

DEVELOPMENT OF A SUSTAINABILITY-BASED SCIENCE KIT TO ENHANCE SCIENCE INQUIRY AND SCIENCE MOTIVATION

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ABSTRACT

This study aims to develop a sustainability-based science kit centered on the activity of making scented candles that is valid, feasible, and practical for enhancing the scientific inquiry skills and science motivation of junior high school students. The research was motivated by students' limited ability to engage in scientific inquiry processes and their low motivation to learn science, issues stemming from the prevalence of teacher-centered instruction and a lack of contextual experimental activities. The study employed the Research and Development (R&D) method based on the Borg & Gall model, modified into five stages: preliminary study, planning, initial product development, expert validation, and product revision. The developed products include a Lesson Plan (RPP), Student Worksheet (LKPD), science module, and the sustainability-based science kit. Validity testing was conducted by subject matter and media experts, while practicality testing was carried out by science teachers acting as educational practitioners. Expert validation results showed an average score of 84.28% (categorized as highly feasible) for subject matter and 81.99% (highly feasible) for media. The practicality test conducted by educators yielded an average score of 98.39%, placing it in the highly practical category. The findings indicate that the sustainability-based science kit is of high quality, meets feasibility criteria, and is easily implemented in science instruction. Integrating the scented candle-making activity provides a contextual, active, and meaningful learning experience, thereby potentially fostering students' scientific inquiry skills and motivation. Thus, the sustainability-based science kit is suitable as an instructional innovation that supports the implementation of education for sustainability at the junior high school level.

Keywords: *Science KIT, Sustainability, Scientific Inquiry, Science Motivation, Education for Sustainability.*

1. INTRODUCTION

The 21st century is characterized by rapid advancements in science and technology, the digitalization of information, globalization, and the emergence of the Fourth Industrial Revolution (Industry 4.0), all of which have transformed various aspects of human life, including the education sector. These conditions require educational systems to produce human resources who not only possess academic knowledge but also demonstrate critical thinking, creativity, collaboration, and communication skills, alongside the ability to solve problems scientifically and act responsibly toward their environment (Redhana, 2019; OECD, 2023). Such competencies constitute a vital part of the 21st-century skills that learners need to navigate increasingly complex social, economic, and environmental challenges.

In the context of science education, Natural Science (IPA) instruction plays a strategic role in shaping students' scientific thinking skills. Natural Science is viewed not merely as a collection of concepts, facts, principles, and theories, but also as a scientific process involving observation, investigation, experimentation, data analysis, and the drawing of conclusions based on empirical evidence (National Research Council, 2012). Therefore, Natural Science instruction should provide students with opportunities to gain firsthand experience in conducting scientific investigations, enabling them to independently build conceptual

understanding through the process of inquiry. However, various international reports indicate that the scientific literacy skills of Indonesian students still require improvement. Results from the 2022 Programme for International Student Assessment (PISA) show that Indonesian students' scientific literacy performance remains below the OECD average (OECD, 2023). This situation suggests that a significant number of students still struggle to connect scientific concepts with real-world phenomena encountered in daily life. Furthermore, science instruction in schools tends to focus on concept mastery and rote memorization, thereby failing to fully foster higher-order thinking skills, science process skills, and problem-solving abilities.

Preliminary observations at SMPN 03 Teluk Keramat indicate that the science learning process is still dominated by lectures and simple discussions, while practical activities have not been optimally implemented due to limited learning media and facilities. Teachers lack science kits specifically designed to support experimental activities that are contextual and relevant to environmental issues in the students' surroundings. Consequently, students have not gained optimal learning experiences in developing skills such as identifying problems, formulating hypotheses, designing experiments, collecting data, analyzing observations, and drawing conclusions based on empirical evidence. These conditions indicate that the students' scientific inquiry skills remain low.

Scientific inquiry refers to a learner's ability to conduct a systematic scientific investigation—involving observation, questioning, hypothesis formulation, experimentation, data analysis, and drawing conclusions to acquire new knowledge (National Research Council, 2000). This ability is a crucial competency in science education because it enables learners to understand the nature of science as both a process and a product of knowledge. Recent research indicates that inquiry-based learning can enhance scientific literacy, critical thinking skills, problem-solving abilities, and active student engagement in the learning process (Cairns & Areepattamannil, 2022).

