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# Development of E-LKPD Based on Discovery Learning Integrated with the Jelajah Alam Sekitar Approach Using Baros Mangrove Local Potential

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## ABSTRACT

Critical thinking and scientific literacy are essential 21st-century competencies that enable students to analyze information, make informed decisions, and solve real-world problems. This study aimed to develop and evaluate the feasibility and practicality of an electronic student worksheet (E-LKPD) based on Discovery Learning integrated with the Jelajah Alam Sekitar (JAS) approach by utilizing the local potential of the Baros Mangrove ecosystem in ecosystem learning for Stage E students. The study employed a Research and Development (R&D) method using the ADDIE model, which consists of analysis, design, development, implementation, and evaluation stages. The feasibility evaluation involved assessments by material, media, and teaching material experts using validated evaluation instruments. The results indicated that the developed E-LKPD achieved very high feasibility scores, categorized as "very feasible," while practicality assessments from teachers and students were also categorized as "very practical," with scores of 85.68% and 98.23%, respectively. The integration of Discovery Learning, the JAS approach, and local environmental potential provides contextual and meaningful biology learning experiences that support the development of students' critical thinking and scientific literacy. Therefore, the developed E-LKPD is considered suitable for implementation in biology learning, particularly in ecosystem materials.

**Keywords**: Baros Mangrove, Discovery Learning, E-LKPD, Jelajah Alam Sekitar Approach

## INTRODUCTION

The 21st century is marked by challenging global dynamics, ranging from water, food, and energy crises, climate change, global warming, and the depletion of natural resources. The industrial revolution 4.0 and society 5.0 are here to bring a breakthrough in science and technology that improves the quality of human life, but at the same time widens the gap in living standards between nations (Salmia & Yusri, 2021).

This condition requires every country, including Indonesia, to prepare superior human resources who are adaptive, critical, and scientifically literate in various fields. The role of education, especially in the field of biology, which is closely related to the phenomena of daily life, plays a strategic role in preparing and forming students who are knowledgeable, skilled, and able to face the dynamics of the times (Asrial et al., 2020). 21st-century education emphasizes

the mastery of critical thinking, literacy, problem-solving, communication, and collaboration skills, so that the essential focus of the Indonesian science education curriculum, namely critical thinking and scientific literacy, is the main focus to be developed (Indarta et al., 2021; Sutrisna, 2021; Amelia & Astuti, 2022).

Critical thinking is an important cognitive skill that allows students to analyze problems logically, make informed decisions, and determine effective actions (Sternberg & Halpern, 2020). Critical thinking skills are vital to meet the demands of the 21st century, helping students solve everyday problems and protect against the negative effects of globalization as well as contributing to better academic achievement (Chouari & Nachit, 2016; D'Alessio et al., 2019; Hidayati & Sinaga, 2023). However, the results of a survey at SMA Negeri 1 Kretek Bantul have been carried out, showing that the average critical thinking skills of students reached 58.06% which is relatively low.

In addition to critical thinking, scientific literacy is also an essential ability so that students can understand socio-scientific issues, apply science concepts, and contribute as intelligent and responsible global citizens (Li & Guo, 2021). Scientific literacy trains students to understand the essence of science, use scientific methods, and process technology effectively (Virtič, 2022). The urgency is even more evident when it is associated with global challenges such as the environmental crisis (Latif et al., 2022), and the results of a survey at SMA Negeri 1 Kretek that has been conducted show that the scientific literacy of phase E students is still low, with an average score of only 55.06%.

The low level of critical thinking and scientific literacy of students is inseparable from teacher-centered learning, the use of textual and non-contextual teaching materials, and the lack of scientific literacy-based questions (Sarip et al., 2022). Less innovative learning models and approaches also limit students' thinking processes, while existing teaching materials do not support active interaction and contextual understanding (Sutrisna, 2021). This condition emphasizes the need for teaching tool innovations that are more interactive, contextual, and in accordance with learning needs. One potential solution is to develop an electronic student worksheet (E-LKPD).

E-LKPD is a digital teaching material that can be accessed online, with the advantage of being able to increase efficiency, effectiveness, and encourage independent learning (Syafitri & Tressyalina, 2020). Using E-LKPD, students not only read the material but also actively explore concepts, participate in activities, and experience meaningful learning Rahayu et al., 2021). To be more optimal, E-LKPD can be developed using a constructivist learning model, such as the Discovery Learning model. The excellence of Discovery Learning in learning encourages students to discover concepts independently or in groups in investigation, problem-solving, and knowledge construction activities and has been proven to be effective in improving critical thinking and students' scientific literacy (Rahman et al., 2022).

In addition to the learning model, the use of local potential as a learning resource in the development of E-LKPD also has the potential to be carried out to create more contextual learning. Local potential contains pedagogical values that can enrich teaching materials and

bring the concept of biology closer to students' lives (Alimah, 2019). In this context, the Baros Mangrove ecosystem in Bantul is very relevant to be used as a natural laboratory. This ecosystem has five main species of mangroves, distinctive vegetation zoning, and functions as a coastal protector (Rahmadhani et al., 2021). The existence of the Baros Mangrove can be integrated into learning to strengthen students' critical thinking and scientific literacy skills (Lorena et al., 2019; Sukirno et al., 2020).

