

Development of Science Literacy-Based Student Worksheets for Fifth Grade Students at Madrasah Ibtidaiyah Ma'arif Maron, Garung

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ABSTRACT

This study aimed to examine the feasibility, effectiveness, and practicality of developing a science literacy-based Student Worksheet for fifth-grade students at Madrasah Ibtidaiyah Ma'arif Maron. The research employed a research and development (R&D) approach focusing on the Human Digestive System classification topic. The feasibility of the developed Student Worksheet was evaluated through expert validation involving a language expert, a material expert, and a media/design expert. The validation results indicated that the Student Worksheet was categorized as highly feasible, with scores of 80% from the language expert, 92.5% from the material expert, and 87.5% from the media/design expert. The effectiveness and practicality of the Student Worksheet were assessed through student and teacher response questionnaires. The results showed that students' responses reached 84.62%, while teachers' responses reached 86.67%, both categorized as very feasible. These findings suggest that the science literacy-based Student Worksheet is valid, effective, and practical for supporting science learning and enhancing students' scientific literacy in elementary education.

Keywords: *human digestive system, research and development, science literacy, student worksheet*



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INTRODUCTION

Scientific literacy has become a central objective of science education in the twenty-first century, particularly in response to rapid technological advancement and the increasing complexity of global challenges (Irvani et al., 2023; Osborne, 2007). It refers to individuals' capacity to understand scientific concepts, apply scientific knowledge in real-life contexts, interpret empirical evidence, and make reasoned decisions concerning personal, social, and global issues (Schleicher, 2019). Scientific literacy extends beyond the mastery of factual knowledge; it includes the ability to explain phenomena scientifically, evaluate and design scientific investigations, and interpret data and evidence critically. In this sense, scientific literacy equips students with competencies necessary for active participation in a knowledge-based society.

Scientific literacy is conceptually distinct from learning achievement. While learning achievement typically measures the extent to which students attain predetermined instructional objectives, scientific literacy emphasizes the meaningful application of knowledge through inquiry, reasoning, and problem-solving processes (Cahyanti et al., 2024). Consequently, science instruction should not be limited to content transmission and procedural exercises but should instead prioritize contextual, inquiry-oriented, and investigation-based learning experiences. Such approaches encourage students

to actively construct understanding, engage with authentic problems, and develop higher-order thinking skills essential for lifelong learning.

In Indonesia, students' scientific literacy remains a persistent and systemic challenge within the national education landscape. Results from the Programme for International Student Assessment (PISA) organized by the Organisation for Economic Co-operation and Development consistently indicate that Indonesian students perform below the international average in science literacy. Specifically, Indonesia's mean scores in science for the 2006, 2009, and 2012 cycles ranged between 382 and 395, which is substantially lower than the OECD average score of 500 (OECD, 2017). These findings position Indonesia among the lower-performing countries in scientific literacy and highlight structural issues in science education, including limited emphasis on inquiry, reasoning, and the application of scientific knowledge in authentic contexts. The PISA framework defines scientific literacy as the capacity to engage with science-related issues and with the ideas of science as a reflective citizen, which requires competencies beyond rote memorization (Schleicher, 2019).

The relatively low performance of Indonesian students suggests that science instruction has not yet fully facilitated the development of higher-order thinking skills and scientific reasoning. Several studies argue that classroom practices in Indonesia tend to prioritize content transmission and procedural exercises rather than inquiry-based and problem-oriented learning (Mubarokah et al., 2024; Savitri et al., 2024; Yopianti & Sadiq, 2023). As a result, students may demonstrate adequate recall of concepts but encounter difficulties when required to interpret data, evaluate evidence, or apply scientific understanding to real-world problems. Strengthening scientific literacy therefore requires systematic improvements in instructional design, learning resources, and assessment practices that align with international literacy frameworks and promote meaningful engagement with scientific phenomena (Schleicher, 2019).

Recent studies in science education have underscored the importance of integrating inquiry-based learning (Mubarokah et al., 2024), problem based learning (Firdaus, 2017; Savitri et al., 2024; Trisnowati & Firdaus, 2017), and literacy-oriented (Fanguna et al., 2024; Firdaus et al., 2021; Rahayu et al., 2022) instructional materials to enhance students' scientific literacy. Inquiry-based learning has been widely recognized as an effective strategy to promote conceptual understanding and scientific reasoning, as it actively engages students in questioning, investigating, and constructing explanations based on evidence (Cahyanti et al., 2024). In parallel, contextual and problem-based approaches encourage learners to connect scientific concepts with real-world situations, thereby strengthening the relevance and applicability of knowledge. The OECD (2017) framework further emphasizes that science instruction should cultivate competencies in explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting data and evidence.