In addition to limited inquiry skills, another issue identified is the students' low level of science motivation. Science motivation is a crucial factor influencing students' interest, engagement, and success in learning science. Students with high motivation tend to be more active in seeking information, exploring, asking questions, and participating in various science learning activities. Conversely, low motivation leads students to become passive, lose interest in the lesson, and struggle to comprehend the material (Glynn et al., 2011). Observations indicate that the majority of students lack enthusiasm when presented with contextual problems related to environmental phenomena in their surroundings. This situation highlights the need for instructional innovations capable of enhancing student engagement and learning motivation.

One approach currently garnering attention in the field of education is Education for Sustainable Development (ESD). UNESCO emphasizes that ESD is an educational approach aimed at equipping learners with the knowledge, skills, values, and attitudes necessary to support sustainable development. Through ESD, learners are encouraged to understand the interconnections between environmental, social, and economic aspects and to take responsible action toward a sustainable future (UNESCO, 2020).

Various recent studies indicate that integrating Education for Sustainable Development (ESD) principles into science education enhances students' environmental awareness, systems thinking abilities, problem-solving skills, and sustainability competencies. Filho et al. (2021)

explain that implementing ESD contributes to the development of 21st-century competencies and the strengthening of sustainability literacy. Research by Baptista et al. (2025) demonstrates that inquiry-based science learning integrated with local environmental issues improves students' ability to understand sustainability challenges and take concrete environmental action. Meanwhile, Setiyaningsih et al. (2024) found that sustainability-focused inquiry learning enhances critical thinking skills and student engagement in science education.

One medium that can support the implementation of Education for Sustainable Development (ESD) in science learning is the sustainability-based science kit. These kits enable students to conduct hands-on experiments, allowing scientific concepts to be understood through empirical experience. Integrating sustainability principles into the kits helps students grasp the connections between concepts of material change and various environmental issues, such as waste management, pollution, resource efficiency, and environmental conservation. Through contextual experimental activities, students not only understand scientific concepts but also develop environmental awareness and a sense of responsibility toward the environment.

While extensive research has been conducted on inquiry-based learning and Education for Sustainable Development, studies specifically developing sustainability-oriented science kits to enhance scientific inquiry and motivation regarding the topic of material changes remain relatively limited. Most prior research has focused on improving cognitive learning outcomes or scientific literacy, whereas the development of science kits designed to simultaneously boost scientific inquiry and motivation has not been widely explored. Thus, this study offers a novel contribution through the development of a sustainability-oriented science kit that integrates Education for Sustainable Development principles and inquiry activities centered on the topic of material changes to enhance the scientific inquiry skills and motivation of junior high school students.

The development of sustainability-focused science kits is significant because it offers students a more concrete, contextual, and meaningful learning experience. By using these kits, students can conduct hands-on experiments, thereby fostering an active, student-centered learning process. Furthermore, experiments designed around sustainability principles enable students to grasp the connection between scientific concepts and environmental conservation efforts. Consequently, the use of sustainability-focused science kits is expected to enhance students' scientific inquiry skills and their motivation for science.

While various studies have examined the use of science learning media and the implementation of Education for Sustainable Development, research specifically focused on developing a sustainability-based science kit to enhance scientific inquiry and motivation regarding the topic of material changes remains relatively limited. Most existing studies prioritize improving cognitive learning outcomes, whereas the aspects of inquiry and learning motivation have rarely been investigated concurrently. Therefore, this study offers a novel contribution through the development of a sustainability-based science kit designed to support inquiry skills while simultaneously boosting student motivation in learning about material changes. Based on this context, the study aims to develop a sustainability-based science kit that is valid and suitable for use in junior high school science instruction, and to analyze its potential to enhance students' scientific inquiry skills and motivation regarding the topic of material changes.

2. METHODS

This study employs the Research and Development (R&D) method. The R&D model adopted as a reference is the development design by Gall, Gall, and Borg (2003), which originally comprised ten stages. Given time constraints and the research focus which centers on developing a final product draft ready for large-scale field testing the researcher condensed these stages into a more streamlined process, comprising: (1) information gathering and preliminary study (Research and Information Collecting), (2) planning (Planning), (3) development of the initial product draft (Develop Preliminary Form of Product), (4) preliminary field testing or expert validation (Preliminary Field Testing), and (5) main product revision (Main Product Revision).