The development of E-LKPD products based on the Baros Mangrove ecosystem will be more effective if integrated using the Jelajah Alam Sekitar (JAS) approach. The characteristics of the JAS approach utilize the environment as a source of direct learning, allowing students to make observations, develop curiosity, and build authentic and meaningful learning experiences (Kumalasari & Marianti, 2021). Learning the Jelajah Alam Sekitar approach using the environment as a means of learning can encourage students to recognize objects, symptoms, and problems, as well as draw conclusions or concepts from what is learned, while positively changing behavior and ensuring their active participation. This approach enhances students' understanding through real-world exploration of the material, while developing cognitive, affective, and psychomotor skills (Alamiah & Marianti, 2016). Learning to explore the environment is in accordance with the principles of the Independent Curriculum, which encourages exploration learning outside the classroom to be more fun, enjoyable, and student-centered, forming confident, independent, and intelligent characters in socializing (Yusuf & Arfiansyah, 2021). Therefore, one of the most relevant content used in the development of E-LKPD Discovery Learning products that are integrated with the JAS approach based on the Baros mangrove ecosystem material.

Learning ecosystem material can make direct contact with nature, identify problems in students' daily lives, and apply the concept of ecosystem material learned. Ecosystem materials not only include the collection of concepts, facts, and principles during the learning process, but also involve the process of discovery. The selection of this ecosystem material is based on its relevance to the richness of the ecological system in the Baros mangrove. The learning of ecosystem materials in the high school phase E shows a close relationship between the content of biology learning and natural resources in the Baros Mangrove area and the Kretek community of Bantul Regency. This connectivity is a very strong value in enriching biological insights based on local potential. In addition to its relevance, the use of ecosystem materials is also based on the problems and learning needs at SMAN 1 Kretek.

Based on the results of interviews with Biology teachers and a questionnaire analyzing student needs at SMA Negri 1 Kretek, it is known that several things are: 1) learning ecosystem material is only applied in the classroom and has never been tried to learn directly in the school environment, one of the obstacles is the lack of more adequate teaching tools and facilitating students to learn directly in nature, such as the existence of E-LKPD based on the local potential of the Baros mangrove ecosystem, 2) the availability of tools and teaching materials for ecosystem materials is still limited such as science package books, biology modules and printed LKPDs. There are no teaching materials that utilize digital technology and are based on local

potential. 3) Students tend to be more interested in learning biological materials, such as ecosystem materials, which allow them to learn directly in nature because they are in accordance with the kinesthetic learning style that students have. Meanwhile, the form of teaching materials that is most preferred and in demand by students is digital-based teaching materials. However, these types of teaching tools and materials are not yet available in schools. This is also a research gap, and the urgency of developing more innovative teaching materials needs to be addressed.

Based on the description above, this study aims to determine the feasibility and practicality of a Discovery Learning-based E-LKPD integrated with the JAS approach by utilizing the local potential of the Baros Mangrove ecosystem to enhance high school students' critical thinking and scientific literacy skills in ecosystem learning.

This study also addresses a research gap in the development of digital teaching materials, particularly the limited availability of E-LKPDs that integrate Discovery Learning, the JAS approach, and contextual local environmental potential within a single digital learning platform. Unlike existing digital worksheets, the developed E-LKPD incorporates authentic ecological data and environmental phenomena from the Baros Mangrove ecosystem, enabling students to engage in contextual exploration and inquiry-based learning experiences.

Furthermore, although students tend to prefer kinesthetic learning activities involving direct interaction with nature, the developed digital E-LKPD is designed to support these learning needs through interactive features, guided field observation activities, exploration tasks, digital documentation, and contextual problem-solving activities integrated with real environmental conditions. Therefore, the integration of digital technology with environmental exploration is expected to facilitate more meaningful, student-centered, and experiential biology learning. To the best of the authors' knowledge, studies integrating Discovery Learning, the JAS approach, and Baros Mangrove local potential into a digital E-LKPD designed to promote students' critical thinking and scientific literacy remain limited.

## METHOD

This study employed a Research and Development (R&D) design using the ADDIE model to develop a Discovery Learning-based Electronic Student Worksheet (E-LKPD) integrated with the Jelajah Alam Sekitar (JAS) approach utilizing the local potential of the Baros Mangrove ecosystem. The ADDIE model consists of five interconnected stages, namely Analyze, Design, Develop, Implement, and Evaluate, which systematically guide the development of instructional products according to students' learning needs.

This research applied a mixed-methods approach by combining quantitative and qualitative data to obtain comprehensive, objective, and in-depth findings. Quantitative data were obtained from feasibility and practicality assessments, while qualitative data were collected through observations and interviews to support the interpretation of the findings.

The population of this study consisted of all Phase E students of grade X at SMA Negeri 1 Kretek Bantul, totaling 112 students from four classes. The sample was determined using cluster random sampling. SMA Negeri 1 Kretek Bantul was selected based on several

considerations: the school is located in the South Coastal Area of Bantul Regency, has an "A" accreditation status, implements the Independent Curriculum, and is situated near the Baros Mangrove ecosystem, which serves as relevant local environmental potential for biology learning. In addition, most students possess Android-based devices, and the school supports the use of digital technology and outdoor learning activities during the instructional process.

Data collection techniques included observation, interviews, and questionnaires. Accordingly, the research instruments consisted of observation sheets, interview guidelines, validation sheets, and response questionnaires. The feasibility and practicality assessments employed a four-point Likert scale ranging from 1 to 4. The Likert scale was used to measure participants' perceptions, opinions, and responses regarding the developed E-LKPD.

The feasibility data were obtained through validation conducted by expert lecturers specializing in biology education, instructional media, and teaching materials. The expert validators were selected based on their academic expertise and professional experience in biology education, instructional media development, and curriculum implementation. The material expert validation assessed several aspects, including content feasibility, presentation, didactic aspects, construction, and language. Meanwhile, media and teaching material experts evaluated aspects related to format, graphics, visual communication, and presentation.

Practicality data were collected from biology teachers and students after the implementation of the developed E-LKPD in ecosystem learning activities. Student response assessments included aspects of presentation, language, visual communication, and usefulness. Teacher response assessments covered content feasibility, presentation, language, media graphics, visual communication, and instructional characteristics.

