nurul Ula by calculating the N-gain from pretest and posttest scores, which reached 0.51. According to Hake & Reece (1999) classification, this score falls within the medium category, indicating a fairly significant improvement in students' SPS after using the worksheet on swamp vegetation biodiversity integrated with local wisdom through the guided inquiry model. This improvement demonstrates that the learning activities were able to provide students with direct experiences in the scientific process, ranging from observing phenomena, defining problems, proposing hypotheses, gathering data, and deriving conclusions.

Overall, the N-gain score for the SPS indicators is 0.51, belonging to the category of medium. The N-gain scores from the pretest and posttest outcomes for each student is displayed in Table 2 below.

Table 4. N-gain Test of Students

No.	Students Initial	Nilai *Pre-test*	Nilai *Posttest*	*N-gain*	Ket.
1.	ADH	25	35	0,133	High
2.	AA	30	100	1	High
3.	AH	40	95	0,916	High
4.	AKP	30	60	0,4298	Medium
5.	CVB	45	100	1	High
6.	GFR	30	70	0,571	Medium
7.	KP	20	30	0,125	Low
8.	MAR	40	20	-0,333	Low
9.	MY	25	100	1	High
10.	MAF	45	50	0,0909	Low
11.	MIK	35	75	0,615	Medium
12.	MMJ	25	100	1	High
13.	MRA	25	100	1	High

No.	Students Initial	Nilai *Pre-test*	Nilai *Posttest*	*N-gain*	Ket.
14.	NFA	50	95	0,9	High
15.	NGA	30	90	0,857	High
16.	NNP	45	35	-0,181	Low
17.	NUR	50	60	0,2	Low
18.	RAL	45	100	1	Low
19.	SAR	25	30	0,0667	Low
20.	SSM	20	100	1	High
		Mean		**0,57**	**Medium**

As indicated by the results in Table 4, it is evident that most students experienced an improvement in learning outcomes after the lesson, as indicated by positive N-gain values. The N-gain score reflects the extent of improvement from pretest to posttest, where a higher score indicates greater progress. Several students, such as AA (2), CVB (5), and MY (10) even achieved an N-gain of 1 or 100%, which means they reached the maximum improvement from pretest to posttest. However, there were also students who showed medium to low improvement, and even two students: MAR (9) and NNP (16) who had negative N-gain values. This indicates that their posttest scores were actually lower than their pretest scores. According to the researcher, these negative N-gain values were caused by several factors, such as a lack of concentration during the posttest, poor physical or mental condition, teaching methods that did not align with their learning styles, or even technical errors when answering the questions. Nevertheless, both of these students were in fact very actively involved during the field learning activities. Even so, overall the computed mean N-gain score for 0.57 or 57% indicates that students engaged with a worksheet integrating local wisdom and guided inquiry was quite effective in enhancing the understanding of most students.

Thus, the medium category of N-gain can be interpreted as evidence that the learning media used was effective in developing students' SPS, although there remains room for improvement through enriching investigative activities, strengthening teacher guidance, and diversifying fieldwork activities. The findings across four meetings, in which the guided inquiry model was applied, consistently showed an increase in students' SPS. Additionally, the significance of teacher guidance was evident as guided inquiry activities cultivate an environment where students can collaborate in constructing knowledge, which is fundamental to understanding scientific concepts (Hasanah et al., 2020; Winarti & Sari, 2020)

The findings of this study indicate consistent with earlier studies from other disciplines that guided inquiry-based worksheets can significantly improve SPS. For example, guided inquiry worksheets in physics topics such as Hooke's Law achieved an N-gain of 0.69, while chemistry topics like colloids yielded an N-gain of around 0.6 with very positive student responses (Putri et al., 2022; Sari et al., 2021). Similarly, in biology, students learning about carbon compounds scored nearly 30 points higher in posttests when using guided inquiry compared to control groups (Sartika et al., 2020). Developmental studies using models such as 4-D also demonstrated high feasibility and practicality scores above 80%, with N-gain results varying from 0.50 to 0.91 (Pradana et al., 2021).