This study focuses on validation and practicality testing. The validation phase involved experts (lecturers) in Science Education from Universitas PGRI Semarang, specifically two science content experts and two instructional media/design experts. Meanwhile, the practicality test involved three education practitioners—science teachers from SMPN 3 Teluk Keramat, Sambas Regency. The product developed in this study is a comprehensive instructional package covering the topic of Environmental Pollution for Grade VII junior high school students. Data collection utilized a closed-ended validation questionnaire that included a section for open-ended suggestions. A Likert scale ranging from 1 to 4 was used for assessment (1 = Very Poor, 2 = Poor, 3 = Good, 4 = Very Good). The aspects evaluated included content suitability, language, presentation, and design/graphics. Teknik analisis data kuantitatif dilakukan dengan menghitung persentase skor perolehan dari setiap validator menggunakan rumus:

$$P = \frac{\sum x}{\sum x_i} \times 100\%$$

Keterangan:

P = Persentase Kelayakan

$\sum x$ = Total skor jawaban aktual dari validator

$\sum x_i$ = Total skor maksimal ideal

The resulting percentage (P) was then converted into feasibility or validity level criteria based on guidelines by Arikunto (2010), as follows:

1. 81% - 100%: Highly Feasible / Highly Valid (Can be used without major revision)
2. 61% - 80%: Feasible / Valid (Can be used with minor revisions)
3. 41% - 60%: Moderately Feasible / Moderately Valid (Can be used with major revisions)
4. 0% - 40%: Not Feasible / Not Valid (Cannot be used)

Meanwhile, qualitative data consisting of criticisms, input, and suggestions written by validators on the questionnaire forms were reduced, categorized, and analyzed to serve as the primary basis for the fifth step: the revision of the main product prior to its classroom simulation.

3. RESULTS AND DISCUSSION

RESULTS

His study successfully developed a sustainability-based science kit designed to enhance scientific inquiry and motivation in science. Before being deemed ready for distribution to the target users (students), the kit underwent a series of expert appraisals to evaluate its construct and content validity, as well as its practical usability.

Subject Matter Expert Validation Results

The sustainability-based science kit centered on scented candle making to enhance students' scientific inquiry and motivation was developed by the researcher and has undergone a formal research and expert review process. The initial assessment was conducted by experts specializing in sustainability-based science learning materials designed to foster scientific inquiry and motivation. A summary of the assessment results from the subject matter experts is presented in Table 1.

Table 1. Summary of Subject Matter Expert Validation Results

No	Instructional Materials	Assessment Criteria	Average Score (%)	Eligibility Criteria
1	RPP	Alignment of sustainability-based learning syntax	85,50	Highly Worth It
		Alignment of learning objectives with Science learning outcomes	83,00	Highly Worth It
		Kelengkapan Indikator	83,26	Highly Worth It
		Rata-rata RPP	83,92	Highly Worth It
2	LKPD	Alignment of the Student Worksheet (LKPD) content with the sustainability approach.	85,00	Highly Worth It
		The capacity of Student Worksheets (LKPD) to facilitate science inquiry skills and science motivation.	84,18	Highly Worth It
		Language Use	83,09	Highly Worth It
		Average LKPD	84,09	Highly Worth It
3	Science Module	Alignment of the material with science and sustainability concepts	86,50	Highly Worth It
		Completeness of the Science Kit components	85,02	Highly Worth It
		Evaluation Aspects	83,00	Highly Worth It
		Average Modul	84,84	Highly Worth It
Overall Average of Subject Matter Experts			84,28	Highly Worth It

The product's achievement percentage falls within the "good" category, though minor revisions are required. Nevertheless, the expert validator offered suggestions to the author regarding the lesson plan (RPP), student worksheets (LKPD), and the module, subject to the following notes:

- The product is suitable for use provided revisions are made to specific sections, particularly those concerning the application of the independent variable.
- Please refer to the draft of the instructional materials.

Result Media and Design Expert Validation

Validasi media dan desain menitikberatkan pada aspek visual, kegrafikaan, tata letak (*layout*), tipografi, ilustrasi, fungsi navigasi (pada modul), dan daya tarik tampilan secara psikologis bagi remaja usia SMP. Rincian penilaian dari dosen ahli media disajikan pada Tabel 2.

