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Steam-based natural and social sciences learning materials integrated with local culture for elementary schools

Erna Zumrotun[1], Sabar Narimo[2], Harun Joko Prayitno[3]
[1] Elementary School Teacher Education, Faculty of Tarbiyah and Teacher Training, Universitas Islam Nahdlatul Ulama Jepara, Jepara, Indonesia
[1,2,3] Doctoral Program in Education, Faculty of Teacher Training and Education, Universitas Muhammadiyah Surakarta, Surakarta, Indonesia

Corresponding author's e-mail: erna@unisnu.ac.id

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Abstract

Natural and Social Sciences learning in elementary schools requires instructional materials that integrate scientific and social concepts while remaining relevant to students' cultural environments. Existing materials frequently present local culture as supplementary information and provide limited guidance for interdisciplinary learning. This study aimed to develop the Pesona Jepara textbook, which integrates Jepara's local culture into Grade V Natural and Social Sciences learning through a Science, Technology, Engineering, Arts, and Mathematics approach. The study employed a research and development design involving the analysis, design, and development stages of the ADDIE framework. Product feasibility was evaluated by three experts in elementary education, elementary science education, and elementary social studies education using a four-point validation instrument covering nine aspects. Quantitative data were analysed descriptively, while expert comments guided product refinement. The textbook obtained an overall mean score of 3.78 out of 4.00, equivalent to 94.53%, and was categorised as very feasible. Conceptual accuracy, STEAM implementation, and the integration of natural and social sciences received the highest percentages of 97.25%. Design practicality received 88.25% but remained within the very feasible category. Classroom trials are required to establish the product's practicality and effectiveness.

INTRODUCTION

Background of the Study

Natural and Social Sciences, locally referred to as Ilmu Pengetahuan Alam dan Sosial (IPAS), is intended to help elementary students understand relationships among natural phenomena, human activities, social systems, and environmental conditions. Elementary students commonly experience those phenomena as connected events rather than as separate disciplinary categories. Explains that STEAM education can provide an interdisciplinary space in which scientific knowledge is connected with complex situations encountered in everyday life. Teaching materials should therefore organise scientific concepts, social practices, environmental issues, and human decisions within a coherent learning sequence.

Cultural relevance is essential when instructional materials are expected to connect school knowledge with students' lived environments. Local practices, artefacts, narratives, technologies, and community relationships offer concrete resources for scientific and social inquiry. Zumrotun et al. (2025) found that elementary school and madrasah ibtidaiyah teachers in Jepara required teaching materials that integrate local history, traditions, and folklore. Their findings also identified limited access to suitable culturally grounded resources. Local culture should consequently function as a source of knowledge and investigation rather than merely as an illustration or enrichment text.

The Science, Technology, Engineering, Arts, and Mathematics approach provides a relevant framework for integrated IPAS learning. STEAM activities can guide students to investigate problems, examine technological processes, design solutions, apply mathematical reasoning, and communicate ideas through creative forms. Coherence depends on explicit links among learning objectives, disciplinary contributions, activities, and assessment rather than on the simple appearance of five disciplinary labels (Li et al., 2022). A teaching material must therefore show how each disciplinary perspective contributes to understanding or solving the same contextual problem.

Arts integration requires particular attention because artistic components are sometimes reduced to colouring, ornamentation, or product beautification. Mejias et al. (2021) argue that the arts should contribute to meaning-making, interpretation, communication, and creative decision-making within STEAM. Elementary students should be invited to examine the aesthetic qualities, functions, production processes, cultural meanings, and social uses of artistic products. Such treatment positions the arts as a substantive knowledge domain rather than as a decorative addition to science and engineering activities.

Jepara provides cultural and environmental resources that are suitable for contextual IPAS learning. Wood carving, Troso weaving, coastal fisheries, local industries, historical heritage, and community traditions contain scientific, technological, social, artistic, and mathematical dimensions. These resources can support observation, classification, measurement, comparison, design, problem solving, and reflection. Culturally responsive science education becomes more meaningful when community knowledge and lived experience are recognised as legitimate foundations for academic understanding (Smith et al., 2022).

The Problem of the Study

Elementary IPAS learning still faces limitations in the availability of integrated and culturally relevant materials. National textbooks provide broad examples but cannot always represent the environmental, economic, historical, and cultural realities surrounding students. Auliya et al., (2025) emphasise that local potential can strengthen contextual IPAS learning when students construct concepts through phenomena found in their immediate environment. Teachers consequently need structured resources that translate curriculum content into learning experiences connected with local life.

