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Development and Expert Validation of an Ethnochemistry-Based Chemistry Magazine on Ionic and Covalent Bonding

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A B S T R A C T

Contextual chemistry resources can connect familiar cultural practices with representations of chemical bonding, but product appraisal alone cannot demonstrate learning benefits. This design-and-development study produced a Grade 10 chemistry magazine linking ionic and covalent bonding with Samarinda woven-sarong practices and obtained preliminary expert appraisals. The study implemented the define, design, and develop stages of an adapted 4-D model. The needs assessment drew on responses from 200 students and input from teachers; two subject-matter specialists, two media specialists, and two chemistry teachers appraised the prototype. The magazine contains concept maps, illustrated explanations, culturally contextualized prompts, questions, reflection activities, and optional QR-linked videos. The documented prototype and dimension-level appraisals provide a preliminary basis for refinement, although the reported aggregate needs and validation percentages still require reconciliation with original scoring records. The contribution is a context-specific instructional-design proposition, not evidence of improved chemical literacy or effective digital learning. Further research should verify the scientific representations and reported scores and examine student usability, use of linked resources, and learning outcomes.

Abstrak

Bahan ajar kimia kontekstual dapat menghubungkan praktik budaya yang dikenal siswa dengan representasi ikatan kimia, tetapi penilaian produk belum membuktikan manfaat pembelajaran. Penelitian pengembangan ini menyusun majalah kimia kelas X yang mengaitkan ikatan ion dan kovalen dengan praktik Sarung Tenun Samarinda serta memperoleh penilaian awal ahli. Model 4-D diadaptasi melalui tahap define, design, dan develop. Analisis kebutuhan melibatkan 200 siswa dan masukan guru, sedangkan prototipe dinilai oleh dua ahli materi, dua ahli media, dan dua guru kimia. Majalah memuat peta konsep, penjelasan berilustrasi, contoh budaya, pertanyaan, kegiatan refleksi, dan video tambahan berkode QR. Produk dan penilaian per aspek telah didokumentasikan, tetapi angka ringkasan kebutuhan serta validasi masih memerlukan pencocokan dengan lembar skor asli. Kontribusi penelitian berupa rancangan pembelajaran kontekstual yang belum diuji efektivitasnya terhadap literasi kimia maupun penggunaan sumber digital. Penelitian lanjutan perlu memverifikasi ketepatan konsep, perhitungan skor, kepraktisan bagi siswa, pemanfaatan video, dan hasil belajar.

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1. Introduction

Chemical literacy entails applying chemical concepts to phenomena and explanations. Indonesia's mean science score in PISA 2022 was 383, compared with the OECD mean of 485 [1]; this national indicator provides context but does not measure the students in this study. Ionic and covalent bonding are challenging because learners must coordinate observable properties, submicroscopic particle models, and symbolic expressions [2]–[4]. Reviews of difficulties in learning chemistry also identify challenges in connecting these representations [5]. Consequently, supplementary materials

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should be evaluated for the clarity and scientific accuracy of their explanations, whereas claims of improved learning require direct evidence from learners. A synthesis of 48 studies of chemical-bonding instruction [6] distinguishes descriptions of alternative conceptions from evidence of reasoning with models. Research examining representational transitions [7] further supports explicit guidance when learners move among observable, particle-level, and symbolic descriptions. Research on Lewis structures also shows that visual features can influence students' reasoning in unintended ways [8].

Related development studies offer better comparisons than subject-area lists. A chemistry magazine focused on FTIR spectra underwent expert validation and collected responses from 58 university students [9]; a chemical-elements magazine was examined with teachers and 100 upper-secondary students [10]. An electronic biology magazine used a digital delivery format and underwent content-validity assessment [11], whereas a chemistry e-book integrated explanatory material, videos, and exercises [12]. Other contextual and ethnoscience resources address different educational levels and cultural practices [13]–[19]. Compared with these products, the present magazine focuses on Grade 10 chemical bonding and Samarinda textile practices, but it does not report student responses after development, use of linked videos, or learning outcomes. These comparisons show differences in context, media, and evaluation, not a demonstrated advantage. Research on connected representations further indicates that explanatory images must link observable, particle, and symbolic meanings without encouraging alternative conceptions [20], [21]. A more direct comparison is a contextual digital chemistry magazine that reported expert checks and student-response testing [22], whereas a digital branching module on chemical bonding reported pre- and post-assessment evidence from university learners [23]. Other culturally situated digital media include a validated ethnoscience-based PBL e-module [24], a biotechnology e-module [25], an ethno-vlog-linked worksheet [26], and accessibility-oriented multimodal chemistry media [27]. These resources differ in level, technology, and direct student evaluation. None establishes this magazine's effectiveness.