The data analysis technique used in this study was descriptive quantitative analysis. The obtained feasibility and practicality scores were converted into percentage values and interpreted into qualitative categories. The developed E-LKPD was considered feasible if it achieved at least the "quite valid" category and practical if it reached at least the "practical" category.

The feasibility score from expert validation was calculated using the following formula:

$$P = \frac{F}{N} \text{ x } 100\%$$

Information:
P = Feasibility percentage score,
F = Total score obtained from all assessment aspects,
N = Maximum possible score.

The percentage results were subsequently converted into qualitative practicality criteria according to Nasihah and Utami (2024), as shown in Table 2.

Table 1. Validation criteria by experts

| Percentage | Criterion |
|---|---|
| $0 \leq p \leq 25$ | Very invalid |
| $25 \leq p \leq 50$ | Invalid |
| $50 \leq p \leq 75$ | Quite valid |
| $75 \leq p \leq 100$ | Very valid |

The practicality score obtained from teachers' and students' responses was calculated using the following formula:

$$NK = \frac{R}{SM} x\ 100\%$$

Information:

NK = Practicality percentage score,

R = Score obtained

SM = Maximum score

The percentage results were subsequently converted into qualitative practicality criteria according to Nasihah and Utami (2024), as shown in Table 2.

Table 2. Validation criteria by teachers and students

| Percentage | Criterion |
|---|---|
| 80-100 | Very Practical |
| 61-80 | Practical |
| 41-60 | Quite Practical |
| 21-40 | Less Practical |
| 0-20 | Very Impractical |

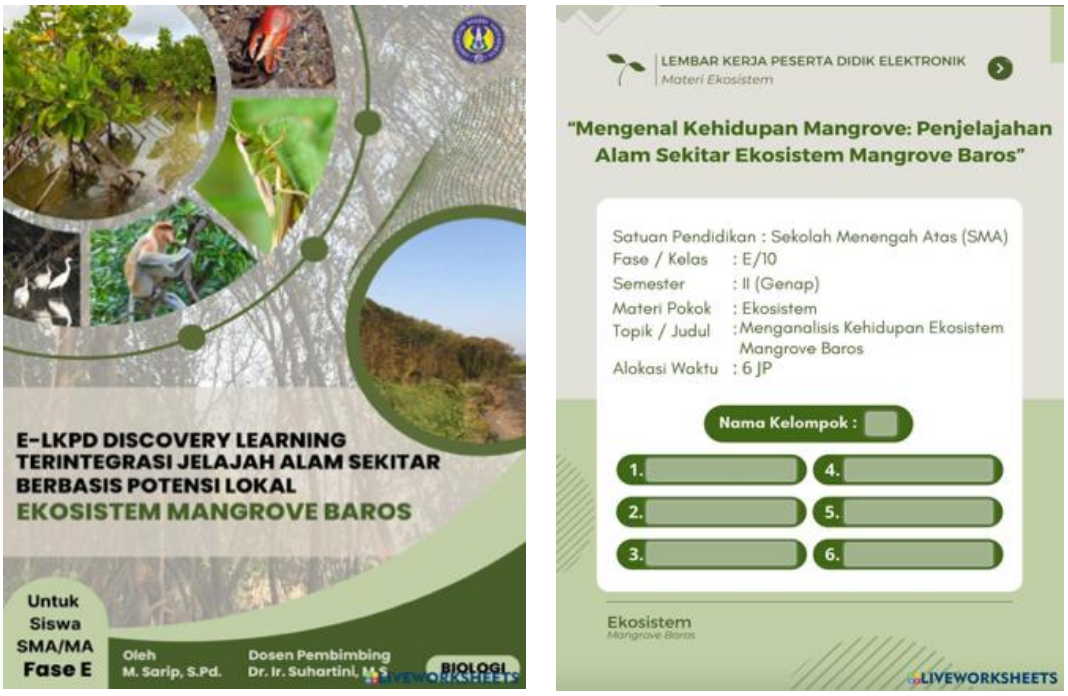
## RESULT AND DISCUSSION

### Development of E-LKPD Based on Integrated Discovery Learning integrated with the Jelajah Alam Sekitar (JAS) approach using Baros Mangrove Ecosystem

The product developed in this study was a Discovery Learning-based Electronic Student Worksheet (E-LKPD) integrated with the JAS approach by utilizing the local potential of the Baros Mangrove ecosystem. The development process adopted the ADDIE model framework to ensure systematic instructional design and alignment among learning objectives, learning activities, assessment components, and expected learning outcomes.

The developed E-LKPD was designed as a contextual and interactive digital learning resource to support ecosystem learning for Phase E high school students. The integration between Discovery Learning syntax and JAS principles represents the primary intellectual contribution of this study. Each Discovery Learning stage was systematically aligned with JAS principles, including exploration, constructivism, science process skills, learning community, bioedutainment, and authentic assessment. This integration was intended to facilitate inquiry-based, experiential, and student-centered biology learning while fostering students' critical