Another problem concerns the instructional position of culture. Cultural elements are frequently presented as photographs, short readings, or enrichment boxes without being linked to observation, inquiry, measurement, engineering, or problem-solving tasks. Local-wisdom-based materials may successfully introduce cultural values, but their activities do not always connect natural science, social science, and interdisciplinary learning within the same sequence. Students may recognise a cultural object without examining its materials, processes, technologies, economic relationships, and environmental implications.

STEAM implementation also presents practical challenges. Spyropoulou et al. (2025) report that teachers generally acknowledge the educational value of STEAM but still require clear guidance, adequate resources, and manageable classroom procedures. Teaching materials should therefore specify objectives, contextual problems, required materials, stages of inquiry and design, reflection prompts, and assessment criteria. Without such guidance, STEAM may be implemented as a collection of disconnected activities rather than as integrated learning.

Differences in students' participation and readiness must also be considered. Elementary students may demonstrate different levels of confidence, communication, reasoning, creativity, and involvement during interdisciplinary activities. Flexible resources should provide visual, verbal, collaborative, manipulative, and reflective pathways for participation. STEAM activities informed by universal design principles can widen meaningful access when learning tasks offer multiple forms of engagement and expression (Thoma et al., 2023).

Research's State of the Art

Table 1. Previous Studies

Previous Study	**Main Result**	**Limitation Related to the Present Study**
Turahmat et al. (2025)	A local-wisdom-based writing e-module supported writing instruction and cultural awareness among elementary students.	The product addressed writing instruction and did not integrate IPAS concepts through a STEAM framework.

Previous Study	Main Result	Limitation Related to the Present Study
Ismirawati et al.,(2025)	Traditional games and community cultural practices were identified as potential resources for STEAM learning.	The study mapped cultural resources but did not develop a complete Grade V IPAS textbook.
Otemusu et al. (2025)	Local weaving supported creative production, collaboration, and contextual STEAM activity.	The investigation focused on one cultural activity rather than a textbook containing several Jepara cultural themes.
Kamila et al. (2024)	Students' science literacy and cultural awareness profiles supported the need for locally integrated STEAM-PBL materials.	The study concerned junior secondary science and a specific local product rather than elementary integrated IPAS.

Novelty, Research Gap, & Objective

Previous research confirms that cultural knowledge can increase the contextual relevance of elementary learning. Culturally responsive IPAS instruction can connect academic concepts with community practices and students' experiences (Sari & Kumalasani, 2025). Cultural content, nevertheless, is often positioned as supplementary information rather than as the organising basis for scientific observation, social interpretation, design, calculation, and reflection. This limitation reduces the role of culture in shaping the actual learning process.

Research on STEAM has similarly stressed interdisciplinary activity, authentic problem solving, creativity, and collaboration. White and Delaney (2021) found that integration frequently remains unclear when schools and instructional resources do not provide a systematic map of relationships among disciplines. A collection of activities cannot be considered integrated merely because it contains science, technology, arts, or mathematics elements. Each element must contribute to a shared learning purpose and be visible in the assessment design.

A research gap therefore exists in the availability of Grade V IPAS materials that simultaneously integrate natural and social science concepts, local culture, and coherent STEAM activities. Existing cultural materials may not explain the contribution of each STEAM discipline, whereas STEAM resources may rely on generic problems disconnected from students' immediate cultural environments. The gap concerns not only the presence of cultural content but also the instructional architecture used to transform that content into interdisciplinary inquiry.

The novelty of this study lies in positioning Jepara's local culture as the central object of scientific and social inquiry within a STEAM-based IPAS textbook. Cultural resources organise the content, contextual problems, investigations, engineering tasks, mathematical activities, artistic representations, and reflection exercises. Natural and social science concepts are connected within each cultural theme rather than being presented as independent subject sections. Accordingly, this study aimed to develop Grade V IPAS teaching materials that integrate Jepara's local culture through a STEAM approach and to determine their feasibility based on expert validation. Classroom practicality, student responses, and learning effectiveness were outside the scope of the present stage.

METHOD

Type and Design

This study employed a Research and Development design to produce the printed Pesona Jepara textbook for Grade V Natural and Social Sciences. The development process used the analysis, design, and development stages of ADDIE, followed by expert validation and product refinement. Implementation and effectiveness testing were not conducted because the study focused on early product quality assurance. ADDIE supports systematic alignment among identified needs, learning objectives, content, activities, assessment, and product evaluation when its stages are adapted transparently to the scope of a development project (Shakeel et al., 2023).