The observed N-gain improvement in this study aligns with the notion that effective worksheet can enhance students' SPS, as supported by (Kamaluddin et al., 2022), who argue that guided inquiry is effective in improving learning outcomes by engaging students performing inquiry-based exploration and investigation. Maryani et al. (2023) further emphasized that guided inquiry should involve exploring phenomena, formulating questions, planning investigations, collecting data, performing analysis, and drawing the conclusions, all of which were successfully integrated in the present worksheet. This is in line with Nuayi & Very (2020), who highlighted the role of guided inquiry in developing students' critical and scientific reasoning skills.

Moreover, Oktavia et al. (2024) identified that effectiveness can be assessed through the improvement of SPS indicators such as hypothesis formulation, variable identification, experimentation, data analysis, and result communication. This study demonstrated improvements across all these indicators. Similarly, Matsna et al. (2023) categorized SPS into basic competencies (observation, classification, prediction, measurement, communication, and conclusion) and integrated competencies (hypothesis formulation, variable control, planning investigations, conducting experiments, data interpretation, and application). The present findings indicate that the worksheet developed successfully enhanced both sets of skills.

Beyond cognitive gains, the worksheet also increased student engagement and active participation. Safitri et al. (2018) noted that the efficacy of a learning model lies in how it enhances students' understanding and involvement. Handayani (2021) added that guided inquiry encourages students to discover concepts independently through investigation. Consistent with this, students in this study reported finding the worksheet engaging and supportive of their understanding of ecological concepts.

b) Normality Test Result

The study conducted a normality test employing the parametric statistical Shapiro-Wilk test in the SPSS for Windows program on the pretest and posttest. This was done to ensure that the analyzed data were taken from a population characterized by a normal distribution. A brief overview of the normality test results is presented in Table 5.

Table 5. Normality test Pretest and Posttest SPS Data

	Experiment	**Shapiro-Wilk**		
		Statistic	**df**	**Sig.**
Pretest score	*Pretest*	.898	20	.037
Posttest score	*Posttest*	.828	20	.002

The normality test results showed significance values below 0.05 regarding the pretest and posttest results, indicating that the data were not normally distributed and did not meet the assumptions for parametric testing. Since t-tests require normally distributed data, their use under these conditions could lead to inaccurate results (Tapio, 2025). Therefore, this study adopted the Mann–Whitney test as a non-parametric option, as the test does not rely on normality assumptions and is considered more reliable when applied to non-normal data and small-scale samples (Nahm, 2016).

c) Homogeneity Test Result

In the homogeneity test, the data were analyzed to determine whether the pretest and posttest on ecology and biodiversity results had equal or varying variances. This test was implemented with Levene's Test, alongside the homogeneity test outcomes presented in Table 6.

Table 6. Homogeneity Test of Pretest and Posttest SPS Data

Levene Statistic	**df1**	**df2**	**Sig.**
1.461	4	10	.285

The results obtained through the homogeneity test in Table 6 reveal a statistical significance of 0.285, above the set alpha level of 0.05. This means that the data have equal variances, so H0 is accepted. In statistical analysis, homogeneous data indicate that the variability between groups is similar and does not affect the test results (Field, 2020). Therefore, the data in this study meet the homogeneity assumption and are appropriate for further analysis.

d) Mann-Whitney U Test Result

The two-sample difference test was conducted using the Mann-Whitney U method in SPSS for Windows, with the results as follows.

Table 7. Mann-Whitney Test of Prestest and Posttest SPS Data

	Value
Mann-Whitney U	59.000
Wilcoxon W	269.000
Z	-3.839
Asymp. Sig. (2-tailed)	.000
Exact Sig. [2*(1-tailed Sig.)]	.000[a]