The design problem extends beyond a magazine about Sarung Tenun Samarinda. It concerns how a familiar textile practice can provide a scientifically defensible starting point for interpreting ionic and covalent bonding rather than merely serving as decoration. In the prototype, short explanations, diagrams, contextual questions, reflective tasks, and optional QR-linked videos are organized to support this instructional aim. Cultural examples function as prompts for inquiry, not as experimental evidence about the chemical composition of particular dyes or fibers; no material assay was conducted. This study therefore examines two focused questions: (1) how reported needs were translated into the magazine's instructional features and (2) how content, media, and teacher-practitioner assessors evaluated those features. The study contributes a documented case of locally contextualized design and preliminary appraisal. It also proposes links among cultural prompts, chemical representations, and learner tasks for subsequent evaluation. Ethnochemistry research documents locally grounded practices in secondary chemistry education in Zambia [28] and Kerinci contexts [29], while Indonesian work on culturally contextualized chemical-bonding materials [30], Sasak laboratory learning [31], and local-wisdom-based ethnochemistry [32] indicates different ways of generating and evaluating contextual claims. These findings cannot be transferred to the untested Samarinda prototype. The challenge, therefore, is not to claim novelty solely from a different location but to specify a model-based task design with scientifically defensible chemical explanations.

The proposed mechanism is an instructional sequence, not an observed learning process. A cultural or textile-related observation first prompts a question; a scientifically defensible chemical model then provides a particulate or symbolic explanation; and a contextual question or reflection asks learners to justify the connection. Stowe and Esselman caution that representations should serve explanation rather than become decorative pictures [33], while Talanquer emphasizes that chemical models are complementary simplifications rather than literal copies of matter [34]. Together, these

perspectives inform the magazine's design, although neither the quality of the material-specific analogies nor students' use of the proposed sequence was independently assessed.

2. Method

This design-and-development study applied only the define, design, and develop stages of an adapted 4-D model [35]. The define stage identified perceived needs through student questionnaires and teacher accounts; the design stage translated these needs into selections of bonding concepts, text–visual sequences, contextual activities, and optional QR-linked resources; and the develop stage produced the magazine and obtained appraisals from content, media, and teacher-practitioner assessors. These stages describe the activities reported in the research record, not the full four-stage process. The evaluation focused on the magazine's content and media attributes. The study did not assess classroom implementation, student learning outcomes, or access to and use of the linked videos. Conclusions about these aspects lie beyond its design. The original four-phase sourcebook specifies all four stages [36]; this study reports only the first three. Citing the 4-D approach does not imply that the omitted phase was performed.

2.1. Research Context and Setting

The study took place at SMA Negeri 2 Samarinda, East Kalimantan, Indonesia, in the context of Grade 10 chemistry instruction. The magazine addressed ionic and covalent bonding through selected descriptions and visual examples associated with Sarung Tenun Samarinda. The magazine was designed for supplementary use with the existing curriculum; the study reports no separate classroom intervention or assessment of learning gains.

2.2. Participant

At SMA Negeri 2 Samarinda, East Kalimantan, 200 Grade 10 students responded to the needs questionnaire, and teachers provided input on bonding instruction. The prototype was appraised by two subject-matter specialists, two media specialists, and two chemistry teachers serving as practitioners. The record omits student recruitment and inclusion criteria, assessor qualifications, the number of interviewed teachers, and any overlap with practitioner assessors. These omissions make it difficult to assess selection bias and the independence of stakeholder input; the results should therefore be interpreted only for the documented setting. The authors must confirm the relevant institutional permissions, participant consent or assent, and privacy safeguards from original records before resubmission.

2.3. Research Instruments

The reported instruments included a five-point student needs questionnaire, semi-structured teacher interviews, and five-point appraisal forms completed by subject-matter, media, and teacher-practitioner assessors. Reported appraisal domains included scientific content, cultural integration, presentation, language, visual design, and perceived ease of use. Research on the validation of culturally grounded learning media illustrates the importance of specifying design and content criteria [37]. Questionnaire responses were summarized quantitatively; teacher accounts were summarized descriptively and were not treated as student achievement data. The questionnaire, item-domain mapping, interview guide, original scores, assessor ratings, and prior instrument checks were not provided. These records are needed to reconstruct the study and verify its overall ratings. Studies of digital ethnoscience products provide a useful methodological contrast: some include separate student-response or performance instruments after expert checks [22], [24], [26]. Because this study did not administer such instruments, the outcomes reported elsewhere cannot be attributed to this magazine.