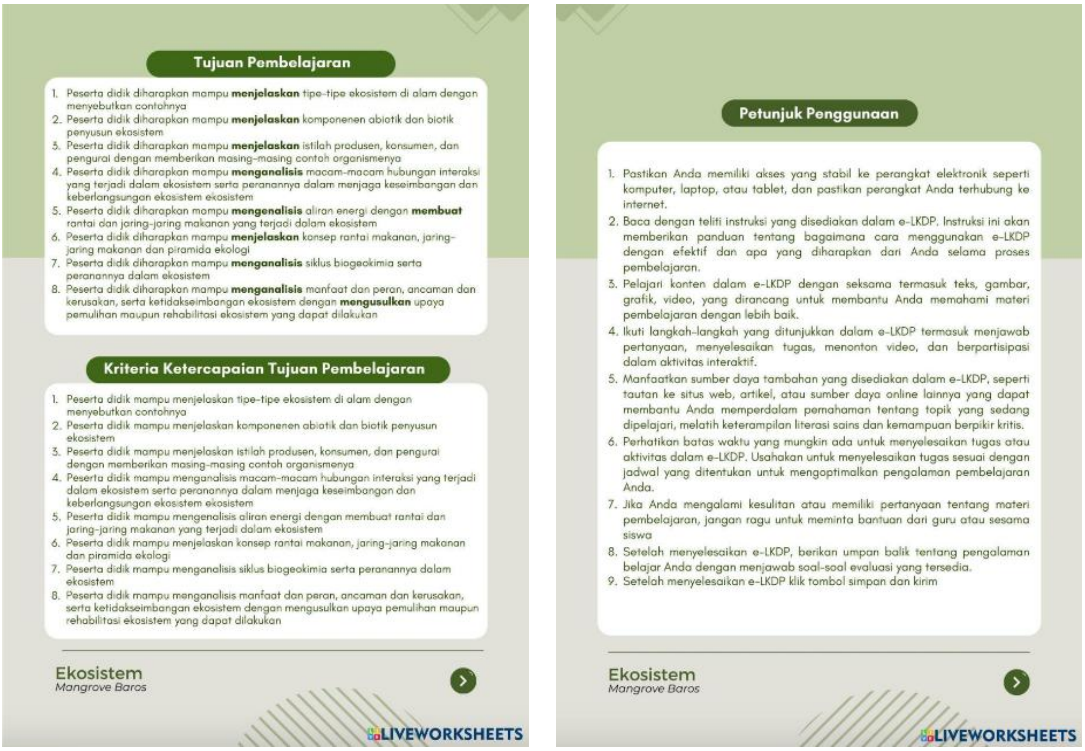
thinking and scientific literacy skills. The overall structure and features of the developed E-LKPD are presented in Figures 1–5.




(a) (b)

Figure 1. Initial interface of the developed E-LKPD: (a) cover page and (b) identity page.

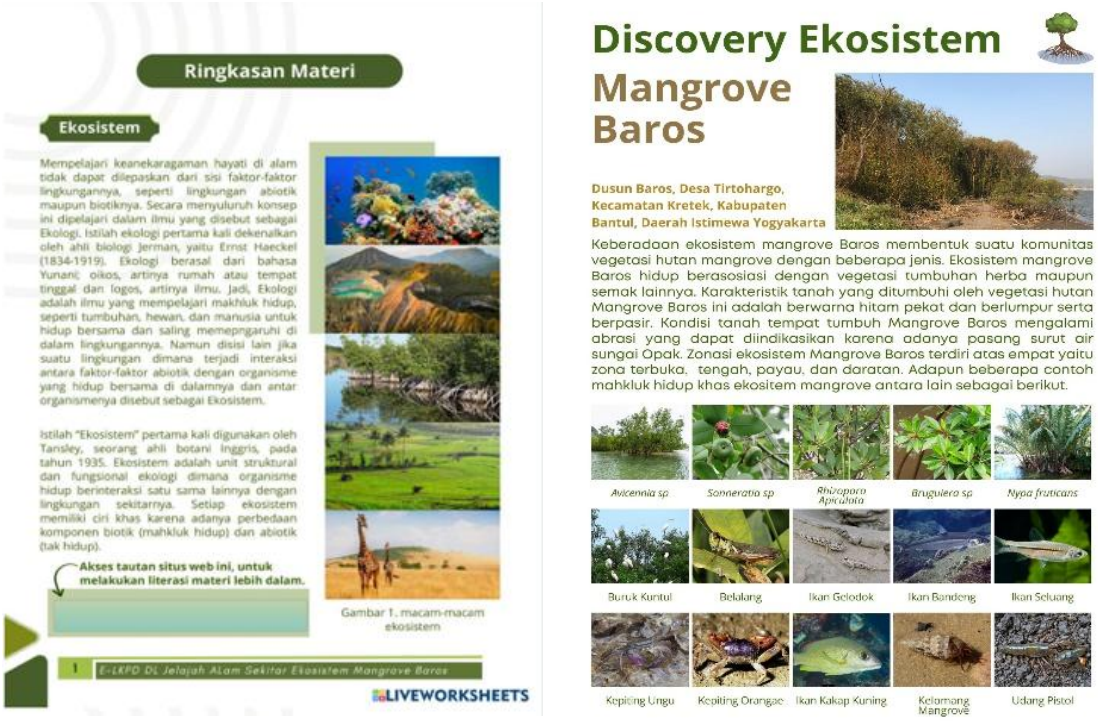
Figure 1 presents the introductory interface of the developed E-LKPD, consisting of the cover page and identity page. The cover page was designed using contextual visual elements related to the Baros Mangrove ecosystem, including mangrove vegetation, fauna, and ecosystem illustrations to attract students' attention and strengthen contextual learning experiences. In addition, the cover page included the title of the E-LKPD, institutional identity, and author information. Meanwhile, the identity page contained general information regarding the learning theme and instructional identity of the developed E-LKPD.




(a) (b)

Figure 2. Learning preparation components of the developed E-LKPD: (a) learning objectives and KKTP and (b) instructions for use.