Tabel 2. Rekapitulasi Hasil Validasi Ahli Media dan Desain Pembelajaran.

No	Perangkat Pembelajaran	Aspek Penilaian	Rata-rata Skor (%)	Kriteria Kelayakan
1	RPP	Sistematika dan Keterbacaan	82,14	Sangat Layak
		Rata-Rata RPP	82,14	Sangat Layak
2	LKPD	Desain Sampul (*Cover*)	83,00	Sangat Layak
		Desain Isi dan Tata Letak	80,50	Sangat Layak
		Pemilihan Fon dan Ilustrasi	81,81	Sangat Layak
		Rata-Rata LKPD	81,81	Sangat Layak
3	Modul IPA	Desain Komunikasi Visual	82,10	Sangat Layak
		Kualitas Gambar dan Resolusi	82,00	Sangat Layak
		Rata-Rata Modul	82,03	Sangat Layak
		Rata-Rata Keseluruhan Ahli Media	81,99	Sangat Layak

Hasil persentase capaian produk tersebut berada pada kualifikasi baik dan perlu direvisi. Akan tetapi, walaupun demikian validator ahli memberikan saran kepada penulis terkait RPP, LKPD, dan modul dengan catatan sebagai berikut:

- Mohon diligat draft perangkat
- Susunlah berdasarkan indikator LKPD yang baik
- Aspek kelayakan kegrafisan (desain perlu dibuat yang lebih menarik lagi)
- Aspek kelayakan isi (perlu penguraian materi yang lebih detail agar mudah dipahami)

Result Practicality Test by Education Practitioners (Science Teachers)

This assessment is crucial because teachers are the end-users who best understand the actual conditions on the ground, including constraints on learning time, the availability of equipment, and the characteristics of students at the respective schools. The assessment is conducted by science teachers.

Table 3. Summary of Practicality Test Results by Practitioners (Science Teachers)

No	Instructional Materials	Assessment Criteria	Average Score (%)	Eligibility Criteria
1	RPP	Implementation of the Syntax	98,00	Very practical
		Time Allocation	98,42	Very practical
		Average RPP	98,21	Very practical
2	LKPD	Ease of Project Guidance	97,50	Very practical
		Availability of Local Raw Materials	97,94	Very practical
		Average LKPD	97,72	Very practical
3	Science Module	Reading Interest and Language Appropriateness	99,00	Very practical
		Material Enrichment Function	99,48	Very practical
		Average Modul	99,24	Very practical
		Overall Average of Media Experts	98,39	Very practical

DISCUSSION

Discussion on the Quality, Feasibility, and Practicality of a Sustainability-Based Science Kit

The development of a sustainability-based science kit centered on scented candle making aims to enhance scientific inquiry and motivation among junior high school students. Prior to implementation, the product underwent a series of validity tests by subject matter and media experts, as well as practicality tests by education practitioners. The results indicate that the developed product is of high quality, suitable for use, and practical to implement in science instruction.

Product Quality and Suitability Based on Subject Matter Expert Validation

Validation results from subject matter experts indicate that the sustainability-based science kit achieved an average score of 84.28%, placing it in the "highly feasible" category. This score demonstrates that the developed kit meets the criteria regarding content suitability, learning objectives, and indicators, as well as its alignment with sustainability concepts and science education. Regarding the lesson plan component, an average score of 83.92% was obtained; this indicates that the designed instructional sequence aligns with sustainability-based learning principles and science learning outcomes.

Integrating sustainability issues into learning activities enables students to connect science concepts with real-world problems in their immediate environment. According to UNESCO (2020), Education for Sustainable Development aims to cultivate students who can think critically, make responsible decisions, and participate in resolving environmental issues in a sustainable manner. Regarding the Student Worksheet (LKPD), an average score of 84.09% was achieved, placing it in the "highly feasible" category. These results indicate that the worksheet effectively facilitates scientific inquiry activities, including making observations, formulating problems, developing hypotheses, conducting experiments, analyzing data, and drawing conclusions. These activities align with the view of the National Research Council (2000), which states that inquiry-based learning provides students with opportunities to construct knowledge through the process of scientific investigation.