2.4. Data Collection Procedures

The three completed phases had distinct purposes and outputs. In define, student responses and teacher accounts suggested a need for clearer representations and culturally recognizable examples. In design, the reported needs informed the planned page sequence, illustrations, contextual prompts, and practice and reflection activities. In develop, the assembled prototype was presented to subject-matter, media, and teacher-practitioner assessors and revised in response to documented feedback. The record lacks a complete version history, all assessor recommendations, and comparable second-round documentation across groups. Accordingly, this description reports documented development activities without reconstructing unrecorded iterations.

2.4.1. Define

The define stage drew on the student questionnaire, teacher discussions, observational information, and relevant chemistry-education literature. The reported needs concerned clearer explanations of chemical bonding, visual support, and opportunities to discuss concepts through local examples. These were resource perceptions, not chemical-literacy or misconception test scores. In particular, teachers' concerns about students' proficiency were professional observations, not findings independently measured in this sample.

2.4.2. Design

During design, the researchers storyboarded magazine content on ionic and covalent bonding, including illustrations, concept mapping, contextual questions, reflection, and a glossary. Sarung Tenun Samarinda was used to motivate discussions about textile practices, while particle-level and symbolic examples were intended to remain grounded in scientifically supported chemical concepts. Optional QR-linked videos were added as supplementary resources; they did not constitute an interactive or adaptive learning system. The output was a draft instructional resource for expert review; no classroom intervention was tested.

2.4.3. Develop

During develop, the prototype incorporated the planned explanations, concept map, contextual questions, practice activities, reflection tasks, glossary, and optional links to external videos. Two content specialists, two media specialists, and two teacher-practitioners assessed specified product attributes. Table 6 reports two assessment stages for content specialists, whereas Tables 7 and 8 display only one stage for media and practitioner assessments. Claims of improvement are limited to comparisons explicitly reported; without the original item ratings and documented revision log, changes across all assessor groups cannot be quantified reliably. No subsequent student usability or learning-outcome trial was performed.

2.5. Product Evaluation and Data Analysis

Questionnaire and appraisal ratings were expressed as percentages of maximum scores; teacher interviews were summarized descriptively. The study also reported a percentage-of-agreement (PA) formula for paired assessor ratings. These measures capture needs, expert judgments, and agreement; they do not establish learning gains or the chemistry of untested textile materials. Reproducing these percentages requires the original item counts, score totals, denominators, and any unequal domain weights. The equal-weight means of displayed category percentages presented below are diagnostic checks, not substitutes for aggregates calculated from original scores. Table 4 repeats the appraisal thresholds from Table 3 for reference; it is not an additional instrument.

2.5.1. Needs Analysis

Table 1 presents the five-point response options, while Table 2 shows the reported thresholds for interpreting percentages. The needs questionnaire assessed preferences for learning resources, not

demonstrated chemical literacy. The overall index can be interpreted reliably only if its calculation accounts for the number of questions, the number of responses, possible missing values, and the maximum achievable score; these elements must be checked against the original questionnaire records.

Table 1. Likert Scale Score

Score	Category
5	Strongly agree
4	Agree
3	Neutral
2	Disagree
1	Strongly disagree

The percentage of questionnaire scores was calculated using the following formula:

$$P = \frac{n}{N} \times 100\%$$

Table 2. Percentage Descriptive Analysis

Percentage (%)	Criteria
$84 \leq P \leq 100$	Strongly agree
$68 \leq P < 84$	Agree
$52 \leq P < 68$	Somewhat disagree
$36 \leq P < 52$	Disagree
$20 \leq P < 36$	Strongly disagree

2.5.2. Validity Testing

Content, media, and practitioner assessors used five-point forms to rate the prototype. The percentages were interpreted according to the criteria in Table 3. Favorable appraisal ratings indicate endorsement of particular product features; it does not by itself demonstrate usability among students, the accuracy of every depicted textile-related substance, or improved understanding of bonding. Verifying group percentages requires criterion counts, assessor-level scores, aggregate denominators, and original records.