Figure 2 presents the learning objectives and operational guidelines integrated into the developed E-LKPD. The learning objectives and KKTP (Kriteria Ketercapaian Tujuan Pembelajaran) were developed based on the Independent Curriculum learning outcomes for ecosystem material in Phase E. The objectives were aligned with critical thinking indicators and scientific literacy competencies to support 21st-century learning skills. Furthermore, the instructions for use provided operational guidance regarding procedures for accessing and utilizing the E-LKPD features effectively and systematically. This section was designed to support students' independent learning activities during the implementation process.




(a) (b)

Figure 3. Contextual learning materials in the developed E-LKPD: (a) summary of ecosystem material and (b) overview of the local potential of the Baros Mangrove ecosystem.

Figure 3 presents the contextual learning materials integrated into the developed E-LKPD. The summary of material section functioned as conceptual support to help students understand ecosystem concepts before and during the Discovery Learning activities. The materials were presented systematically and contextually to facilitate meaningful learning experiences. In addition, the overview of the Baros Mangrove ecosystem introduced students to the ecological characteristics, environmental functions, and local potential of the mangrove ecosystem. The integration of local environmental potential enabled students to relate scientific concepts to authentic environmental phenomena encountered in their surrounding environment.

The integration of the Discovery Learning stages and the principles of the JAS approach in the developed educational student worksheet. An illustration can be seen in Figure 4.

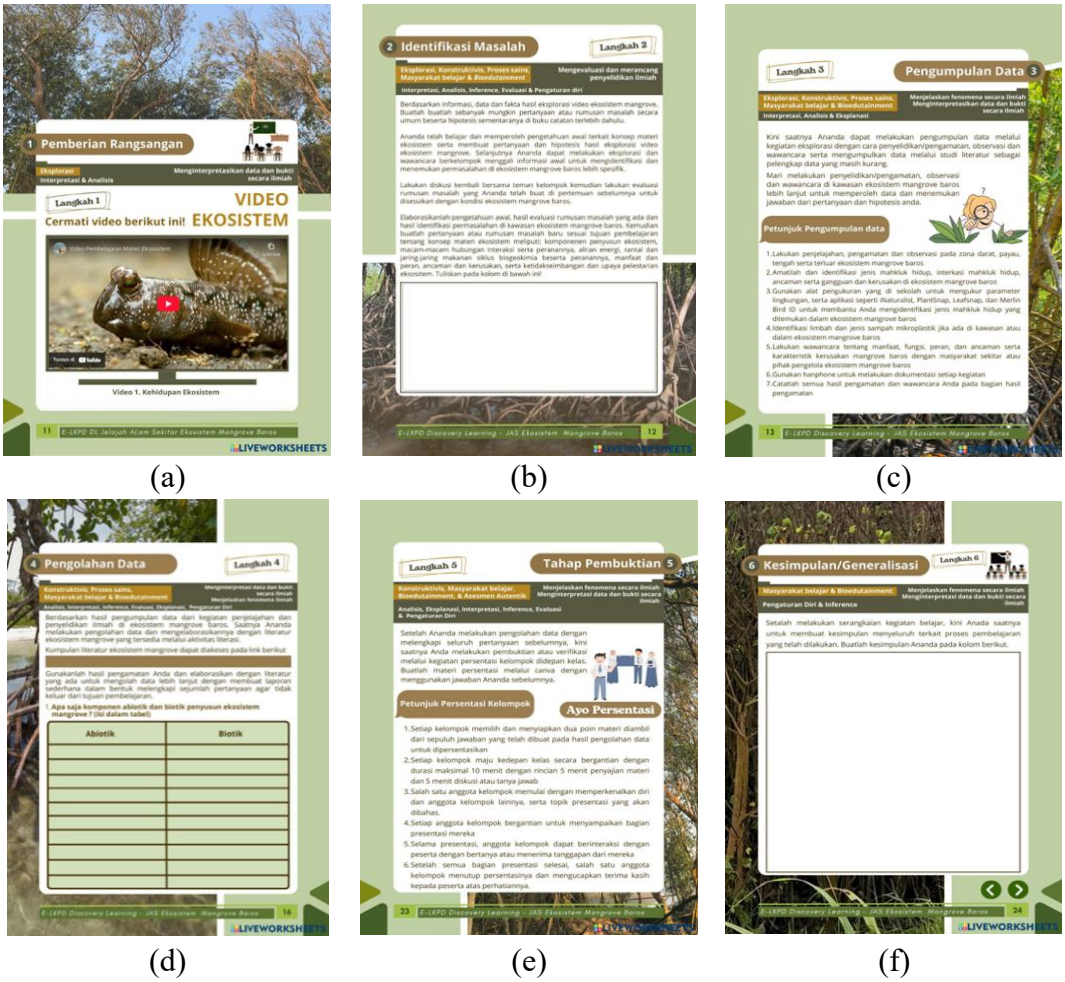



Figure 4. Integration of Discovery Learning stages and the JAS approach in the developed E-LKPD: (a) stimulation stage, (b) problem identification stage, (c) data collection stage, (d) data processing stage (e) verification stage, and (f) generalization stag.

Figure 4 illustrates the integration between Discovery Learning stages and the principles of the JAS approach in the developed E-LKPD. The stimulation stage presented contextual videos and environmental phenomena related to the Baros Mangrove ecosystem to stimulate students' curiosity and scientific inquiry. The problem identification stage facilitated students in identifying ecological problems through exploratory and collaborative learning activities integrated with constructivist principles and scientific process skills.

Furthermore, the data collection stage directed students to conduct direct environmental exploration through observation, investigation, interviews, and literature studies within the mangrove ecosystem. At the data processing stage, students analyzed observational findings, interpreted scientific evidence, and organized the collected data into scientific reports. The E-LKPD also provided interactive digital submission features to support reporting and collaborative learning activities.