The data in Table 7 show an Asymp. Sig. (2-tailed) value of 0.000, reflecting that the p-value < 0.05. Therefore, the results lead to rejection of H0 and acceptance of Ha. It is evident from the findings that the pretest and posttest differ significantly. The negative Z value in the Mann-Whitney test indicates that the pretest scores were lower than the posttest scores. Thus, the biodiversity worksheet swamp vegetation integrated with the guided inquiry model has a significant influence on enhancing the SPS of seventh-grade students at MTs Nurul Ula, Burai Village. The adoption of guided inquiry helped enhance the achievement of SPS indicators because students were not just passive recipients but participated in actively involved in discovering knowledge under teacher guidance. Integrating local wisdom into the topic of swamp vegetation biodiversity made learning activities closely related to the students' routine experience, motivating them to engage more fully in the learning process. This aligns in accordance with constructivist theory, which emphasizes that knowledge is actively built upon real experiences, thereby enhanching students' ability to understand concepts and connect them with their surrounding swamp ecosytem. Research indicates that using contextual teacher learning can significantly enhance student outcomes by facilitating connections between academic content and real-life experiences, ultimately increasing enthusiasm and commitment to learning (Dwi et al., 2023; Latuny et al., 2021; Wiradika & Retnawati, 2021).

Further emphasizing the essentiality of localized content, incorporating local wisdom into educational frameworks makes learning more relevant for students. This relevance enhances their ability to engage with the subject matter, as it resonates with their community experiences, thereby increasing their intrinsic motivation (Rahmah et al., 2024; Wedaswari & Tegeh, 2023).

e) Effect Size Test Result

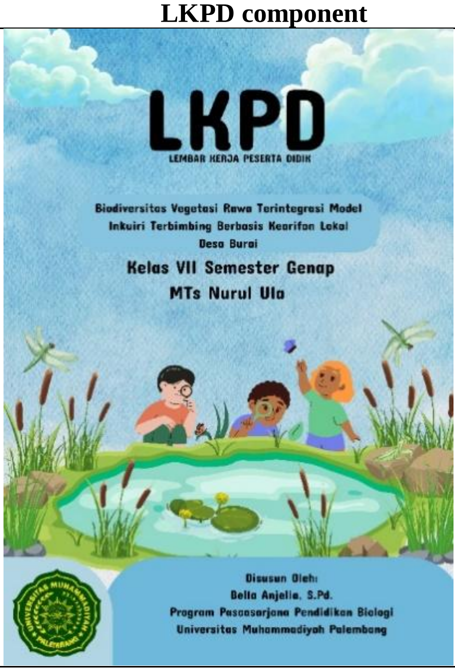
The effect size test of the Mann-Whitney analysis is used to identify the strength of the effect of the biodiversity worksheet of swamp vegetation incorporated through the guided inquiry approach on students' SPS after the pretest and posttest. Following the calculation formula, the effect size value obtained was 0.72, and is considered to be in the medium range. This means that the influence of the biodiversity worksheet of swamp vegetation integrated with the guided inquiry model has a medium effect on improving students' SPS.

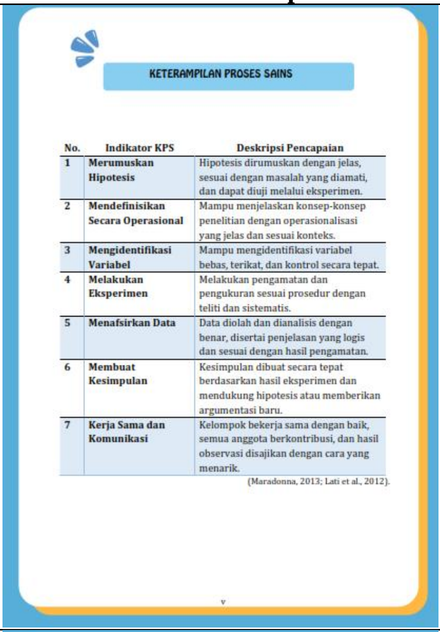
The role of guided inquiry in fostering critical thinking and scientific attitudes has also been confirmed by Widiya & Radia (2023), who found that it helps students analyze, connect concepts to real-life contexts, and communicate results with confidence. Likewise, Zainudin et al. (2023) showed that guided inquiry improves students' ability to write scientific reports and build evidence-based arguments. From the perspective of biology education, highlighted that guided inquiry worksheets promote deeper understanding because students actively investigate rather than passively receive information (Nisa & Utaminingsih, 2020). The positive responses of both students and teachers in this study mirror these findings, with teachers noting that the worksheet supported lesson delivery and fostered interactive learning (Cahyani et al., 2023). Taken together, these results confirm that the workhseet on swamp vegetation biodiversity integrated with guided inquiry and local wisdom meets the criteria of effectiveness proposed by various scholars. Its effectiveness is not only evident in improved SPS but also in fostering critical thinking, increasing student participation, and supporting teachers in delivering lessons.