Furthermore, the science module achieved an average score of 84.84%. This figure indicates that the presented material aligns with scientific concepts and sustainability principles. Additionally, the provided kit components are considered comprehensive and conducive to achieving learning objectives. A high-quality module serves as an effective independent learning resource, enabling students to grasp concepts systematically and contextually (Prastowo, 2018). Although the module was rated as highly suitable, validators offered suggestions for refining the materials—specifically regarding the implementation of independent variables and adjustments to certain instructional components. These recommendations demonstrate that the validation process serves not only to assess product quality but also to facilitate refinements that better align the product with its development goals.

Product Quality and Suitability Based on Media and Design Expert Validation

Media expert validation results yielded an average score of 81.99%, placing the product in the "highly suitable" category. These results indicate that the product's visual design, layout, typography, illustrations, and graphic elements meet the standards for instructional media suitability. The Lesson Plan (RPP) component achieved a score of 82.14%, demonstrating effective presentation structure and document readability. Meanwhile,

the Student Worksheet (LKPD) obtained an average score of 81.81%, indicating that the cover design, content layout, font selection, and illustrations effectively support student readability and comprehension. The science module achieved an average score of 82.03%, indicating that its visual communication design and image quality met the expected criteria. According to Arsyad (2019), learning media with high visual quality enhances learners' attention, interest, and motivation, thereby making the learning process more effective. However, the media validator offered several recommendations for improvement, such as structuring the student worksheets (LKPD) based on more systematic indicators, enhancing the graphic design's appeal, and providing more detailed explanations of the content. These suggestions are crucial for improving the media's aesthetic quality and functionality, ensuring better alignment with the characteristics of junior high school students, who tend to be drawn to engaging and interactive visual media. Overall, the media expert validation results indicate that the developed science kit meets the necessary standards for visual quality and instructional communication, making it suitable for use as a supporting tool for sustainability-based science learning.

Product Practicality Based on the Assessment of Education Practitioners

The product's practicality was evaluated by science teachers acting as direct users during the instructional process. The assessment results yielded an average score of 98.39%, placing it in the "highly practical" category. This exceptionally high score indicates that the developed materials are user-friendly, easy to comprehend, and applicable to real-world classroom settings. Regarding the lesson plan component, an average score of 98.21% was achieved; these results demonstrate that the instructional steps are easy to implement and the planned time allocation aligns with actual classroom conditions. According to Nieveen (1999), an educational product is considered practical if it is easy for users to employ and can be implemented in accordance with its intended design.

The student worksheet (LKPD) achieved an average score of 97.72%. These results indicate that the scented candle-making project is easy for teachers to guide and utilizes raw materials that are readily available in the local environment. The use of local materials exemplifies the principle of sustainability by encouraging the efficient and eco-friendly use of resources. Regarding the science module component, an average score of 99.24% was obtained; this figure demonstrates that the language used is easily understood by students and that the module functions effectively as a resource for material enrichment.

The high score in this aspect indicates that the module effectively supports independent learning while simultaneously fostering students' interest in reading. Its high level of practicality suggests that the sustainability-based science kit has significant potential for widespread implementation in science education. Beyond being user-friendly for teachers, the kit also facilitates the execution of project-based and inquiry-based learning aimed at developing 21st-century skills.

Implications of the Development Results

Based on the validation and practicality test results, it can be concluded that the sustainability-based science kit is of high quality, highly suitable for use, and highly practical to implement in instruction. Integrating the scented candle-making activity not only helps students understand science concepts in a contextual manner but also provides a learning experience that fosters the development of scientific inquiry skills and motivation for science learning. These findings align with research indicating that project-based and sustainability-

oriented learning can enhance student engagement, learning motivation, scientific thinking skills, and awareness of environmental issues. Therefore, the developed science kit has the potential to serve as an effective educational innovation to support the implementation of sustainability education in junior high schools.

5. CONCLUSION

Based on the research findings and discussion regarding the development of a sustainability-based science kit—centered on scented candle making activities designed to enhance scientific inquiry and motivation among junior high school students—it can be concluded that the developed kit is of excellent quality, as evidenced by validation from subject matter and media experts. The subject matter expert validation yielded an average score of 84.28% (categorized as "highly suitable"), indicating that the learning materials align with science learning outcomes and sustainability principles while effectively fostering scientific inquiry skills and motivation. Meanwhile, the media expert validation resulted in an average score of 81.99% (categorized as "highly suitable"), demonstrating that aspects such as design, layout, illustrations, readability, and visual communication meet the standards for high-quality instructional media.

