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Development of a Science Flipbook within the Framework of NTT Local Wisdom to Enhance Junior High School Students' Conceptual Understanding

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Abstract: The widespread availability of instructional materials, particularly textbook packages, allows students to access learning resources either independently or through schools. However, many of the images and phenomena presented in these materials originate from contexts unfamiliar to students, requiring them to imagine situations they have never encountered. To address this issue, instructional materials were developed based on real-world problems drawn from local contexts, specifically salt production and gula lempeng (traditional palm sugar) production from palm sap, to provide meaningful and contextual learning experiences. This study employed a research and development approach using the ADDIE model. Data collection involved questionnaire techniques for validating the instructional materials through expert validation sheets, as well as test techniques to measure students' conceptual understanding after implementation. The validation results showed that the instructional materials achieved high feasibility scores in terms of material (0.90), language (0.85), presentation (0.83), and media (0.86), all of which fall within the very valid category. Furthermore, students' conceptual understanding test results exceeded 80%, indicating very good mastery of the concepts. These findings suggest that science instructional materials based on local wisdom and supported by a flipbook format are highly valid and effective in optimizing students' conceptual understanding of temperature, heat, and thermal expansion.

Keywords: ADDIE; Conceptual understanding; Local wisdom; Palm sugar slab production; Salt production; Science instructional materials

Introduction

Science education at the junior secondary school level plays a fundamental role in developing students' scientific thinking, problem-solving abilities, and character, which are essential for adapting to rapid technological and social changes. Within the framework of the Merdeka Curriculum, science learning is directed toward developing scientific, critical, and creative competencies through meaningful, experience-based activities that connect scientific concepts with real-life situations (Saputro et al., 2023). Meaningful science learning enables students to understand natural phenomena, apply scientific concepts to everyday contexts, and develop both critical and creative thinking skills.

One important factor that influences meaningful science learning is the quality of instructional materials. Instructional materials function not only as sources of information but also as learning guides that support students in constructing conceptual understanding through structured learning experiences (Fitridiyanti et al., 2025). Well-designed instructional materials can facilitate the presentation of abstract scientific concepts and help students achieve expected learning competencies (Tafonao, 2018; Wijayanti et al., 2021). Furthermore, the integration of appropriate learning media and

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technology-based instructional materials has been shown to enhance student engagement, motivation, and independent learning, while also supporting effective and efficient learning processes (Illahi, 2018; Nurhakim et al., 2024; Putra & Wiyasa, 2021).

Despite the availability of various instructional materials, many students still experience difficulties in understanding science concepts. This challenge is often caused by the use of complex language, unfamiliar problem contexts, and learning illustrations that depict phenomena outside students' lived experiences (Eveline et al., 2023; Satriawan & Rosmiati, 2016). In several textbooks, scientific concepts such as thermal expansion are frequently illustrated using examples from large urban settings, such as railway tracks, which are not familiar to students in regions like Nusa Tenggara Timur. As a result, students struggle to relate abstract concepts to real-world situations, limiting their ability to develop meaningful conceptual understanding (Armiati et al., 2025).

Previous studies have reported that real-world problem–based learning and the use of electronic instructional materials can enhance student engagement and learning outcomes (Febryanti & Satriyani, 2022; Nupus et al., 2021; Riasti et al., 2016). In addition, technology-based instructional materials such as flipbooks have been shown to create more interactive and motivating learning environments through the integration of multimedia elements (Damayanti et al., 2023; Prasasti & Anas, 2023; Puspitasari et al., 2020; Sibarani & Silalahi, 2024). However, limited research has focused on integrating local wisdom as authentic learning contexts within electronic instructional materials for junior secondary science learning. Therefore, this study aims to develop and validate electronic science instructional materials based on real-world problems derived from local wisdom—specifically salt production in Oebelo Village and palm sugar slab (gula lempeng) production in the coastal area of Lasiana—supported by a flipbook format. This development is considered urgent to provide contextual and culturally relevant learning resources that can optimize students' conceptual understanding of temperature, heat, and thermal expansion.

Method

The type of research conducted in this study is development research (Research and Development). The development model employed is the ADDIE model, which consists of five stages in producing the instructional materials. The first stage is the analysis stage, which involves conducting a needs analysis, as well as analyzing the learning content and objectives aligned with the Learning Outcomes for Science (IPA) in Phase D, Grade VII. The design stage aims to design or plan the instructional materials based on the results of the learning outcomes analysis. In this stage, the research instruments to be used for data collection are also developed. The next stage is the development stage, during which the instructional materials designed in the previous stage are produced using flipbook software.