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

Definitions:

P = Percentage Score

Σx = Score Obtained

Σxi = Total Ideal Score

Table 3. Validity Percentage Criteria

Percentage (%)	Criteria
$84 \leq P \leq 100$	Very Valid
$68 \leq P < 84$	Valid
$52 \leq P < 68$	Moderately Valid
$36 \leq P < 52$	Less Valid
$20 \leq P < 36$	Invalid

A percentage-of-agreement (PA) statistic was reported for paired assessor ratings, using a 75% decision threshold attributed to the cited observation manual [38]. Paired item ratings, the aggregation unit, and verification of the cited threshold are absent, so reported PA values cannot be reproduced. Agreement between assessors does not, by itself, establish instrument reliability, content accuracy, or

effectiveness. The formula below is retained as reported, pending verification against the source data. Table 4 instead makes the manuscript's proposed feature-to-concept mapping explicit; the mapping is a design rationale, not a tested result.

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

Explanation:

A: The highest score given by the evaluator

B: The lowest score given by the evaluator

Table 4. Product-Appraisal Thresholds Repeated from Table 3 for Reference

Percentage (%)	Criteria
$84 \leq P \leq 100$	Very Valid
$68 \leq P < 84$	Valid
$52 \leq P < 68$	Moderately Valid
$36 \leq P < 52$	Less Valid
$20 \leq P < 36$	Invalid

3. Result and Discussion

3.1. Result

3.1.1. Need Analysis

The needs questionnaire collected responses from 200 Grade 10 students. The source report states an overall index of 79.71%, whereas the arithmetic mean of the ten percentages displayed in Figure 1 is 81.96%. Unequal item counts, denominators, or weights might explain this difference, but none is documented in the material provided. The index remains unverified and cannot be corrected by assumption. The ten numbered bars also lack the corresponding item wording, preventing a source-level interpretation of individual needs. These data reflect stated preferences, not a tested deficit in chemical literacy or a measured effect of the product.

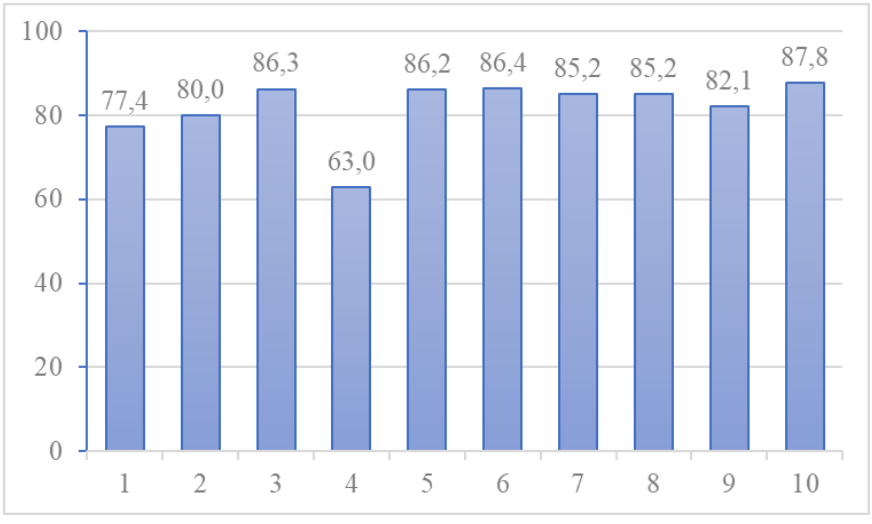


Figure 1. Item-level responses from the student needs questionnaire (n = 200)

The plotted responses indicate reported interest in explanatory visuals and familiar contexts, but the original question wording and individual scoring records are unavailable. Table 5 summarizes teacher perceptions rather than direct measures of students' knowledge. Item-level reconstruction or estimates of misconception prevalence require the original questionnaire. This limitation does not prevent description of the prototype, but it constrains quantitative claims about the need for it.