The developed sustainability-based science kit was deemed suitable for use in science instruction following revisions based on validator feedback. This suitability is evidenced by the alignment of the content with science and sustainability concepts, the completeness of the kit's components, and the instructional materials' capacity to support project-based and inquiry-based learning. The product is also considered capable of linking scientific concepts to real-world issues related to sustainable development, thereby providing students with a more contextual learning experience. The sustainability-based science kit demonstrated a very high level of practicality, as indicated by practitioner (science teacher) evaluations yielding an average score of 98.39%, placing it in the "highly practical" category.

These results indicate that the instructional kit is user-friendly and easy to understand, features an easily implementable learning procedure, utilizes readily available materials, and supports practical classroom application tailored to real-world school conditions. Overall, the sustainability-focused science kit centered on scented candle making meets the criteria of validity, feasibility, and practicality for use in junior high school science instruction. The developed product holds potential as an effective educational innovation that supports the implementation of education for sustainability while enhancing students' scientific inquiry skills and motivation through active, contextual, and meaningful learning experiences.

REFERENCES

- Anisa Nurhasanah, Haldini Reygita, & Salsa Nabila Marcella Kalalo. (2024). The Influence of Modern Technology on the Morality and Responsibility of Primary School Pupils. *Student Scientific Creativity Journal*, 2 (1), 175–186. <https://doi.org/10.55606/sscj-amik.v2i1.2701>

- Astini, N. K. S. (2019). The Importance of Information and Communication Technology Literacy for Primary School Teachers in Preparing the Millennial Generation. *Proceedings of*, 113–121, 113–120.
- Indarta, Y., Ambiyar, & Samala, Agariadne Dwingo, Wathrianthos, R. (2022). The Metaverse: Challenges and Opportunities in Education. *Basicedu Journal*, 6(3), 3351–3363.
- Madyawati, L., Marhumah, M., & Rafiq, A. (2021). The Urgency of Religious Values in Children's Morality in the Society 5.0 Era. *Al-Hikmah: Journal of Religion and Science*, 18 (2), 132–143. [https://doi.org/10.25299/al-hikmah:jaip.2021.vol18\(2\).6781](https://doi.org/10.25299/al-hikmah:jaip.2021.vol18(2).6781)
- Marhamah. (2023). The Implementation of the Discussion Method in the Subject of Fiqh. *Journal of Educational Research and Learning*, 3(1), 9–14.
- Miskiah, M. (2019). A Character Education Model in Madrasah Ibtidaiyah. *Journal of Educational Development: Foundations and Applications*, 6 (1), 59–69. <https://doi.org/10.21831/jppfa.v6i1.20611>
- Muri'ah, S. (2018). Strategies for the Development of Education in Border Areas (A Case Study of the Sebatik and Nunukan Border Primary Madrasahs). *Fenomena*, 10 (2), 135–148. <https://doi.org/10.21093/fj.v10i2.1340>
- Noor-Ul-Amin, S. (2013). An Effective Use of ICT for Education and Learning by Drawing on Worldwide Knowledge, Research, and Experience: ICT as an Agent of *Department of Education, University of Kashmir*, 1 (1), 1–13. <https://doi.org/6th August 2016>
- Putri, F. A., & Wisudaningsih, E. T. (2025). Implementation of Fiqh Learning through the Diyanah Textbook: A Behaviourist, Constructivist, and Islamic Education Review of the Topic of Najis. *Kartika: Journal of Islamic Studies*, 5(3), 2316–2329.
- Rohman, M. I., & Darmaningrum, K. T. (2024). The Use of Digital Technology to Improve the Well-being of Coastal Communities. *Jurnal Selasar KPI: A Reference for Communication and Da'wah Media*, 4(1), 30–40.
- Solarz, M., & Swacha-Lech, M. (2021). Determinants of the adoption of innovative fintech services by millennials. *E a M: Ekonomie a Management*, 24 (3), 149–166. <https://doi.org/10.15240/TUL/001/2021-3-009>