

## STUDENT WORKSHEETS BASED ON DISCOVERY LEARNING INTEGRATED ENVIRONMENTAL LITERACY ON HYDROCARBON MATERIALS

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### Abstract

Students' awareness of environmental sustainability issues, particularly the adverse effects of hydrocarbon compound combustion, remains relatively low. To address this concern, this study aims to evaluate the validity of a discovery learning-based student worksheet (LKPD) integrated with environmental literacy within the hydrocarbon topic. The development of the LKPD employed the ADDIE model, limited to the development phase. Validation was conducted by two subject matter experts, two media experts, and two practitioners. The assessment instrument comprised a 38-item questionnaire covering aspects of content feasibility, presentation feasibility, language feasibility, and graphical feasibility. Validation data were analyzed qualitatively through percentage-based score interpretation. The validation results showed scores of 94.56% from subject matter experts, 95.83% from media experts, and 88.28% from practitioners, all falling into the "very valid" category. The reliability test of the instrument yielded a score of 85.71%, indicating that the product is considered reliable. Based on these findings, the LKPD is deemed suitable for further testing to assess its effectiveness and practicality in classroom learning. However, this study is limited to the validation stage; therefore, further classroom implementation is required to evaluate its direct impact on student learning outcomes and attitudes toward environmental issues.

**Keywords:** discovery learning, environmental literacy, impact of hydrocarbon compound combustion, student worksheets

### INTRODUCTION

Climate change, driven by increased greenhouse gas emissions, has led to various problems, including health issues that particularly affect workers in industrial, agricultural, construction, and plantation sectors [1]. One important mitigation effort is to foster a sense of responsibility for environmental sustainability from an early age through education. School-based learning serves as a strategic medium for instilling these values, especially through the integration of environmental literacy into teaching materials and appropriate learning models.

Environmental literacy refers to an individual's ability to understand the importance of protecting the environment for current and future sustainability [2]. Environmentally literate individuals not only comprehend theoretical concepts but also demonstrate critical and responsive attitudes. The concept of environmental

literacy has gained both global and national attention. UNESCO (2020) emphasizes the importance of environmental literacy as an integral part of Education for Sustainable Development (ESD) [3]. Therefore, environmental literacy indicators are essential to be integrated into instructional materials such as student worksheets, which can be used independently by learners to develop their knowledge, skills, and attitudes [4].

To be effective, student worksheets must be developed based on contextual learning models that promote active student engagement in understanding environmental issues. The discovery learning model is selected as the framework because it encourages students to solve problems through exploratory and investigative processes grounded in real-life situations [5][6]. Integrating environmental literacy within the discovery learning framework enables students not only to critically understand ecological concepts

but also to develop awareness through meaningful and applicable learning experiences.

Several previous studies have developed student worksheets based on environmental literacy, such as those addressing environmental pollution topics through a virtual field trip approach [7]. However, these studies did not incorporate the use of an explicit learning model as the foundation for structuring learning activities. Moreover, there is a lack of student worksheets that specifically address the environmental impacts of hydrocarbon combustion within the context of discovery learning. In fact, hydrocarbons are a key topic in chemistry that is highly relevant to environmental issues such as air pollution and the greenhouse effect.

Based on these considerations, it can be concluded that the development of a discovery learning-based student worksheet integrated with environmental literacy on the topic of hydrocarbons is highly necessary. This study aims to develop and assess the validity of such a student worksheet so that it can be used as a teaching material capable of enhancing students' awareness and concern for environmental issues.

## METHODS

This study adopts the ADDIE development model, limited to the development phase. The analysis and design phases were previously conducted by the researcher, and it is expected that future studies will continue with the implementation and evaluation phases.

This study comprises the product development phase of the student worksheet and its validity testing. Data were obtained through a validation instrument in the form of a questionnaire completed by two subject matter experts, two media experts, and two practitioner validators. The subject matter and media experts were university lecturers specializing in relevant courses, while the practitioners were high school chemistry teachers.

The researcher converted the average validation score to a percentage using the formula:

$$P(\%) = \frac{\text{total score}}{\text{Maximum score}} \times 100\%$$

The percentage of validation results by material experts, media experts, and practitioners was then converted into a qualitative assessment based on Arikunto's qualitative assessment interpretation table (2010) [8]. The interpretation of qualitative assessment is shown in Table 1.

Table 1. Qualitative assessment interpretation

Percentage Interval	Criteria	Information
80% < P ≤ 100%	Highly valid	No revision
60% < P ≤ 80%	Valid	Minor revision
40% < P ≤ 60%	Quite Valid	Minor revision
20% < P ≤ 40%	Less Valid	Major revision
0% < P ≤ 20%	Invalid	Major revision

The revision stage is conducted if the validation data shows a percentage ≤ 80%. A reliability test was also conducted in this study to avoid subjectivity by experts and practitioners. The reliability score was calculated using the formula:

$$R = \left[ 1 - \frac{A - B}{A + B} \right] \times 100\%$$

## Description:

A: The highest rating scale given by experts and practitioners

B: The lowest rating scale given by experts and practitioners

The developed student worksheet is said to be reliable if it has a percentage greater than or equal to 75% [9].