The analysis stage examined Grade V learning outcomes, characteristics of elementary learners, instructional needs, and the potential of Jepara's cultural resources. The design stage produced the textbook blueprint, content sequence, learning objectives, STEAM mapping, activity structure, assessment plan, and visual direction. The development stage transformed the blueprint into a complete textbook, reviewed the initial product, submitted it for expert validation, and used the resulting quantitative scores and qualitative comments to direct refinement.

Data and Data Sources

The data comprised quantitative validation scores and qualitative recommendations from three validators. The validators were selected purposively because their expertise represented elementary education, elementary science education, and elementary social studies education. This combination was necessary to evaluate curriculum alignment, conceptual accuracy, integration of natural and social sciences, cultural relevance, and instructional design. João et al. (2023) describe expert collaboration as an important component of educational design research because it enables instructional products to be examined and improved before wider implementation.

The object evaluated was the developed Pesona Jepara textbook. Validation data were limited to judgments about the product and did not include teacher-practicality data, student-response data, observation of classroom implementation, or pretest–posttest outcomes. This boundary was maintained throughout the analysis to prevent expert feasibility from being interpreted as evidence of classroom effectiveness.

Data Collection Technique

Data were collected using a structured expert-validation sheet containing indicators grouped into nine aspects: curriculum alignment, conceptual accuracy, clarity of presentation, integration of local culture, STEAM implementation, holistic learning approach, integration of natural and social sciences, quality of activities and evaluation, and design practicality. Each indicator was scored on a four-point scale: 4 = very appropriate, 3 = appropriate, 2 = less appropriate, and 1 = inappropriate. The instrument also provided space for comments and recommendations.

Each validator received the product and validation sheet and reviewed the textbook according to the same aspects. The scores were compiled after the independent review. Written comments were organised according to the textbook component to which they referred, including content, instructions, activities, assessment, cultural information, and visual presentation. The qualitative recommendations were used to identify revision priorities, while the numerical scores were used to report the product's level of feasibility.

Data Analysis

Quantitative data were analysed descriptively. The mean score for each aspect was obtained by dividing the total score by the number of ratings represented in that aspect. The percentage was calculated using the formula: feasibility percentage = (obtained mean score ÷ maximum mean score) × 100%. The maximum mean score was 4.00. For operational reporting, percentages of 81–100% were categorised as very feasible, 61–80% as feasible, 41–60% as moderately feasible, 21–40% as less feasible, and 0–20% as not feasible.

Qualitative comments were reviewed according to their relevance to specific product components. Comments were not converted into frequencies because the purpose of the qualitative data was to guide revision rather than to represent prevalence. The final interpretation combined the score pattern with the scope of the study. A high expert score was interpreted as evidence of conceptual and pedagogical feasibility only, not as evidence of practicality or effectiveness.

RESULTS

Analysis Stage

The analysis identified a need for materials that connect Grade V IPAS concepts with students' cultural and environmental experiences. Existing resources offered broad conceptual content, but further contextualisation was required to help students examine how scientific and social concepts operate in their immediate surroundings. The applicable Grade V learning outcomes were mapped against potential cultural themes to prevent local content from being added without a clear curricular function.

Jepara's cultural resources were then classified according to their instructional potential. Wood carving was connected with material properties, plant resources, production technology, geometric patterns, artistic composition, local employment, and environmental sustainability. Troso weaving supported the study of fibres, dyes, pattern repetition, measurement, production processes, household industry, and cultural identity. Coastal fisheries connected ecosystems, resource management, technology, economic exchange, measurement, and community livelihoods. The analysis established local culture as a unifying context for natural and social science concepts.

Design Stage

The design stage produced a blueprint containing a cultural orientation, learning objectives, initial questions, contextual reading, scientific and social investigation, a STEAM task, collaborative problem solving, reflection, formative assessment, and follow-up activity. Natural and social science concepts were mapped within the same thematic sequence rather than divided into unrelated subject blocks. Each theme was required to show how students moved from recognising a cultural phenomenon to investigating, interpreting, designing, calculating, communicating, and reflecting.

The STEAM mapping clarified the contribution of each discipline. Science supported observation and explanation of materials or natural phenomena. Technology addressed tools, information, and production processes. Engineering required planning, constructing, testing, or improving a solution. Arts involved aesthetic judgment, cultural expression, interpretation, and communication. Mathematics supported measurement, calculation, comparison, pattern recognition, and data representation. This map reduced the risk of treating STEAM as a list of unrelated components.