The proof or verification stage encouraged students to present and communicate investigation findings collaboratively using digital presentation tools. Finally, the generalization stage facilitated students in drawing conclusions based on scientific evidence and reflective learning activities. Overall, the integration between Discovery Learning syntax and JAS principles was designed to promote inquiry-based, contextual, and student-centered biology learning experiences.


(a) (b) (c)

Figure 5. Evaluation and supporting components of the developed E-LKPD: (a) multiple-choice questions, (b) essay questions, and (c) bibliography section.

Figure 5 presents the evaluation and supporting components included in the developed E-LKPD. The evaluation section consisted of multiple-choice and essay questions developed based on critical thinking and scientific literacy indicators. These evaluation activities were designed to assess students' analytical reasoning, interpretation abilities, scientific explanation skills, and problem-solving competencies related to ecosystem material. Meanwhile, the bibliography section contained references used in the development of the E-LKPD to ensure the scientific credibility and academic validity of the learning materials.

**Product Validation**

The E-LKPD eligibility has been carried out through a validation test by 1 lecturer who is an expert in materials and 1 expert in media and teaching materials. The validation test of material experts consists of several aspects of differentiation, namely, aspects of content components, presentation, didactics, construction, and language. The results of the qualification assessment of subject matter experts are presented in Table 3.

Table 3. Material expert validation results

| Assessment Aspects | Percentage | Criterion |
|---|---|---|
| Content Eligibility | 100 | Very valid |
| Serving | 100 | Very valid |
| Didactic | 100 | Very valid |
| Construction | 100 | Very valid |
| Language | 100 | Very valid |
| **Average** | **100** | **Very valid** |

The results of the E-LKPD feasibility assessment by biology learning material experts, Table 3, stated that from all aspects of the assessment, obtaining an average score of 100% was included in the very valid criteria. These results show that E-LKPD Discovery Learning, integrated with the JAS approach based on the local potential of the Baros mangrove ecosystem, is very feasible to be used in learning to improve critical thinking and scientific literacy of high school students in phase E on ecosystem materials. This result is in line with a similar study, namely by Costadena & Suniasih (2022), showing that the assessment of material experts on E-LKPD Discovery Learning is stated to be very feasible for ecosystem learning. The results of the study by Ratnaningsih & Fatchurrohman (2023) reported the results of the validation of material experts on LKPD based on the JAS approach, and the inquiry model was stated to be very feasible for use in ecological learning. Meanwhile, research by Pristiwanti et al. (2024) shows that E-LKPD based on local potential has received a very decent assessment from subject matter experts used in learning to improve students' critical thinking. For more details, the results of the assessment of each of these aspects are described as follows.

Based on the results of the assessment of the feasibility aspect of the content, a score of 100% was obtained with very valid criteria, which shows that the material in the E-LKPD is comprehensive, concise, and relevant to the curriculum and student learning needs. The presentation of ecosystem concepts associated with the real phenomenon of the Baros mangrove ecosystem makes learning more contextual, so that students can connect theory with direct experience in the surrounding environment. This is in accordance with the view of Facione (2020), that contextual material can encourage students' analytical and evaluative abilities, and is strengthened by research by Hikmawati et al. (2024) who affirm that environment-based learning increases students' understanding of concepts and active involvement. In addition, systematic presentation, the use of multimodal media, and the integration of the Discovery Learning model with the JAS approach are able to build an authentic, fun, and effective learning experience to train critical thinking skills (Kurniasari & Harjono, 2021).

The construction, didactic, and linguistic aspects also each obtained a score of 100% with very valid criteria, showing that it is very feasible to use because the preparation of the E-LKPD has met the principles of clarity of learning objectives, high readability, and the use of language in accordance with the level of cognitive development of students. The clarity of instructions, effective sentence structure, and conformity with the General Guidelines for Indonesian Spelling

make E-LKPD easy to understand and support independent learning (Samawati & Rahayu, 2021). The integration of Discovery Learning with the local potential of the Baros mangroves can provide an authentic learning experience that not only enriches conceptual understanding, but also fosters environmental awareness, responsibility, and cooperative skills.

Furthermore, the results of the E-LKPD feasibility validation test by media experts and teaching materials include aspects of format, graphics, visual communication, and presentation. The results of the expert validation can be seen in Table 4.

Table 4. Validation results of media experts and teaching materials

| Assessment Aspects | Percentage | Criterion |
|---|---|---|
| Format | 100 | Very valid |
| Media Graphics | 98.96 | Very valid |
| Visual Communication | 93.75 | Very valid |
| Serving | 100 | Very valid |
| **Average** | **98.18** | **Very valid** |

Based on the results of the feasibility assessment by media experts on E-LKPD Discovery Learning integrated with the JAS approach, based on the Local Potential of the Baros Mangrove Ecosystem, the average percentage score was 98.18%, classified as very valid from all assessment aspects. These results indicate that, in general, the developed E-LKPD includes aspects of format, graphics, visual communication, and presentation, and is very suitable for use in learning to improve the critical thinking and scientific literacy of students on ecosystem material. These results are in line with the research of Costadena & Suniasih (2022), reporting that the results of the validation of media experts on E-LKPD Discovery Learning on ecosystem material obtained a value that was classified as very suitable for use in learning ecosystem material. In addition, research by Ratnaningsih & Fatchurrohman (2023) showed that the results of the validation of media experts on LKPD based on the JAS approach were recorded as very suitable for learning ecosystem material. Research by Pristiwanti et al. (2024) stated that the validity of media experts on E-LKPD based on local wisdom is very suitable for use in learning to improve students' critical thinking skills.