In the Indonesian context, the development of Student Worksheets integrated with problem-based learning, project-based learning, or STEM approaches has demonstrated positive impacts on students' engagement, motivation, and conceptual mastery. These instructional designs provide structured guidance for students to participate actively in learning activities. However, many Student Worksheet products remain predominantly content-oriented, emphasizing the completion of exercises and factual recall rather than systematically embedding core scientific literacy competencies (Putra et al., 2019). As a result, although students may improve in terms of content acquisition, the explicit development of skills such as scientific explanation, inquiry design, and data interpretation is often insufficiently addressed. This gap indicates the need for Student Worksheet that are intentionally and comprehensively designed based on scientific literacy indicators aligned with international assessment frameworks.

Although numerous studies have focused on the development of Student Worksheets for elementary science learning, most of these efforts emphasize improving conceptual understanding or increasing student engagement through specific instructional models. Only a limited number of studies have systematically designed Student Worksheets explicitly grounded in scientific literacy indicators aligned with the competencies outlined in the PISA framework developed by the Organisation for Economic Co-operation and Development. In many cases, scientific literacy is addressed implicitly rather than operationalized into structured components such as explaining phenomena scientifically, evaluating and designing investigations, and interpreting data and evidence. Consequently, the

alignment between instructional materials and internationally recognized scientific literacy competencies remains insufficiently examined.

Furthermore, empirical validation of science literacy-based Student Worksheet within the context of Madrasah Ibtidaiyah, particularly in rural settings, is still limited. Existing research rarely provides comprehensive evidence regarding the feasibility through expert validation, as well as the effectiveness and practicality of implementation from both student and teacher perspectives. This lack of context-specific and empirically tested instructional materials highlights a clear gap in the literature, underscoring the need for systematic development and evaluation of Student Worksheets that are pedagogically aligned with scientific literacy frameworks and responsive to the characteristics of elementary Islamic school environments.

This study offers a structured development of a science literacy-based Student Worksheet explicitly grounded in core scientific literacy competencies as defined in the PISA framework by the Organization for Economic Co-operation and Development. The novelty of this research lies in the systematic integration of three principal competencies, explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting data and evidence, into contextual learning activities on the topic of the Human Digestive System for fifth-grade students. Unlike conventional Student Worksheets, which primarily emphasizes content mastery and procedural exercises, the developed worksheet operationalizes scientific literacy indicators into measurable, activity-based components within each learning task.

In addition, this study provides a comprehensive evaluation of the developed product through expert validation and empirical testing to determine its feasibility, effectiveness, and practicality in the context of Madrasah Ibtidaiyah. By aligning instructional design with internationally recognized scientific literacy competencies while adapting it to local elementary school characteristics, this research contributes a context-responsive and empirically validated instructional model for strengthening scientific literacy at the primary education level.

The urgency of this study is grounded in the persistent challenge of improving students' scientific literacy in Indonesia, as reflected in international assessment outcomes reported by the Organisation for Economic Co-operation and Development (OECD, 2017). Despite curriculum reforms that emphasize higher-order thinking and inquiry-based learning, the availability of instructional materials that explicitly operationalize scientific literacy competencies remains limited, particularly at the elementary level. In Madrasah Ibtidaiyah, science learning resources are often oriented toward content completion and textbook-based exercises, with insufficient emphasis on inquiry processes, contextual problem-solving, and evidence-based reasoning.

Without structured and empirically validated learning tools, initiatives to strengthen scientific literacy risk remaining normative at the policy level rather than being effectively implemented in classroom practice. Teachers require practical and pedagogically sound materials that translate abstract literacy frameworks into concrete learning activities. Therefore, the development and validation of a science literacy-based Student Worksheet are essential to bridge the gap between policy expectations and instructional realities. Such an effort supports teachers in delivering meaningful science instruction and equips students with critical thinking, inquiry skills, and scientific reasoning competencies necessary for lifelong learning in the twenty-first century.

Based on these considerations, this research aims to develop and evaluate a science literacy-based Student Worksheets as an innovative instructional resource to support meaningful and inquiry-oriented science learning at the elementary level.

METHODS

This study employed a Research and Development (R&D) approach aimed at developing and validating a science literacy-based student worksheet. The R&D method enables researchers to systematically design, produce, and evaluate an instructional product to ensure its relevance, feasibility, and effectiveness in real classroom settings (Gall et al., 2007). The product developed in this study was a science literacy-based student worksheet for the subject of Natural and Social Sciences at Madrasah Ibtidaiyah Ma'arif Maron. The development process included stages of needs analysis, product design, expert validation, revision, limited trial, and final revision.

The subjects of this study were fifth-grade students of Madrasah Ibtidaiyah Ma'arif Maron in the relevant academic year. Three expert validators were involved to assess the feasibility of the developed product, consisting of a language expert, a material expert, and a media/design expert. In addition, a classroom teacher participated in evaluating the practicality of the product implementation.