Table 4. Chemistry Teacher Interview Data

No	Aspect	Result
1.	Learning Objectives	a. Teachers create learning objectives based on the Learning Outcomes (CP) and the Learning Objective Flow (ATP) in the Merdeka Curriculum. b. Learning objectives are adjusted to the material and students' characteristics to support achievement of the intended objectives.
2.	Learning Strategies	a. Teachers use a variety of teaching strategies to help students understand abstract concepts, such as educational videos, PhET Interactive Simulations, PowerPoint presentations, educational games, group discussions, and lab experiments. b. Visual aids are used to help students understand the processes of ionic and covalent bond formation more concretely.
3.	Students' Chemistry Literacy	Students' chemical literacy skills in connecting theory to everyday life are still relatively low. Students need contextual examples to understand how chemical concepts relate to real-world phenomena in their surroundings.
4.	Learning Challenges	The main challenges faced by teachers are the abstract nature of the material, students' low interest in learning, and the difficulty of keeping students focused, especially during afternoon classes. Unsupportive classroom conditions, such as hot classrooms, also affect the effectiveness of learning.
5.	Effectiveness of Learning Resources	Printed textbooks are considered insufficiently effective in boosting students' motivation to learn and engage in independent exploration. Teachers encourage students to utilize various learning resources such as the internet, AI, journals, and e-books
6.	Use of Learning Media	Teachers have never used chemistry magazines as a teaching resource. The teaching resources used to date have consisted mainly of textbooks, PowerPoint presentations, videos, and worksheets.
7.	Integration of Local Wisdom	Local wisdom has not yet been consistently integrated into chemistry instruction. Teachers occasionally relate the material to local issues, but this has not yet been incorporated into the teaching materials in a structured way.
8.	Potential of Ethnochemistry in Learning	Samarinda woven sarongs are considered to have great potential for use as a context for chemistry instruction. The use of local wisdom as a context is expected to stimulate curiosity and make learning more contextual.
9.	Responses to the Development of Chemistry Magazine Learning Materials	Teachers expressed positive views about developing an ethnochemistry-based chemistry magazine. Teachers considered the medium innovative and creative, with the potential to increase students' interest in learning and their conceptual understanding.
10	Development of Chemistry Magazine Learning Materials	The chemistry magazine should use simple language, include key points, engaging illustrations, QR codes, and contextual information about the Samarinda Woven Sarong. Teachers hope that the developed material will improve students' chemical literacy, motivation, and understanding of abstract concepts.

Together, these findings support structured explanations and questions in a familiar local context. They do not establish participants' baseline chemical literacy, the prevalence of the reported problems across other schools, or any advantage of the completed magazine over existing textbooks and digital resources. These questions require separate evaluation beyond the reported development stage.

3.1.2. Design of the Chemistry Magazine

The completed prototype is intended to supplement Grade 10 instruction on ionic and covalent bonding. It contains learning objectives, a concept map, illustrated explanations, examples drawn from Samarinda textile practices, contextual questions, a game, self-reflection activities, practice tasks, and a glossary (Figures 2-7). The design rationale links a familiar textile context to a scientifically verifiable question, an appropriate particle-level or symbolic model, and a prompt for explanation or reflection. This is an interpretive mapping, not a tested pedagogical mechanism. The optional QR-linked videos provide access to external resources but do not offer adaptive support or monitored digital engagement.

The cultural example is used as an entry point rather than as proof of a particular ionic or covalent composition in sarong dyes, yarns, or finishing agents. Without samples of those substances or independent chemical analysis, instructional descriptions should not attribute unverified chemical identities to those materials. Modeling research emphasizes that any diagram is a selective representation of a chemical phenomenon [34], and superficial graphical cues may divert students' reasoning [8]. Before classroom use, the magazine needs checks for scientific accuracy, task wording, and alignment of observations, models, and bonding symbols.



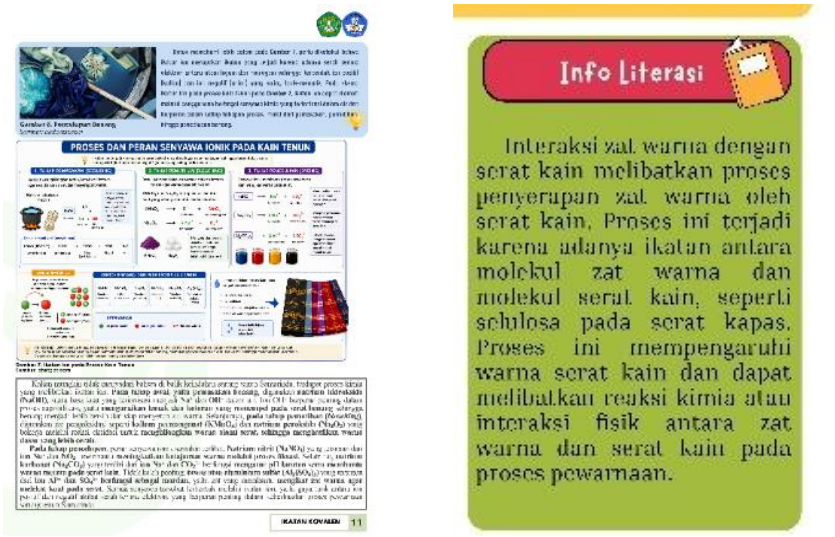
(a) (b)