One challenge in ecology education is the limited availability of teaching materials contextualized to local environments. By grounding the worksheet in the ecological and cultural context of Desa Burai, the materials became more relevant and meaningful to students. The use of illustrations, case studies, and inquiry-based activities also made learning more engaging. Studies have shown that worksheets whether interactive digital tools like worksheet electronic (Jannah et al., 2024) or process skills oriented worksheets (Safitri et al., 2019) can meaningfully enhance both conceptual understanding and scientific skills, encouraging practical engagement. Accordingly, students gained more than just conceptual understanding but also developed practical skills and environmental awareness, which can be applied in daily life.

This worksheet on swamp vegetation biodiversity was developed to promote meaningful and contextual learning by integrating local wisdom into ecology instruction. Its components are systematically organized to guide students through structured inquiry activities that foster Science Process Skills, such as observing, identifying, analyzing, and communicating scientific findings. Each section is designed to ensure clarity, coherence, and in accordance with the desired learning objectives. The accompanying table outlines the components of the worksheet and explains their instructional functions for both teachers and students. Before being implemented in the main study, the locally based guided inquiry worksheet was evaluated for its validity and practicality. Expert validation indicated a very high level of validity, with an overall score of 94.74%, demonstrating that the content, learning design, evaluation, media, and language met quality standards. In addition, the initial field trial showed that the worksheet was highly practical, as reflected in positive responses from teachers 95%, very high category and students 75%, high category. Limited trial results also indicated an improvement trend in students' SPS, as evidenced by higher posttest scores compared to pretest scores. Overall, these findings confirm that the developed worksheet is valid, practical, and suitable for examining its effectiveness in enhancing students' SPS.

Table 8. Results of the Biodiversity Worksheet on Swamp Vegetation

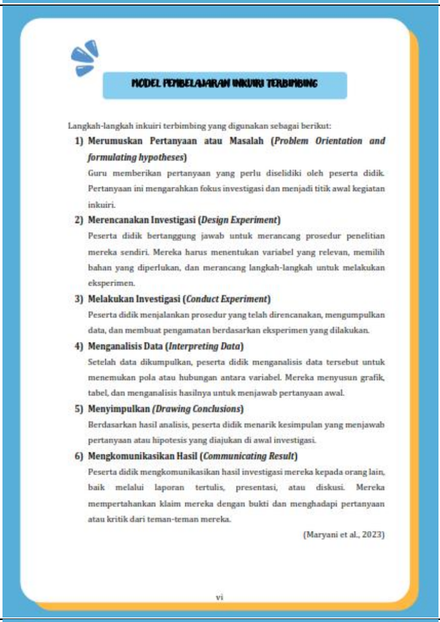
<table>
<tr><th>No</th><th>LKPD component</th><th>Description</th></tr>
<tr><td>1</td><td>
</td><td>The cover contains an overview of the content presented in the worksheet.</td></tr>
</table>

<table>
<tr><th>No</th><th>LKPD component</th><th>Description</th></tr>
<tr><td>2</td><td>