Data were collected using validation sheets, questionnaires, and documentation. The validation sheets were used to obtain expert judgments regarding the feasibility of the product in terms of language, content, and design aspects. Student response questionnaires were administered to measure effectiveness and attractiveness, while teacher response questionnaires were used to evaluate practicality in classroom implementation. The instruments employed a Likert scale to quantify responses.

The data obtained from expert validation and questionnaires were analyzed quantitatively using descriptive statistics in the form of percentage scores. The percentage results were then interpreted according to predetermined feasibility criteria (e.g., very feasible, feasible, less feasible). Qualitative feedback from experts and users was analyzed descriptively to revise and improve the product. Through this analysis, the study determined the feasibility, effectiveness, and practicality of the developed science literacy-based student worksheet

RESULTS AND DISCUSSION

The results of this study indicate that the product validation was conducted in three stages. The first stage involved validation by a language expert, the second stage by a media/design expert, and the third stage by a subject-matter expert in fifth-grade science at Madrasah Ibtidaiyah Ma'arif Maron, Garung, Wonosobo. The validation data were obtained from expert assessments and field product trials. The feasibility evaluation demonstrated that the developed science literacy-based student worksheet on the topic of the Human Digestive System was categorized as highly feasible for classroom implementation. The percentage scores were 80% from the language expert, 92.5% from the material expert, and 87.5% from the media/design expert, all of which fall within the "very feasible" category.

A limited product trial was conducted by implementing the developed worksheet in fifth-grade learning activities. The purpose of this trial was to examine its feasibility, practicality, strengths, and limitations. The results of the student response questionnaire showed a percentage score of 84.62%, categorized as very feasible. Students reported that the worksheet helped them understand the material more deeply through structured reading, analyzing, and concluding scientific information. They also responded positively to the systematic presentation, contextual content, and visually engaging anatomical illustrations. The practicality of the developed science literacy-based worksheet was demonstrated by its ease of use during the learning process, both individually and in groups, as reflected in the teacher response score of 86.67%, which was categorized as very feasible. The broader implementation demonstrated a substantial improvement in students' conceptual understanding. Teachers also provided highly positive responses, indicating that the product was practical and supportive of classroom instruction. Overall, the findings confirm that the developed worksheet is feasible, effective, and practical as an alternative instructional resource to enhance students' scientific understanding in a meaningful and engaging manner.

The findings demonstrate that the developed science literacy-based student worksheet was categorized as "very feasible" based on expert validation covering language, content, and media/design aspects. The validation results indicate that the product fulfills essential academic standards required for elementary science instruction. A score of 80% from the language expert confirms that the worksheet uses clear, age-appropriate, and communicative language, which is crucial for ensuring readability and comprehension at the primary education level. Meanwhile, high scores from material and media experts suggest that both conceptual accuracy and visual presentation were carefully designed to support effective learning.

From a pedagogical perspective, instructional materials that are systematically developed and validated tend to contribute more effectively to meaningful learning processes. Well-designed learning resources serve as structured cognitive scaffolds that guide students through stages of understanding, from initial exposure to deeper conceptualization. When content, language clarity, and visual

organization are aligned, students are better able to focus on conceptual relationships rather than being distracted by ambiguous explanations or poorly structured tasks.

These results can be explained through constructivist learning theory, which emphasizes that learners actively construct knowledge through interaction with structured experiences (Serafin & Havelka, 2015). According to Bruner (1961), learning becomes more meaningful when new information is organized coherently and connected to learners' prior knowledge. In this context, the worksheet's structured activities and sequential tasks likely facilitated students' cognitive engagement by enabling them to gradually build understanding through guided inquiry and reflection.

The high score obtained from the material expert (92.5%) further indicates that the scientific content was accurate, relevant, and aligned with curriculum standards. Conceptual accuracy is particularly important in science learning, especially when addressing abstract topics such as the Human Digestive System. Accurate and systematically organized content supports students in forming correct mental models, reducing misconceptions, and strengthening conceptual coherence.

Overall, the strong validation results reflect the alignment between instructional design principles and cognitive learning theory. By integrating clear language, accurate scientific content, and supportive visual elements within a structured framework, the developed worksheet provides an effective foundation for meaningful science learning. This alignment explains why the product was considered highly feasible for classroom implementation and capable of supporting students' conceptual development.

The positive student responses (84.62%) and strong teacher evaluations indicate that the developed worksheet was perceived as both effective and practical in classroom implementation. A response rate within the "very feasible" category suggests that students experienced meaningful engagement during learning activities, while teachers found the material supportive and manageable within instructional time constraints. Such outcomes reflect the alignment between the instructional design and the learning needs of elementary students.