Development Stage

The blueprint was developed into the printed Pesona Jepara textbook using language adjusted to Grade V readers. The product contained explanatory texts, photographs, illustrations, process diagrams, maps, activity instructions, reflective prompts, and formative assessment. Learning activities required students to observe cultural objects, formulate questions, collect information, compare findings, design solutions, produce representations, and communicate conclusions. The preliminary product was reviewed for conceptual accuracy, sequence, language, cultural relevance, visual consistency, and STEAM coherence before expert validation.

Product Structure and Interdisciplinary Integration

Table 2. Examples of Cultural and STEAM Integration in the Pesona Jepara Textbook

Cultural Theme	Integrated IPAS Concepts	STEAM Contribution	Principal Learning Task
Jepara wood carving	Material properties, plant resources, local industry, environmental responsibility	Science of wood; production technology; design engineering; artistic motifs; geometric measurement	Examine wood and motif characteristics, then design a resource-conscious carving pattern.

Cultural Theme	Integrated IPAS Concepts	STEAM Contribution	Principal Learning Task
Troso weaving	Fibres, dyes, pattern repetition, household economy, cultural identity	Science of fibres and colour; weaving technology; pattern engineering; arts; mathematics	Compare fibres and construct a repeat-pattern design using measured units.
Coastal fisheries	Coastal ecosystems, fishing technology, distribution, livelihoods, resource management	Ecosystem science; fishing technology; solution design; data representation	Analyse a fisheries problem and propose a balanced solution for livelihood and sustainability.
Mantingan heritage	Materials, historical change, community meaning, visual symbols	Material observation; documentation technology; preservation design; artistic interpretation	Interpret heritage features and create an evidence-based preservation message.
Community traditions	Natural conditions, social participation, cultural values, organisation of community activities	Observation; communication technology; planning; artistic performance; time and quantity	Map the natural and social elements of a tradition and plan a responsible learning project.

Validation by Experts

Three validators assessed the textbook from the perspectives of elementary education, elementary science education, and elementary social studies education. The nine assessed aspects represented the alignment of the product with curriculum, disciplinary content, cultural integration, STEAM design, learning activities, evaluation, presentation, and practical design. Table 3 reports the recalculated percentages using the four-point maximum score stated in the method.

Table 3. Summary of Expert Validation Results for the Pesona Jepara Textbook

Assessed Aspect	Mean Score	Percentage	Category
Curriculum alignment	3.67	91.75%	Very feasible
Conceptual accuracy	3.89	97.25%	Very feasible
Clarity of presentation	3.83	95.75%	Very feasible
Integration of local culture	3.83	95.75%	Very feasible
STEAM implementation	3.89	97.25%	Very feasible

Assessed Aspect	Mean Score	Percentage	Category
Holistic learning approach	3.83	95.75%	Very feasible
Integration of natural and social sciences	3.89	97.25%	Very feasible
Quality of activities and evaluation	3.67	91.75%	Very feasible
Design practicality	3.53	88.25%	Very feasible
Overall result	**3.78**	**94.53%**	**Very feasible**

The overall mean score was 3.78 out of 4.00, equivalent to 94.53%, and all nine aspects fell within the very feasible category. Conceptual accuracy, STEAM implementation, and the integration of natural and social sciences received the highest percentages, each reaching 97.25%. These results show that the validators considered the content and interdisciplinary structure internally coherent. Integration of local culture, clarity of presentation, and holistic learning each obtained 95.75%, indicating strong alignment among cultural content, presentation, and the intended learning experience.

Curriculum alignment and the quality of activities and evaluation each obtained 91.75%. Design practicality received the lowest percentage, 88.25%, although it remained within the very feasible range. The comparative score pattern identifies design practicality as the principal area requiring attention before classroom trials, particularly the manageability of instructions, page density, activity duration, resource availability, and visual hierarchy. The results establish expert-assessed feasibility but do not establish teacher practicality, student acceptance, or learning effectiveness.

DISCUSSIONS

The high score for conceptual accuracy indicates that the textbook connects natural and social science concepts within shared cultural themes rather than placing separate disciplinary explanations beside one another. Chappell et al. (2025) describe effective STEAM pedagogy as engagement with authentic problems through disciplinary interaction, creative inquiry, and meaningful response. Pesona Jepara reflects this orientation by using cultural phenomena as the starting point for observation, scientific explanation, social interpretation, design, calculation, and reflection. The validation result therefore represents internal conceptual coherence, not proof of improved student achievement.