KETERAMPILAN PROSES SAINS

<table>
<tr><th>No.</th><th>Indikator KPS</th><th>Deskripsi Pencapaian</th></tr>
<tr><td>1</td><td>Merumuskan Hipotesis</td><td>Hipotesis dirumuskan dengan jelas, sesuai dengan masalah yang diamati, dan dapat diuji melalui eksperimen.</td></tr>
<tr><td>2</td><td>Mendefinisikan Secara Operasional</td><td>Mampu menjelaskan konsep-konsep penelitian dengan operasionalisasi yang jelas dan sesuai konteks.</td></tr>
<tr><td>3</td><td>Mengidentifikasi Variabel</td><td>Mampu mengidentifikasi variabel bebas, terikat, dan kontrol secara tepat.</td></tr>
<tr><td>4</td><td>Melakukan Eksperimen</td><td>Melakukan pengamatan dan pengukuran sesuai prosedur dengan teliti dan sistematis.</td></tr>
<tr><td>5</td><td>Menafsirkan Data</td><td>Data diolah dan dianalisis dengan benar, disertai penjelasan yang logis dan sesuai dengan hasil pengamatan.</td></tr>
<tr><td>6</td><td>Membuat Kesimpulan</td><td>Kesimpulan dibuat secara tepat berdasarkan hasil eksperimen dan mendukung hipotesis atau memberikan argumentasi baru.</td></tr>
<tr><td>7</td><td>Kerja Sama dan Komunikasi</td><td>Kelompok bekerja sama dengan baik, semua anggota berkontribusi, dan hasil observasi disajikan dengan cara yang menarik.</td></tr>
</table>

(Maradonna, 2013; Lati et al., 2012).

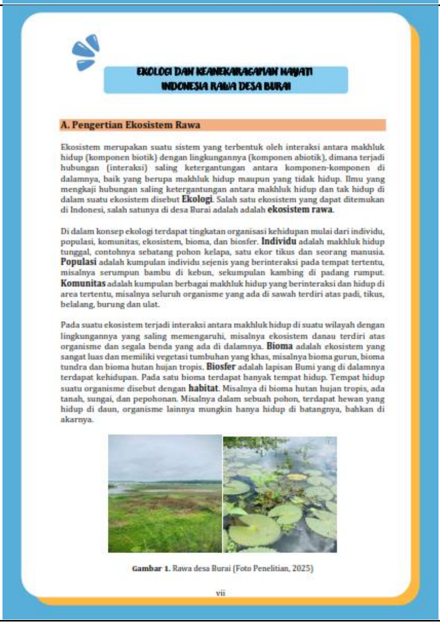
v</td><td>Indicators of Science Process Skills used as a guide for observing and evaluating students' skills.</td></tr>
<tr><td>3</td><td>

MODEL PEMBELAJARAN INKUIRI TERBIMBING

Langkah-langkah inkuiri terbimbing yang digunakan sebagai berikut:

1) Merumuskan Pertanyaan atau Masalah (Problem Orientation and formulating hypotheses)
Guru memberikan pertanyaan yang perlu diselidiki oleh peserta didik. Pertanyaan ini mengarahkan fokus investigasi dan menjadi titik awal kegiatan inkuiri.
2) Merencanakan Investigasi (Design Experiment)
Peserta didik bertanggung jawab untuk merancang prosedur penelitian mereka sendiri. Mereka harus menentukan variabel yang relevan, memilih bahan yang diperlukan, dan merancang langkah-langkah untuk melakukan eksperimen.
3) Melakukan Investigasi (Conduct Experiment)
Peserta didik menjalankan prosedur yang telah direncanakan, mengumpulkan data, dan membuat pengamatan berdasarkan eksperimen yang dilakukan.
4) Menganalisis Data (Interpreting Data)
Setelah data dikumpulkan, peserta didik menganalisis data tersebut untuk menemukan pola atau hubungan antara variabel. Mereka menyusun grafik, tabel, dan menganalisis hasilnya untuk menjawab pertanyaan awal.
5) Menyimpulkan (Drawing Conclusions)
Berdasarkan hasil analisis, peserta didik menarik kesimpulan yang menjawab pertanyaan atau hipotesis yang diajukan di awal investigasi.
6) Mengkomunikasikan Hasil (Communicating Result)
Peserta didik mengkomunikasikan hasil investigasi mereka kepada orang lain, baik melalui laporan tertulis, presentasi, atau diskusi. Mereka mempertahankan klaim mereka dengan bukti dan menghadapi pertanyaan atau kritik dari teman-teman mereka.