These findings can be interpreted through the framework of scientific literacy proposed by the OECD (2017), which emphasizes three main competencies: explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting data and evidence. The worksheet was explicitly structured around these competencies, allowing students to interact with scientific concepts beyond memorization. By embedding these elements into each activity, the instructional material translated abstract literacy competencies into concrete learning tasks.

Instead of focusing solely on routine exercises, the worksheet required students to read contextual information, analyze scientific explanations, and draw conclusions based on evidence. This shift from procedural completion to analytical engagement likely contributed to students' positive perceptions. When learners are actively involved in interpreting information and constructing explanations, they tend to perceive learning as more meaningful and relevant.

The effectiveness of this approach is consistent with inquiry-based learning theory. Literacy-oriented and inquiry-based instructional designs enhance student engagement and higher-order thinking skills because they stimulate active cognitive processing (Antonio & Prudente, 2023). Activities that involve questioning, investigating, and reasoning encourage learners to connect evidence with scientific concepts, thereby strengthening conceptual understanding.

Moreover, the results align with empirical evidence from Purtadi et al. (2023), who found that structured inquiry-based science instruction significantly improves students' conceptual understanding and scientific reasoning. The integration of literacy competencies within guided inquiry activities appears to provide both cognitive structure and intellectual challenge. Therefore, the strong student and teacher responses observed in this study can be attributed to the alignment between scientific literacy principles, inquiry-based pedagogy, and well-structured instructional design.

Furthermore, the broader trial results showing improved student understanding and highly positive responses toward visual design and contextual tasks support multimedia learning theory. Meaningful learning occurs when verbal and visual representations are integrated effectively. The use of clear anatomical illustrations and contextual problem scenarios likely facilitated dual-channel processing, thereby strengthening comprehension. Previous studies in elementary science education

have similarly reported that visually supported and contextually designed worksheets enhance motivation and learning outcome (Surahman et al., 2025).

The effectiveness and practicality of the developed product can be understood through its strong alignment with scientific literacy competencies, inquiry-based learning principles, and multimedia learning theory. By embedding competencies such as explaining scientific phenomena, designing simple investigations, and interpreting data into structured learning activities, the instructional material encourages students to actively engage with scientific concepts. This alignment ensures that learning moves beyond factual recall toward deeper conceptual understanding and evidence-based reasoning, which are central components of scientific literacy.

From an inquiry-based perspective, structured activities that guide students through questioning, analyzing, and concluding processes promote meaningful cognitive engagement. When learners are provided with systematic scaffolding, they are more capable of connecting prior knowledge with new information and applying concepts to contextual situations. Such integration helps transform abstract scientific content into accessible and relatable experiences, thereby increasing both engagement and comprehension.

Furthermore, the incorporation of clear visual elements and organized content presentation supports principles of multimedia learning, which emphasize the integration of verbal and visual information to enhance understanding. By combining contextual narratives, guided inquiry tasks, and supportive illustrations, the developed material bridges the gap between conceptual knowledge and real-life application. These findings strengthen the argument that structured, literacy-oriented instructional resources play a crucial role in fostering scientific literacy at the elementary education level.

CONCLUSION

Based on the results of the analysis of the study on the development of a science literacy-based student worksheet for fifth-grade students at Madrasah Ibtidaiyah Ma'arif Maron, Garung District, Wonosobo Regency, several conclusions can be drawn. First, the developed product was categorized as highly feasible based on expert validation. The validation results showed that the language aspect obtained a score of 80%, the material aspect achieved 92.5%, and the media/design aspect reached 87.5%, all of which fall into the "very feasible" category. These findings indicate that the product meets linguistic, conceptual, and visual standards appropriate for elementary science learning. Second, the effectiveness of the product was reflected in the positive responses of students, with a percentage score of 84.62%, categorized as very feasible. The results suggest that the developed material supports students in understanding the Human Digestive System topic more deeply through structured activities involving reading, analyzing, and drawing conclusions from scientific information. The contextual presentation and systematic organization also contributed to enhanced engagement and comprehension. Third, the practicality of the product was demonstrated through teacher responses, which reached 86.67% and were categorized as very feasible. This indicates that the developed material is practical to implement in classroom settings and supports the achievement of instructional objectives from the teacher's perspective. Overall, the product is feasible, effective, and practical for use in elementary science learning.

It is recommended that teachers utilize science literacy-based instructional materials to foster students' inquiry skills and conceptual understanding in science learning. Schools may consider supporting the development and dissemination of similar literacy-oriented materials across different topics. Future research is encouraged to conduct broader experimental studies to measure the impact of such materials on students' learning outcomes and scientific literacy using more rigorous research designs and larger samples.

CONFLICT OF INTEREST

The authors confirm that they have no conflicts of interest related to the publication of this study. They have no financial, personal, or professional interests that could be perceived as influencing the research outcomes or interpretations presented in this publication.

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