The score for local-culture integration demonstrates that Jepara's cultural resources were treated as substantive instructional content. Carving, weaving, fisheries, heritage, and community traditions became objects of scientific and social investigation rather than decorative references. Students are expected to analyse materials, processes, patterns, cultural meanings, community roles, economic relationships, and environmental consequences. Elementary students value integrated STEAM experiences when activities connect with recognisable situations and allow active participation (Cook et al., 2025). Familiar cultural themes can therefore offer accessible entry points without reducing the academic demands of IPAS.

The STEAM implementation score also reflects the explicit contribution assigned to each discipline. Activities move from observing and gathering information to designing, producing, communicating, and evaluating. Liao et al. (2022) show that primary students display different interaction, leadership, and higher-order thinking patterns during STEAM projects. The textbook's staged sequence and varied forms of participation are consequently important because a single open-ended task may not support all learners equally. Classroom trials should examine whether the proposed scaffolds allow different learner profiles to participate meaningfully.

The arts component was positioned as interpretation, cultural expression, communication, and design rather than as an additional colouring task. Students examine the aesthetic qualities and cultural meanings of Jepara products alongside their materials, functions, production methods, and social uses. Meaningful arts integration should support creative thinking, aesthetic judgment, and knowledge construction throughout the learning process (Sanz-Camarero et al., 2023). This position strengthens the interdisciplinary character of the product because artistic knowledge contributes to inquiry and decision-making rather than merely to final presentation.

Design practicality obtained the lowest score, although it remained very feasible. Page density, clarity of instructions, expected activity duration, material availability, and assessment manageability therefore deserve particular attention before implementation. Rimbach-Jones et al. (2025) emphasise that primary teachers need program structures and practical support to build capacity for integrated STEM instruction. The textbook should help teachers anticipate preparation, grouping, time allocation, safety, and evaluation so that interdisciplinary intentions can be translated into realistic classroom procedures.

The validation results should also be interpreted in relation to the developmental scope. Expert review can establish whether content and instructional structure are appropriate, but it cannot show whether students understand the language, complete the tasks, or improve their achievement. Carefully scaffolded STEAM instruction has been associated with stronger conceptual understanding of science topics (Özkan & Umdu Topsakal, 2021). Comparable claims about Pesona Jepara require empirical classroom evidence, including readability, implementation fidelity, and pretest–posttest measurement.

Authentic context may increase engagement, but engagement cannot be assumed from the presence of local culture alone. Piila et al. (2021) demonstrate that STEAM projects can generate diverse ideas and interest when students are given meaningful space to investigate and communicate. Small-group testing should therefore examine how students interpret cultural representations, whether activities stimulate productive questions, and whether group participation is distributed fairly. Such evidence will show whether the textbook's intended learning experience is realised rather than merely represented in its design.

The product contributes an early-stage instructional framework that connects local culture with interdisciplinary IPAS. Recent evidence indicates that connected STEAM learning can support digital-age competencies when tasks are coherent, collaborative, and linked with meaningful problems (Mansour et al., 2026) The next stage should test teacher practicality, student readability, classroom resource requirements, cultural accuracy, and learning outcomes. A staged evaluation is essential so that feasibility, practicality, and effectiveness remain analytically distinct.

CONCLUSION

The development of the Pesona Jepara textbook produced Grade V Natural and Social Sciences teaching materials that integrate Jepara's local culture with STEAM-oriented activities. Expert validation yielded an overall mean score of 3.78 out of 4.00, equivalent to 94.53%, placing the product in the very feasible category. Conceptual accuracy, STEAM implementation, and the integration of natural and social sciences obtained the highest percentages of 97.25%. Design practicality obtained the lowest percentage of 88.25%, although it remained very feasible.

The principal contribution of the product lies in positioning local culture as the organising object of interdisciplinary inquiry rather than as supplementary illustration. Cultural phenomena structure scientific explanation, social interpretation, technological analysis, engineering design, artistic expression, and mathematical reasoning. The result supports the textbook's conceptual and pedagogical feasibility at the expert-validation stage.

The study was limited to analysis, design, development, and expert validation. The findings do not establish classroom practicality, student responses, implementation fidelity, or learning effectiveness. Subsequent research should conduct readability and small-group testing, teacher-practicality assessment, classroom observation, and an appropriate experimental or quasi-experimental evaluation. The raw validation worksheet should also be retained as an audit trail for the reported mean scores and percentages.

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