Figure 2. (a) Chemistry magazine cover; (b) learning outcomes and objectives



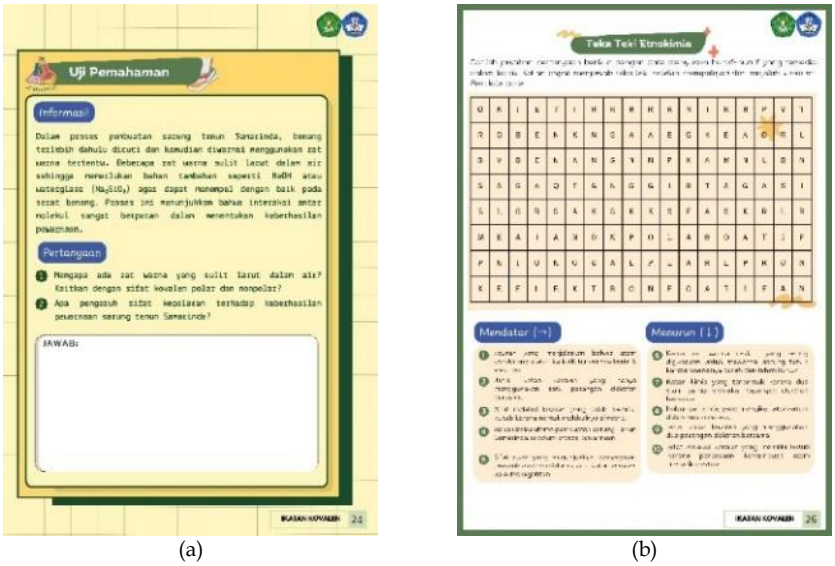
(a) (b)

Figure 3. (a) Chemical-bonding concept map; (b) subchapter cover



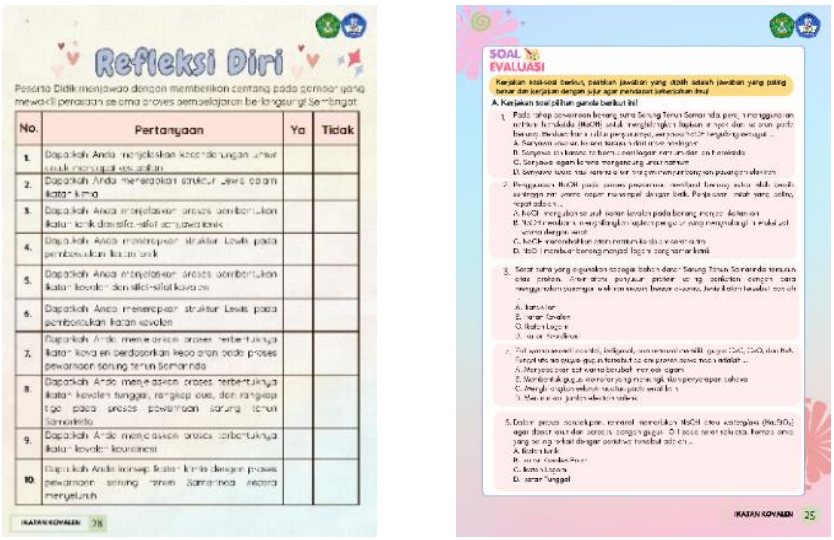
(a) (b)

Figure 4. (a) Learning-material presentation; (b) chemical-literacy information



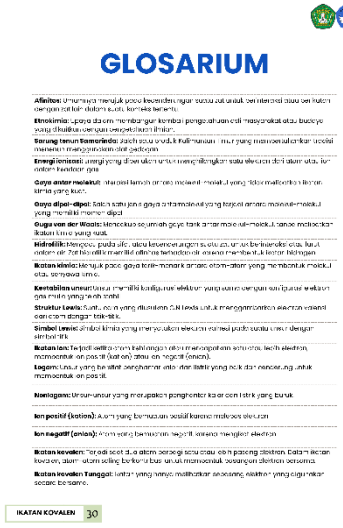
(a) (b)

Figure 5. (a) Chemical-literacy questions; (b) educational game



(a) (b)

Figure 6. (a) Self-reflection; (b) practice questions



(a)

Figure 7. Glossary

Figures 2–7 show that the planned instructional components are present, including the representational and reflective elements. They establish that the prototype exists, but not that students accessed links, interpreted illustrations as intended, or improved achievement. Further evaluation is needed to examine the scientific representations, accessibility, and learning processes.