In the format aspect, the validation obtained a score of 100% with very valid criteria. This is due to the suitability of the title, learning objectives, and content of the material with the curriculum, as well as the preparation of clear and easy-to-understand learning instructions. E-LKPD also uses the Liveworksheet platform, which supports interactivity and flexibility of online learning access. The use of this platform has been proven to be effective in increasing student participation and learning efficiency (Lioba et al., 2021; Baharuddin et al., 2025). In terms of graphics, a score of 98.96% with very valid criteria shows that the visual design, layout, colors, and illustrations used are able to improve readability, interest, and learning effectiveness. This is in line with the research of Febrina & Qomariyah (2024) which states that attractive graphic aspects can motivate students to be more active in learning.

Furthermore, the visual communication aspect obtained a score of 93.75% with very valid criteria, indicating that the ideas and ideas in the E-LKPD are poured creatively and presented with simple navigation that is easy for students to understand. These results are in line with Rahmayani & Atmazaki (2025) who emphasize the importance of visual media in strengthening conceptual understanding. Meanwhile, the presentation aspect obtained a score of 100% with a very valid category. The material is presented communicatively, proportionately, and in accordance with the syntax of Discovery Learning integrated with the JAS approach, thereby encouraging critical thinking activities, scientific literacy, and environmental concern for students. This finding is supported by Paspania et al. (2025) who affirm that environment-based E-LKPD is able to enrich the learning experience, foster scientific literacy, and support students' independent learning.

**Product Practicality**

The practicality test of the E-LKPD Discovery Learning integrated nature exploration based on the local potential of the Baros mangrove ecosystem has been carried out by class X. Science students and biology teachers at SMA Negeri 1 Kretek after being tested in classroom learning activities. The assessment aspects carried out by students include presentation, language, visual communication, and usefulness. The results of the student response assessment can be seen in Table 5.

Table 5. Recapitulation of student response results

| Assessment Aspects | Score | Percentage | Criterion |
|---|---|---|---|
| Presentation | 837 | 83.67 | Very Practical |
| Language | 514 | 85.60 | Very Practical |
| Visual Communication | 265 | 88.33 | Very Practical |
| Benefits | 766 | 85.11 | Very Practical |
| **Average** | **595,5** | **85.68** | **Very Practical** |

Based on Table 5 data, it shows that E-LKPD Discovery Learning integrated with the JAS approach, based on the Local Potential of the Baros Mangrove Ecosystem, obtained a total score of 2,382 with an average score of 85.68% classified as a very practical criterion. This means that E-LKPD is very practical to be used to improve critical thinking and scientific literacy of high school students, phase E of ecosystem material from the student side. This result is similar to previous research by Costadena & Suniasih (2022), reporting that the results of students' responses to E-LKPD Discovery Learning ecosystem materials obtained a score that is classified as very practical to be applied in learning ecosystem materials. In addition, research by Cholidah et al. (2021) also stated similar results that the assessment of students' responses to LKPD based on the approach of exploring the surrounding nature obtained a score with practical criteria to be used in learning ecosystem materials. Meanwhile, research by Sakinah et al. (2023) shows that the results of students' responses to mangrove ecosystem-based LKPD are very practical to use in learning ecosystem materials. According to Azizah & Kuswanti (2022), the practicality of high student responses shows that E-LKPD can be used to improve student learning outcomes.

For a more detailed explanation of the students' responses to each aspect of the assessment, it is described as follows.

In the aspect of presentation, the assessment of student responses was 83.67% with very practical criteria. This shows that the presentation components in E-LKPD such as learning objectives, instructions for use, materials, contextual examples, and evaluations have been presented clearly, structured, and easy to understand. Clarity of learning objectives has been proven to make it easier for students to understand the direction of learning (Nurfadilah et al., 2025), while simple instructions for use increase accessibility and smoothness of the learning process (Safitri et al., 2022). In addition, the presentation of material that is interesting and based on the local potential of mangrove ecosystems makes learning more contextual, relevant, and meaningful (Sani & Ambarwati, 2024). The presence of illustrations, images, and videos also supports a more concrete understanding of scientific concepts.

In the language aspect, E-LKPD obtained a score of 85.60% with very practical criteria. The language used is straightforward, clear, communicative, and in accordance with the student's cognitive development so that it does not cause ambiguity. This is in accordance with the views of Ratnaningsih & Fatchurrohman (2023) who emphasized the importance of effective sentences so that the material is easy to understand. In addition, the choice of simple and communicative language is able to build emotional closeness between students and the material, thereby increasing the spirit of independent learning (Azizah & Kuswanti, 2022). Research by Costadena & Suniasih (2022) also emphasizes that the use of simple and accessible language is an important factor in improving students' understanding of the material.

In the aspect of visual communication, it obtained a score of 88.33% with very practical criteria. These results show that visual displays such as layout, color, font, images, illustrations, and videos have been appropriately structured, attractive, and supportive of readability. Good visualization has been proven to increase students' enthusiasm and concentration in learning (Sani & Ambarwati, 2024; Gabriella & Mitarlis, 2021). Multimedia integration in the form of videos, animations, and infographics also makes learning more interactive and not monotonous (Ayuni et al., 2025). In addition, consistent and aesthetic graphic design is able to attract students' attention while making it easier to understand complex biological concepts (Suryani & Putri, 2024).

Furthermore, the usefulness aspect obtained a score of 85.11% with very practical criteria. E-LKPD has been proven to provide optimal benefits in training critical thinking, scientific literacy, and mastery of ecosystem material concepts. The Discovery Learning stage encourages students to be more active in discovering concepts, increasing creativity, and deepening understanding (Sihotang & Kadri, 2025). The integration of the JAS approach also strengthens meaningful learning through authentic experiences in the mangrove environment (Aminah et al., 2023). In addition, the use of evaluation questions based on critical thinking skills and scientific literacy plays an important role in practicing analysis, application, and problem-solving skills (Salema et al., 2024). The support of the Liveworksheet platform also makes E-LKPD more interactive, efficient, and motivating for students (Basri et al., 2024).