(Maryani et al., 2023)

vi</td><td>A page explaining the guided inquiry model steps, including descriptions of student activities during learning implementation.</td></tr>
<tr><td>4</td><td>

EKOLOGI DAN KEANEKARAGAMAN HAYATI INDONESIA RAWA DESA BURAI

A. Pengertian Ekosistem Rawa

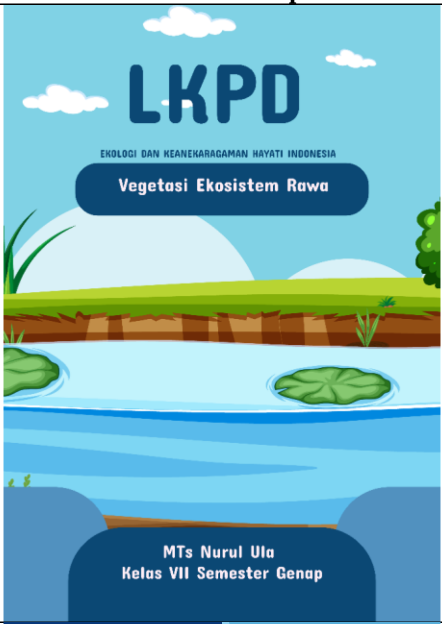
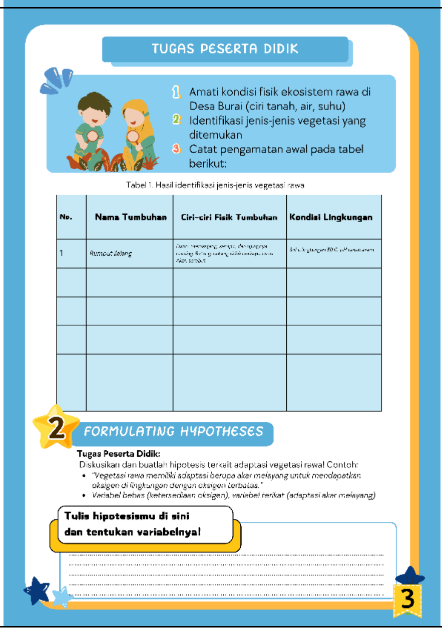
Ekosistem merupakan suatu sistem yang terbentuk oleh interaksi antara makhluk hidup (komponen biotik) dengan lingkungannya (komponen abiotik), dimana terjadi hubungan (interaksi) saling ketergantungan antara komponen-komponen di dalamnya, baik yang berupa makhluk hidup maupun yang tidak hidup. Ilmu yang mengkaji hubungan saling ketergantungan antara makhluk hidup dan tak hidup di dalam suatu ekosistem disebut Ekologi. Salah satu ekosistem yang dapat ditemukan di Indonesi, salah satunya di desa Burai adalah adalah ekosistem rawa.

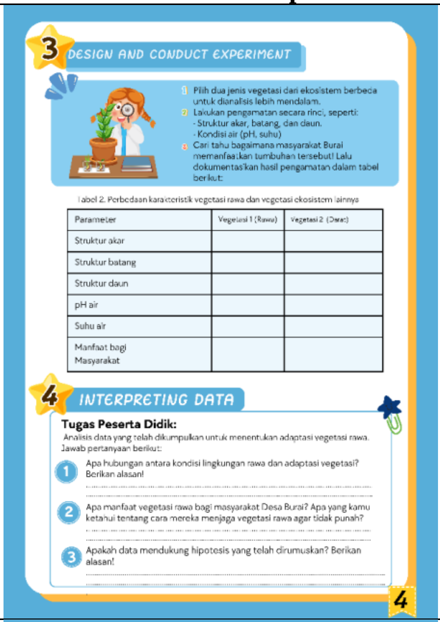
Di dalam konsep ekologi terdapat tingkatan organisasi kehidupan mulai dari individu, populasi, komunitas, ekosistem, bioma, dan biosfer. Individu adalah makhluk hidup tunggal, contohnya sebatang pohon kelapa, satu ekor tikus dan seorang manusia. Populasi adalah kumpulan individu sejenis yang berinteraksi pada tempat tertentu, misalnya serumpun bambu di kebun, sekumpulan kambing di padang rumput. Komunitas adalah kumpulan berbagai makhluk hidup yang berinteraksi dan hidup di area tertentu, misalnya seluruh organisme yang ada di sawah terdiri atas padi, tikus, belalang, burung dan ulat.