3.1.3. Product Evaluation Result

Table 6. Subject-Matter Expert Ratings and Reported Agreement (Stages 1 and 2)

Aspect	Stage 1				Stage 2			
	Average (%)	Criteria	R (%)	Criteria	Average (%)	Criteria	R (%)	Criteria
Material Appropriateness	44,29	Less Valid	40	Not Reliable	94,29	Very Valid	89	Reliable
Ethnochemistry Integration	33,33	Invalid	50	Not Reliable	93,33	Very Valid	89	Reliable
Learning Support Materials	40,00	Less Valid	100	Reliable	100	Very Valid	100	Reliable
Presentation Techniques	36,67	Less Valid	40	Not Reliable	96,67	Very Valid	89	Reliable

Aspect	Stage 1				Stage 2			
	Average (%)	Criteria	R (%)	Criteria	Average (%)	Criteria	R (%)	Criteria
Practice Questions	53,33	Moderately Valid	67	Not Reliable	93,33	Very Valid	89	Reliable
Chemical Literacy	50,00	Less Valid	80	Reliable	93,33	Very Valid	89	Reliable
Rules	66,67	Moderately Valid	86	Reliable	100	Very Valid	100	Reliable
Language				71,09				Valid

Note to Table 6. The Language value of 71.09% is reproduced from the original report. Its assessment round, numerator, denominator, and relationship to the other subscales must be checked against the original forms. The other agreement values could not be recalculated without paired assessor scores.

Table 7. Media-Expert Ratings and Reported Agreement

Aspect	Stage 1			
	Average (%)	Criteria	R (%)	Criteria
Design	90,00	Very Valid	89	Reliable
Illustration	96,67	Very Valid	89	Reliable
Typography	83,33	Valid	89	Reliable
Layout	95,00	Very Valid	89	Reliable
Language Rules	76,67	Valid	89	Reliable
Interactive	85,00	Very Valid	100	Reliable
Media Usability	100	Very Valid	89	Reliable
Reported overall score	88,75			Very Valid

Table 8. Practitioner Ratings and Reported Agreement

Aspect	Stage 1			
	Average (%)	Criteria	R (%)	Criteria
Content Relevance and Suitability	85	Very Valid	89	Reliable
Context Appropriateness	98	Very Valid	89	Reliable
Ease of Use	98	Very Valid	89	Reliable
Perceived learning potential	90	Very Valid	89	Reliable
Reported overall score	96,08			Very Valid

3.2. Discussion

3.2.1. Define

The define phase identified students' preferences for clearer chemistry explanations and local examples, as also reflected in teacher accounts. These inputs justify a preliminary design response but do not establish a measured deficit in chemical literacy. This distinction matters when interpreting the purpose of the product: a preference survey can guide resource selection, whereas assessment of conceptual understanding would require a separate, appropriately validated instrument.

The need to explain bonding through coordinated representations is consistent with research on ionic and covalent bonding [2]–[4] and connected models [20], [21]. A broader review [6] and research on representational transitions [7] indicate that chemically accurate images alone may not support students' reasoning. However, students in this study did not complete diagnostic assessments of chemical bonding. Figure 1 and Table 5 therefore document stated needs and teacher perspectives, whereas Tables 3-4 repeat appraisal thresholds rather than reporting student outcomes.

Teachers reported using slides, videos, simulations, and worksheets, but said that local examples were not consistently integrated into prepared learning materials. The prototype responds by pairing cultural prompts with chemical-bond representations. Other research on contextual resources and

creative media [39], [40] provides relevant design background but does not establish the effectiveness of this particular product. What may be transferable is a question for future research: whether linking an authentic local observation to scientifically vetted representations and explanation tasks helps learners reason about bonding.

3.2.2. Design Stage

Related chemistry magazines differ in topic, medium, and evidence; none is assumed inferior. The FTIR magazine [9] and chemical-elements magazine [10] reported appraisal procedures or collected learner responses, while a contextual digital chemistry magazine [22] also collected responses from 20 students. A branching digital bonding module [23] tested learner outcomes in higher education, unlike this mostly print-oriented magazine whose QR-linked resources were not tested. Ethnoscience digital modules and worksheets [24], [25], [26] similarly illustrate technological functions and additional evaluation stages that were not undertaken here. The scholarly contribution is therefore limited to a documented case of cultural contextualization and planned representational tasks, not a claim of superior multimedia instruction.