The results of the development of this teaching material were subsequently evaluated by validators, including assessments by subject-matter experts and media experts. This process is an essential stage to determine the validity level of the designed teaching materials. After the teaching materials were developed and validated by the experts, they were then implemented with the research subjects. The subjects in this study were 15 seventh-grade students at St. Yoseph Noelbaki Catholic Junior High School. The students were given several test items related to the concepts of heat and temperature in everyday life, aligned with the teaching materials they used. During the evaluation stage, revisions to the teaching materials were made based on feedback from the validators. The development stages carried out are illustrated as follows.

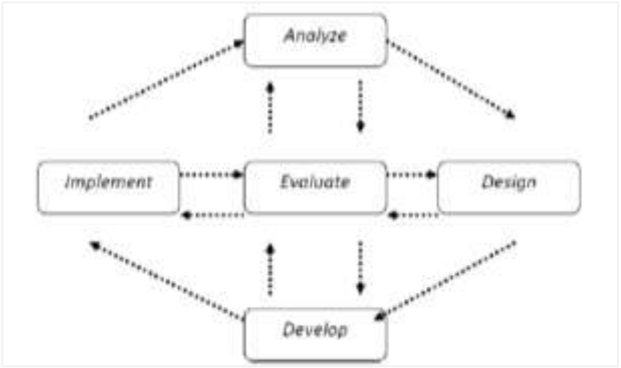

Figure 1. The ADDIE development design

The methods and data collection instruments used in this study included a teaching material validation sheet, tests, and a response questionnaire adapted from the National Education Standards Agency (BSNP). The validation sheet was used to determine the level of validity of the science teaching materials. The instrument blueprint for product assessment and the conceptual understanding test items is presented in Table 1.

Table 1. Assessment Grid for Instrument Evaluation by Validators

Assessment Aspect	Indicator
Material Feasibility	The material aligns with the Learning Outcomes.
	The material is conceptually accurate (temperature, heat, and thermal expansion)
	The material reflects current developments in scientific knowledge
	The depth of the material is aligned with students' cognitive abilities.
	The integration between science concepts and the local context.
	Contextual examples reinforce conceptual understanding.
	The presentation of the material is coherent and logical
	The presentation does not lead to misconceptions
Language Feasibility	The language is communicative and appropriate for students' developmental levels
	The sentences are clear, effective, and unambiguous
	The use of scientific terms is accurate and consistent
	The grammar is correct and appropriate
	The language does not allow for multiple interpretations
	The explanations are easy for junior high school students to understand
Presentation Feasibility	The presentation structure is systematic
	The integration between the text, images, and local context is well established.
	The presentation motivates students
	It facilitates the development of science process skills.
	The activity instructions are clear and easy to follow.
	The presentation encourages student engagement
Media Feasibility	The flipbook is easy to access and operate.
	The font usage is consistent and easy to read
	The layout is attractive and not confusing
	The quality of the images/illustrations is good and supports the material.
	The flipbook navigation is stable and responsive
	The colors and visual design are student-friendly
	The multimedia integration is relevant and functions well

The Aiken's V formula used to calculate the instrument's validity level is as follows (Nisrina et al., 2022). After the data are converted, they are analyzed to determine their level of validity based on the categories presented in the table below (Mawarni et al., 2022).

$$V = \frac{\sum s}{n(c-1)} \quad (1)$$

Table 2. Criteria for Validity Test Assessment

Validity score	Category
V < 0.4	Not valid
0.4 – 0.6	Less valid
0.6 – 0.8	Fairly valid
> 0.8	Highly valid

Table 3. Criteria for Validity Test Assessment

Percentage	Category
≥ 80%	Very Good Mastery
65–79%	Good Mastery
40–64%	Low Mastery
< 40%	Very Low / No Understanding

To determine students' conceptual understanding of the topics of temperature, heat, and thermal expansion, a learning evaluation was conducted using a conceptual understanding test in the form of multiple-choice questions. The table below presents the categories of students' conceptual understanding (Afifah et al., 2022). After the students completed the conceptual understanding test, their conceptual understanding scores were analyzed using the following equation (Afidah et al., 2023).

$$P = \frac{\text{students' total score}}{\text{maximum score}} \times 100\% \quad (2)$$

Result and Discussion

This study employed a development research design using the ADDIE model. The research process followed the stages of ADDIE, beginning with the analysis stage. In this stage, a needs analysis, material analysis, and learning objectives analysis were conducted. This process was carried out to ensure that the development of the teaching materials would align with students' needs and levels of understanding. A review was also conducted of the Science Learning Outcomes for Phase D, particularly on the topic of Temperature and Heat. Based on the analysis of these learning outcomes, several learning objectives were formulated, ensuring that the objectives aligned with the expected competencies.