## RESULTS AND DISCUSSION

### Design of a Discovery Learning-Based Student Worksheet on Hydrocarbon Material Integrated with Environmental Literacy

The components of the student worksheet must be systematically organized. A well-structured worksheet is expected to facilitate students in using and understanding its content. The developed student worksheet consists of the following components: cover page, preface, table of contents, specifications, user guide, learning objectives and outcomes, concept map and

material, learning activities, independent exercises, and references.

The cover page is designed to provide readers with a clear overview and information that the student worksheet is developed based on the discovery learning model, with activities integrated with environmental literacy indicators. The cover design is also used as the background throughout all pages of the student worksheet.

The activities in this discovery learning-based student worksheet refer to environmental literacy indicators, which include environmental knowledge, cognitive skills, and attitudes. For instance, the environmental knowledge indicator is integrated into the stimulus phase, while cognitive skills are emphasized during the problem identification phase. It is expected that these environmental literacy indicators can synergize with the discovery learning model to foster students' awareness of environmental literacy.

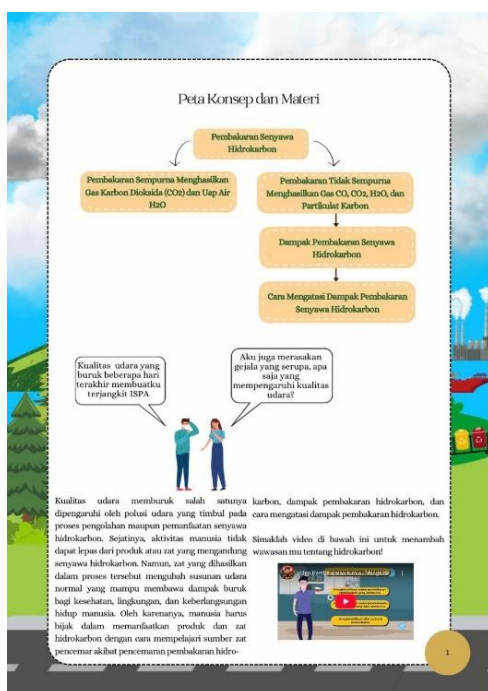


Figure 1. Concept Maps and Materials

The syntax of the discovery learning model consists of the following stages: stimulation, problem identification, data collection, data processing, verification, and concluding. The stimulation phase plays a crucial role in discovery learning, as it serves to guide students toward constructing their own understanding. In this

student worksheet, the stimulation phase is designed by presenting videos and narratives intended to spark students' curiosity about the harmful environmental effects of hydrocarbon combustion. Research conducted by Sulistyorini et al. (2023) also supports the idea that the stimulation phase can enhance students' learning outcomes [10].

The integration of environmental literacy into discovery learning is reflected in the concept map and concise material, which present a narrative on the relationship between hydrocarbon combustion and air quality. The environmental literacy indicator incorporated in this activity is environmental knowledge. Additionally, students are asked to watch a video explaining the complete and incomplete combustion reactions of hydrocarbons. It is expected that through the provided narrative and video, students will be able to construct their understanding of the connection between hydrocarbon combustion and air quality.

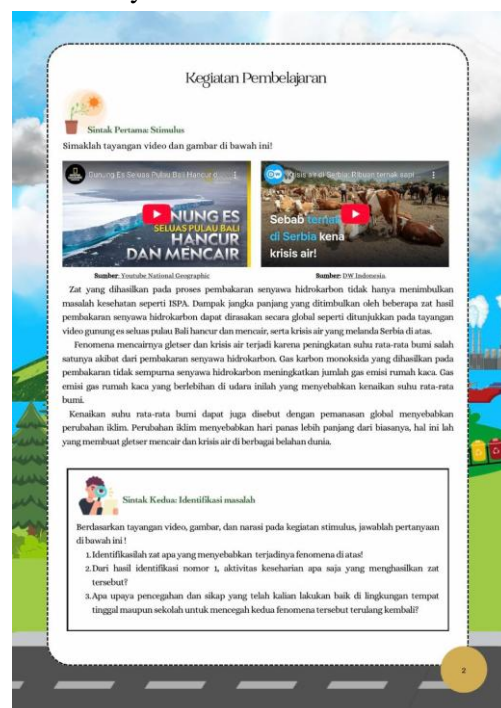


Figure 2. Learning Activities

In the stimulus learning activity integrating environmental literacy, students are asked to watch YouTube videos titled “Iceberg the size of Bali Island melts and collapses” and “Water crisis in Serbia: thousands of cattle and horses at risk, what is the solution?”. In addition, a brief narrative

explains the connection between hydrocarbon combustion and the phenomena depicted in the videos. The environmental literacy indicators integrated into this discovery learning activity are environmental knowledge, specifically sub-indicators related to ecological knowledge and the condition of the surrounding environment.