The sequence begins with a textile-related problem, presents visual, particulate, and symbolic bonding explanations, and ends with a prompt to justify or reflect on the model. The conceptual rationale draws on arguments for representations as explanatory tools [33], research emphasizing model plurality [34], and evidence that surface features of Lewis structures can shape interpretations [8]. These sources support careful task design; they do not show that the magazine improved students' representational competence. Specific claims about dyeing substances require independent scientific verification before the examples can be treated as established chemical facts. A foundational analysis of the chemistry triplet [41] and a recent chemistry-teacher perspective on representational difficulty [42] also support treating these connections as design questions rather than demonstrated benefits.

Contextual chemistry resources have been evaluated using different forms of evidence. Ethnochemistry field studies in Zambia [28] and Kerinci [29] document practices and educational possibilities, whereas quasi-experimental research on culturally grounded green-chemistry textbooks [30] and work on Sasak ethnoscience laboratory learning [31] examine more direct student outcomes. These findings motivate further testing but cannot establish improved performance with a Samarinda magazine assessed primarily by experts. A simulation design study [43] also found that students valued exploratory autonomy while test-based learning gains were comparable across conditions; this cautions against treating the presence of digital links as evidence of effectiveness. QR access and its relationship to reasoning must be measured separately.

Figures 2–7 illustrate the sequence of learning objectives, concept mapping, bonding explanations, culturally contextualized tasks, a game, reflection prompts, exercises, and a glossary. These components could be assessed for scientific clarity, representational alignment, usability, and learner reasoning. The reported validation provides preliminary expert judgments about selected attributes; it does not test the proposed learning mechanisms, and the linked videos remain unevaluated. Applying this design to other ethnochemistry contexts would require independent verification of local material examples and their curricular relevance.

The contribution is a documented design linking local textiles to bonding illustrations, contextual questions, and reflection, with preliminary appraisal of selected attributes. The broader literature offers test-based, interaction-based, or qualitative evidence from evaluations of other products, but such evidence does not transfer automatically to this case. Future work should verify the depicted materials, use validated tasks to assess students' chemical reasoning, examine the accessibility and purposeful use of QR-linked media, and only then test educational outcomes. Studies of accessible ethnochemistry digital resources [27] further suggest accessibility as a separate concern, not a feature demonstrated by this prototype.

3.2.3. Develop

During the develop stage, content, media, and teacher-practitioner assessors evaluated selected attributes of the magazine. Their feedback can guide refinement of the prototype, particularly where it identifies specific weaknesses. Favorable ratings reflect professional appraisals of the material, not evidence of students' understanding, independent usability among learners, or effective use of QR-linked resources. A necessary next step is to reconcile the summary scores with the original assessment sheets.

Table 6 displays two stages of content-expert assessment and higher percentages in the reported second-stage ratings for several content domains. Without dated revision records, item-specific ratings, and clear calculation rules, the magnitude and causes of these changes cannot be independently verified. The isolated Language score (71.09%) lacks a clear round, denominator, and relationship to other dimensions. The authors must verify that entry from the original forms, clarify any reassessment sequence, and distinguish agreement percentages from evidence of content accuracy.

The seven domain percentages in Table 7 yield an unweighted mean of approximately 89.52%, whereas the reported media-expert overall score is 88.75%. Item-level aggregation or unequal weights might explain this, but score totals and denominators are missing. The table also presents only one assessment stage. These results can therefore be described as preliminary positive feedback on the assessed media attributes, but it cannot yet support a verified overall estimate or quantified improvement in media quality across assessment stages.

Table 8 reports practitioner ratings of relevance, context, perceived ease of use, and anticipated learning potential. The displayed domain scores have an equal-weight mean of 92.75%, compared with the reported overall 96.08%; original item scores and any weighting are required for reconciliation. These ratings reflect teachers' expectations, not direct student usability, observed video access, or measured chemistry-literacy improvement. The reported overall score must be checked against the source data before being used in a final evaluative claim.

4. Conclusion

This study produced a supplementary Grade 10 chemistry magazine linking selected Samarinda textile contexts with explanations of ionic and covalent bonding, concept maps, contextual questions, and reflection activities. Within the adapted define–design–develop process, student questionnaire responses and teacher accounts informed the resource, while content, media, and practitioner assessments addressed selected product attributes. The study contributes a documented design case linking local phenomena with proposed representational and reasoning tasks; it has not established learner understanding, accessibility or use of QR-linked resources, or instructional effectiveness. The reported 79.71%, 88.75%, 96.08%, and 71.09% values require source-score verification; documentation of sampling and consent, assessor agreement calculations, and scientific verification of material examples also remain outstanding. Future research should verify the finished product's content validity and accessibility before assessing students' interpretations and learning outcomes with appropriate instruments.

Acknowledgments

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Additional Information

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