Pada suatu ekosistem terjadi interaksi antara makhluk hidup di suatu wilayah dengan lingkungannya yang saling memengaruhi, misalnya ekosistem danau terdiri atas organisme dan segala benda yang ada di dalamnya. Bioma adalah ekosistem yang sangat luas dan memiliki vegetasi tumbuhan yang khas, misalnya bioma gurun, bioma tundra dan bioma hutan hujan tropis. Biosfer adalah lapisan Bumi yang di dalamnya terdapat kehidupan. Pada satu bioma terdapat banyak tempat hidup. Tempat hidup suatu organisme disebut dengan habitat. Misalnya di bioma hutan hujan tropis, ada tanah, sungai, dan pepohonan. Misalnya dalam sebuah pohon, terdapat hewan yang hidup di daun, organisme lainnya mungkin hanya hidup di batangnya, bahkan di akarnya.

Gambar 1. Rawa desa Burai (Foto Penelitian, 2025)

vii</td><td>A section containing a summary of concepts and theories related to ecosystems especially swamp ecosystems that are not included in students' standard textbooks.</td></tr>
</table>

<table>
<tr><th>No</th><th>LKPD component</th><th>Description</th></tr>
<tr><td>5</td><td>
</td><td>The cover page of the first meeting worksheet, containing the theme of the activity, which focuses on observing and identifying swamp vegetation as part of the biotic components of the ecosystem.</td></tr>
<tr><td>6</td><td>
</td><td>This page includes:
1. Learning objectives
2. Group identity
3. Tool preparation
4. First syntax of guided inquiry: problem orientation</td></tr>
<tr><td>7</td><td>
</td><td>This page contains observation activities, including the observation task to be carried out and a table for recording the initial identification results that help determine the direction of the students' investigation. After identifying the problem from the previous activity, students write a hypothesis in the second guided inquiry syntax and determine the variables based on the hypothesis they formulated.</td></tr>
</table>

<table>
<tr><th>No</th><th>LKPD component</th><th>Description</th></tr>
<tr><td>8</td><td>
</td><td>On this page, students continue the steps involved in identifying swamp vegetation by designing and conducting an experiment using several available work options. After completing the activity, they record their observations of two types of vegetation from different ecosystems in Table 2. The next task involves data interpretation, where students respond to two questions as shown by their recorded observations.</td></tr>
<tr><td>9</td><td>
</td><td>This page contains the final activities of the first meeting's worksheet, which include writing a conclusion in the space provided and completing the last stage of the guided inquiry syntax, where students communicate the results they have obtained.</td></tr>
<tr><td>10</td><td>
</td><td>The reference list contains various sources that were used as references for the content presented in this worksheet.</td></tr>
</table>

The worksheet components are systematically designed to support guided inquiry learning and the enhancement of students' SPS. It includes introductory sections, learning outcomes, SPS indicators, inquiry syntax, and learning activities that guide students through observation, hypothesis formulation, experimentation, data interpretation, and conclusion drawing within the context of swamp ecosystems. The integration of structured inquiry stages and local ecological content helps students engage actively in learning. Previous studies indicate that well-designed worksheets are valid and practical learning tools that effectively support students' scientific understanding and skills development (Jannah et al., 2024; Safitri et al., 2019).

CONCLUSION

The evaluation of the guided inquiry based worksheet on swamp vegetation biodiversity shows that its implementation achieved medium effectiveness. The worksheet's effectiveness is clearly demonstrated from the improvement of students' SPS, as shown by the N-gain score measured 0.51 corresponding to the medium category and observation results of 76.78% classified as high. These findings indicate that nearly all planned learning activities were successfully implemented and contributed to active student participation. Overall, the evaluation results confirm that the worksheet is feasible and beneficial to be applied in biodiversity and ecology learning.

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