The next stage is the design phase, during which the researcher developed the material framework based on the previously formulated learning objectives. In this phase, the researcher also collected photos and videos of the salt-making and sugar-slap production processes and arranged their placement within the designed teaching materials. The development stage involved creating the teaching materials using flipbook software based on the established design. The teaching materials included photos and videos depicting the processes of producing salt and sugar blocks, starting from the raw materials to the final products ready for distribution. The following figures present the cover and content of the teaching materials designed using the flipbook.

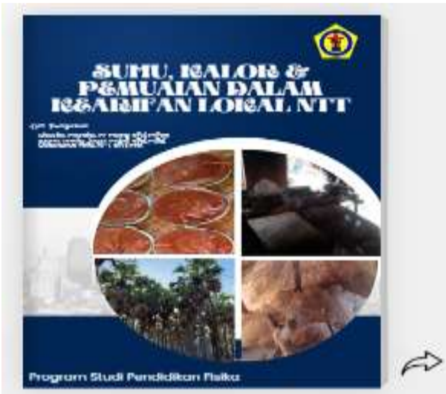

Figure 2. The cover page of the science teaching materials

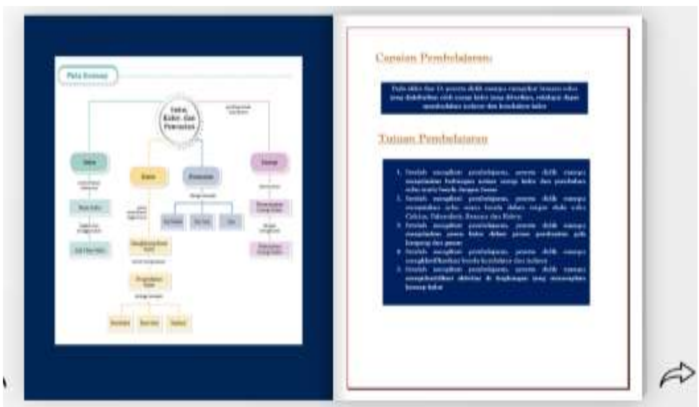

Figure 3. Concept map, learning outcomes, and learning objectives for the science topic of temperature, heat, and thermal expansion

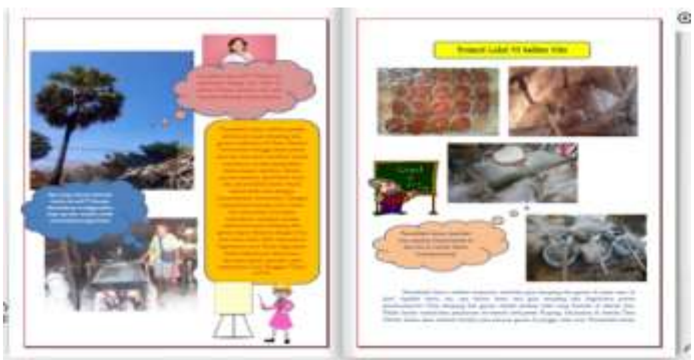

Figure 4. Photos and videos of the salt-making process and sugar-block production process

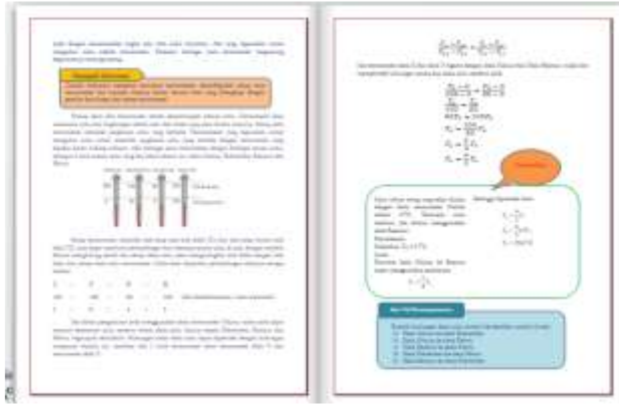

Figure 5. Materials, example problems, and practice exercises

After the instructional material product was completed, the next stage was validation. The validation sheet instrument consisted of four aspects: material feasibility, language feasibility, presentation, and media feasibility. These four aspects were further developed into several assessment indicators. The validation results of the instructional materials from the six validators are presented in the following table.