In addition to the practicality test conducted by students at SMAN 1 Kretek on E-LKPD Discovery Learning integrated with the JAS approach, based on the Local Potential of the Baros Mangrove Ecosystem, biology teachers were also involved to provide a practical assessment. The assessment of biology teachers on E-LKPD assesses several aspects, including the feasibility of content, presentation, language, media, graphography, visual communication, and characteristics. The results of teachers' assessments of E-LKPD can be seen in Table 6.

Table 6. Recapitulation of teacher's response results

| Assessment Aspects | Percentage | Criterion |
|---|---|---|
| Content eligibility | 92.50 | Very Practical |
| Serving | 96.88 | Very Practical |
| Language | 100 | Very Practical |
| Media Graphics | 100 | Very Practical |
| Visual Communication | 100 | Very Practical |
| Characteristic | 100 | Very Practical |
| **Average** | **98.23** | **Very Practical** |

The results of the practicality assessment obtained from the teacher showed that E-LKPD Discovery Learning, integrated exploration of the surrounding nature based on the local potential of the Baros mangrove ecosystem, obtained an average score of 98.23% classified as a very practical criterion. This means that E-LKPD is stated to be very practical to be used in learning to improve students' critical thinking and scientific literacy in ecosystem materials from the side of biology teachers. These results are in line with the results; research by Ratnaningsih & Fatchurrohman (2023) shows that LKPD, with an approach to exploring the surrounding nature, obtained a score that is declared practical to be used in ecosystem materials. In addition, the research of Sukirno et al. (2020) also shows that teaching materials based on the local potential of mangrove forests obtain practical value by teachers in the category of very practical use in learning biodiversity materials. For more details, the results of the teacher's response to each aspect of the assessment are described as follows.

In the aspect of content feasibility, obtaining a score of 92.50% with very practical criteria, showing that the material is in accordance with curriculum standards and biology learning needs. The material in E-LKPD is designed to refer to the learning outcomes of Phase E of the Independent Curriculum and the learning objectives set. This is important because learning objectives are a reference for the achievement of student competencies (Syafitri & Tressyalina, 2020). In addition, the depth of content is adjusted to the student's cognitive level, equipped with a variety of multiple-choice questions and descriptions to measure various aspects of comprehension, in line with the findings of Aliu et al. (2023). The contextualization of materials based on real cases of the surrounding environment also strengthens the linkage of theory with practice (Ayuni et al., 2025).

The presentation aspect obtained a score of 96.88% with very practical criteria, indicating that the material was compiled, interactive, and easy to understand. The presentation starts from simple to complex concepts so as to support meaningful learning (Syafitri & Tressyalina, 2020).

Illustrations, images, and videos of the mangrove ecosystem make the material more concrete, as Mayer (2020) emphasizes that visualization accelerates understanding. Furthermore, direct activity-based presentation in the mangrove environment makes learning authentic, interactive, and fun, which has been proven to increase students' motivation and environmental awareness.

The results of the assessment of linguistic, graphic, and visual communication aspects, each of which obtained a score of 100%, show high quality in the presentation of E-LKPD. The language used is communicative, straightforward, and in accordance with Indonesian rules, thereby reducing misconceptions (Lestari & Muchlis, 2021). Visual design fulfills the principles of readability, attractiveness, and consistency, with harmonious layouts and high-resolution illustrations, in line with the view of Costadena & Suniasih (2022) that attractive displays increase learning motivation. In addition, creative visual communication, simple navigation, and high readability strengthen the effectiveness of E-LKPD as an interactive medium

Finally, the characteristic aspect, obtained a score of 100% with very practical criteria, which shows that the E-LKPD Discovery Learning integrated exploration of the surrounding nature based on the local potential of the Baros mangrove ecosystem has excellent quality in meeting the standard characteristics of the learning device. This is because the E-LKPD developed has the characteristics of the stages of the Discovery Learning model (stimulation, problem statement, data collecting, data processing, verification, generalization) in a clear and orderly manner, as well as integrating components of scientific approaches such as environmental exploration approaches (exploration, constructivism, science processes, learning communities, bioedutainment, and authentic assessment) in a structured manner. In addition, E-LKPD utilizes the local potential of the Baros mangrove ecosystem as a learning resource that is relevant to the concept of ecosystems, contains indicators of critical thinking skills (interpretation, analysis, inference, evaluation, explanation, and self-regulation) that function to empower and train students' critical thinking skills, as well as scientific literacy indicators (explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting data and evidence scientific) that are clearly arranged and organized. Furthermore, E-LKPD is also equipped with evaluation questions based on critical thinking and scientific literacy that are in accordance with the development stage of students, as well as using the Liveworksheets web-based media appropriately, so that it can support the creation of learning that is interactive, contextual, and in accordance with the demands of 21$^{st}$ century competencies.

## CONCLUSION

Based on the results and discussions, E-LKPD Discovery Learning was produced with an integrated Jelajah Alam Sekitar (JAS) approach based on the local potential of Mangrove Baros using a live worksheet in the form of a website link that can be accessed online. The results of the feasibility test from material experts, as well as media and teaching material experts, obtained an average score of 100% and 98.18%, respectively, both of which are included in the "Very Feasible" category. The results of the practicality test by students and teachers obtained scores of 98.23% and 85.68%, respectively, indicating "Very Practical". These results state that E-

LKPD Discovery Learning Integrated JAS approach based on the local potential of the Baros Mengrove Ecosystem is very feasible and practical to be used to improve critical thinking skills and scientific literacy skills of high school students, Phase E in learning ecosystem materials.

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