Figure 3. Exercise

The independent exercises presented differ from those in previously developed student worksheets. The exercises are designed in the form of a narrative related to the phenomenon of extreme hunger caused by the prolonged effects of

hydrocarbon combustion. In contrast, the independent exercises in the worksheet developed by Anisa et al. (2023) were presented in multiple-choice format [11].

### Validity Test

This study was conducted up to the product validation phase of the student worksheet. The feasibility of the developed worksheet was assessed using data obtained from validity testing. Validation of the discovery learning-based student worksheet integrated with environmental literacy was carried out by two subject matter experts, two media experts, and two practitioners using a validity questionnaire. Subject matter experts evaluated the worksheet based on the accuracy of its content and activities in relation to hydrocarbon material, the discovery learning syntax, and environmental literacy indicators.

In this product validity test, media experts assessed the suitability of the worksheet's visual appearance with the hydrocarbon material. Meanwhile, practitioners evaluated the accuracy of the content and activities concerning hydrocarbon material, discovery learning syntax, environmental literacy indicators, as well as the appropriateness of the visual design relative to the hydrocarbon material.

The average percentage scores of the validity tests conducted by subject matter experts, media experts, and practitioners are presented in Table 2.

Table 2. Validity test results

Aspects	Average Percentage	Criteria	R Coefficient	R
Content	93,12%	Highly Valid	85,71%	Reliable
Presentation	90,63%	Highly Valid	85,71%	Reliable
Linguistic	88,34%	Highly Valid	85,71%	Reliable
Graphic	94,17%	Highly Valid	85,71%	Reliable

The validity test results of the discovery learning-based student worksheet integrated with environmental literacy on hydrocarbon material showed a very high average percentage. This percentage directly indicates that the developed product is feasible in terms of content suitability with the learning objectives, discovery learning syntax, integration of environmental literacy indicators, and alignment with students'

characteristics. A study conducted by Agustha et al. (2021) supports these findings, where the content feasibility aspect achieved a percentage of 94.44%, demonstrating the alignment of the e-LKPD with the basic competencies and indicators of competency achievement, as well as fulfilling the main topics of ionic equilibrium and salt solution pH [12]. The content feasibility aspect is crucial in the development research of student

worksheets (LKPD) to ensure that the worksheets align with the intended learning objectives, specifically fostering environmental awareness among students. Educational environmental learning embedded in these worksheets is expected to cultivate students' awareness and caring attitudes toward environmental sustainability. This is essential to prepare a generation capable of living harmoniously with the concept of a forest city promoted by the new capital city, Ibu Kota Nusantara (IKN), where urban development is designed in accordance with sustainability and ecological principles.

The presentation's feasibility aspect received a percentage of 90.63%, categorized as very valid, indicating that the layout—including page structure, formatting, and illustrations—is highly effective in conveying information. It helps students better understand the negative impacts of hydrocarbon combustion, which are presented within the discovery learning model, while also supporting environmental integration. This aligns with Illahi's (2021) statement that presentation feasibility is part of the technical requirements in developing student worksheets. A visually appealing worksheet is effective in capturing students' interest and increasing their motivation to learn [13].

The student worksheet meets the criteria for readability, clarity of meaning, and appropriateness to students' developmental levels. Communicative, clear, and unambiguous language is essential in discovery learning, as students must understand instructions, interpret findings, and independently formulate conclusions. Therefore, a high level of language feasibility supports the effectiveness of the concept discovery process—particularly for complex topics such as hydrocarbons—and reinforces the comprehensive integration of environmental literacy.

The graphical feasibility aspect in this validation test also achieved a very valid percentage, consistent with the feasibility ratings for content, presentation, and language. The student worksheet was carefully and aesthetically designed, covering aspects such as color selection, font type, margin arrangement, layout consistency,

and illustration quality. A graphic design that adheres to proper standards is essential to support readability, learning comfort, and students' attention focus. In discovery learning, well-designed graphics help students follow instructions, observe phenomena through images and videos, and visualize abstract concepts—such as the structure and properties of hydrocarbon compounds—in a more concrete manner. Furthermore, good graphic design also fosters students' interest and motivation in exploring environmental issues integrated within the worksheet. As concluded in the study by Wahyuni & Zulyusri (2023), high graphic validity consistently supports readability, attention focus, and the effective delivery of information in student worksheets [14].

The reliability coefficient for the aspects of content feasibility, presentation, language, and graphics was consistently 85.71%, indicating that the validation instrument is capable of producing stable and trustworthy data. Therefore, the validation results are suitable to be used as a basis for revising and implementing the student worksheet in discovery learning integrated with environmental literacy. The R coefficient also indicates a shared perception among the validators.

## CONCLUSION

The discovery learning-based student worksheet integrated with environmental literacy on hydrocarbon material was deemed *highly valid* based on expert evaluations. This product has the potential to be used in classroom instruction to foster students' environmental awareness. However, this study was limited to the development phase; therefore, further research is needed to implement and evaluate the worksheet to determine its effectiveness in enhancing students' environmental awareness.

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