Table 4. Criteria for Validity Test Assessment

Assessment Aspect	V	Category
Material Feasibility	0.91	Very valid
Language Feasibility	0.85	Very valid
Presentation Feasibility	0.83	Very valid
Media Feasibility	0.86	Very valid

After the instructional materials were validated, the next stage was implementation. At this stage, the materials were used in the students' learning process. After the learning activities were completed, an evaluation was conducted to assess the students' conceptual understanding of the topics of temperature, heat, and thermal expansion within the context of local wisdom. The students' test results are presented in the Table 5.

Based on the concept-understanding test, all students fell into the 'excellent mastery' category. The instructional materials, which incorporated contextual phenomena from the students' environment, provided opportunities for students to utilize their surroundings as learning resources. Learning was therefore not limited to using the textbook as the sole source of information. In the context of science learning, learning resources should include the students' surrounding environment because it provides real phenomena that can be observed, analyzed, and directly linked to scientific concepts. This approach makes learning more contextual, engaging, and meaningful, as students learn from sources that are relevant to their everyday experiences (Nurafni et al., 2020).

Table 5. The Results of the Percentage Analysis of Students' Conceptual Understanding

Name	Percentage conceptual understanding	Category
AH	81	High level of mastery
AN	80	High level of mastery
BK	82	High level of mastery
CM	82	High level of mastery
CT	82	High level of mastery
HR	82	High level of mastery
IR	80	High level of mastery
ID	81	High level of mastery
JW	80	High level of mastery
JP	80	High level of mastery
KL	86	High level of mastery
KB	83	High level of mastery
LT	85	High level of mastery
MF	82	High level of mastery
YR	86	High level of mastery

Moreover, empirical studies also support that science learning based on local wisdom can significantly enhance students' creativity and learning outcomes. This approach demonstrates that diverse learning resources—including the environment and local culture—are more effective than relying solely on textbook-based sources (Pamungkas et al., 2017).

Instructional materials should be developed by linking them to the local wisdom present in the students' living environment. Learning that incorporates objects, events, and problems familiar to students will make the learning experience more meaningful (Vioreza et al., 2022). The use of flipbooks in the development of instructional materials helps students master conceptual content because the materials they read become more interactive and effective. By incorporating images and videos, flipbooks make the learning content more contextual for students. This has a direct impact on their conceptual understanding scores as measured through tests, in which all participating students achieved concept-understanding percentages greater than 80% and were categorized as having good conceptual mastery (Putra et al., 2023).

Thus, the use of the environment and local wisdom as learning resources in science education not only enriches learning academically but also supports the development of students' character, environmental awareness, and scientific skills in a comprehensive manner within their real-life context (Ayudia S, 2025).

Conclusion

The development of science instructional materials based on local wisdom—specifically the traditional processes of salt production and sugar-slap making—which have been validated by experts across four aspects (material feasibility, language feasibility, presentation feasibility, and media feasibility), is recommended for use in science learning, particularly for the topics of temperature, heat, and thermal expansion. By utilizing the environment as a learning resource, students are brought into real-life contexts where scientific concepts are applied in daily life, which in turn makes it easier for them to understand the material.

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Author Contributions

CM; Conceptualization, Methodology, Project Administration, Supervision, Writing – Review & Editing*:* Led the research design using the ADDIE model, coordinated project activities, supervised analysis and design stages, and revised the manuscript. MM; Data Curation, Formal Analysis, Investigation, Visualization, Writing – Original Draft: Collected and managed data from analysis, expert validation, and field testing; conducted quantitative and qualitative analyses; created tables and figures; and drafted the methodology and results sections. OK; Resources, Software, Validation, Writing – Review & Editing: Provided research materials and access to the study site; developed the instructional materials during the design and development stages; coordinated expert validation; and contributed to manuscript refinement.

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Conflicts of Interest

The authors declare no conflicts of interest.

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