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Visual representation and evidential reasoning in STEAM-A learning: A documentary study of an elementary water-filtration project

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ABSTRACT

Classroom photographs and artifacts document educational activity but only partially reveal its meaning, authorship, and continuity. This study investigates visual representation and evidentiary ethics in an Indonesian elementary water-filtration project using STEAM-A, integrating science, technology, engineering, arts, mathematics, and animation. An Evidence-Provenance and Claim-Calibration Protocol was applied to three documents containing 11 visual units: nine classroom photographs and two photographed worksheets. Documentary reconstruction examined relationships among sketches, prototypes, written records, and presentations. The archive supported an eight-phase instructional sequence but neither continuous observation nor individual learning outcomes. Engineering appeared in five visual units, science and material technology in four each, and arts and mathematics in two each. These frequencies indicate archival visibility rather than disciplinary importance. No retained evidence verified learner-created animation or digital activity. Analysis traced transitions from prospective sketches to material demonstrations, documentary inscription, and public display without assigning undocumented intentions to pupils. Of seven candidate claims, two were directly supported, one qualified, and four insufficiently evidenced. The study contributes a provenance-sensitive framework for interpreting incomplete classroom archives and calibrating educational claims. It connects interdisciplinary pedagogy with questions of representation, documentary authority, and interpretive responsibility while preserving uncertainty regarding cognition, character development, and digital competence.

KEYWORDS: archival interpretation, documentary ethics, interdisciplinary learning, material representation, visual evidence, water filtration

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1. Introduction

A classroom project becomes available to later readers through representations: a photograph selects a moment, a drawing anticipates an object, and a worksheet stabilises an account of what was done. These materials are educational records and objects of interpretation. Their meaning depends on how they were produced, selected, connected, and preserved. Critical visual methodology directs attention to the contexts and relations through which images become intelligible (Utomo et al., 2026), while archival scholarship treats preservation as an active shaping of what can subsequently be known (Schwartz & Cook, 2002). This creates a humanities question within interdisciplinary education: how can researchers interpret the relationship between visual representation, material action, and documentary authority without substituting an institutional narrative for the experiences of learners whose accounts are unavailable?

The question is consequential in Science, Technology, Engineering, Arts, and Mathematics (STEAM) education, where drawing, making, observing, recording, and presenting may operate together. Reviews identify considerable variation in what integration means and in the place assigned to the arts (Perignat & Katz-Buonincontro, 2019; Sanz-Camarero, Ortiz-Revilla, & Greca, 2023; Yim, Su, & Wegerif, 2025). An arts-integrated approach requires attention to what representation contributes to inquiry (Liao, 2016). Planned and enacted curricula can diverge as teachers interpret tasks in local settings (Laksmiwati, Lavicza, Cahyono, Yunianto, & Houghton, 2023; Quigley, Herro, King, & Plank, 2020). Analysis of Indonesian senior high school language textbooks also identifies gaps between curriculum goals and the scaffolding and cognitive demands of the tasks provided (Pamungkas, Ariantoni, et al., 2025). A surviving archive introduces another distinction: between the activity described in a project and the activity that its records can support. Counting a sketch as an arts-related trace does not establish aesthetic inquiry; recognising a bottle as a functional tool does not establish digital engagement. The analytic problem concerns the authority of these categories as well as the instructional activity they describe.

Recent work in Research Journal in Advanced Humanities offers relevant points of comparison. Sudigdo et al. (2026) connect adaptive digital learning with culturally situated poetry writing, whereas Indarti et al. (2026), Ngabiyanto et al., (2026) and Utomo & Wijayanti (2026) examine institutional conditions for digital transformation in language learning. Their relevance here is conceptual: claims about mediation must specify the practices and records through which mediation is evidenced. Their findings do not establish digital or cultural outcomes in the present classroom. Research on culturally responsive STEAM likewise links an identifiable cultural form, Kawung batik, with a defined learning activity (Astuti, Retnawati, & Prahmana, 2026). The water-filtration archive contains no comparable documentation of cultural identity or indigenous knowledge transmission. Its humanities contribution therefore lies in the interpretation of visual and material records and the responsibilities of those interpreting them.

The case concerns an elementary water-filtration project in Semarang, Indonesia, originally described using STEAM-A, with the additional A denoting Animation. The surviving project narrative associates the activity with digital literacy and character education. However, the documentary inventory contains no recoverable interviews, questionnaire data, continuous video, complete field notes, historical coding files, or verifiable ethics-and-consent package. The retained corpus comprises a 50-page final report, an earlier manuscript, and a title-page/project document; the report embeds nine classroom photographs and two photographed student worksheet pages, known locally as Lembar Kerja Peserta Didik (LKPD). The materials preserve selected actions and artifacts. They do not provide a complete record of the children's words, intentions, interpretations, or learning trajectories.

This article brings a visual and material interpretation to the existing documentary reconstruction through an Evidence-Provenance and Claim-Calibration Protocol (EPCCP). Its contribution is the explicit connection between a representational resource, the source that preserves it, the interpretation it permits, and the point at which that interpretation must stop. The protocol is a proposed procedure demonstrated in one case, rather than a validated measurement instrument. It combines the contextual caution of documentary and secondary analysis with transparent reporting of evidence and missing records (Aguinis & Solarino, 2019; Bowen, 2009; Irwin, 2013; Levitt et al., 2018; Nosek et al., 2015). This emphasis on cautions interpretation is particulary relevant to research involving language and meaning, as linguistic expressions may shape affective and cognitive processes, while critical engagement with culturally situated texts requires careful interpretation of language, context, and meaning (Baehaqie et al., 2026; Utomo & Anindyarini, 2023). The purpose is to explain what this

archive makes visible about an interdisciplinary learning project and what remains inaccessible. Educational effectiveness, individual competence, and cultural transformation are outside the available evidence.

Three research questions guide the analysis. RQ1: What relationships among visual representation, material action, written records, and presentation can be reconstructed from the archive? RQ2: How does the distribution of documentary support qualify claims about interdisciplinary integration, digital activity, and character-related participation? RQ3: What responsibilities and limits arise when researchers interpret and communicate learning from an incomplete classroom archive?

2. Conceptual framework

2.1 Representation across media and materials

A social-semiotic perspective recognises that meaning is made through socially organised resources, including image, writing, speech, and material arrangements (Kress, 2010). For this study, that perspective provides sensitising concepts rather than a claim to recover all classroom meaning. The analytic question is what each documented resource makes available for expression or inspection. A sketch can externalise an intended arrangement; a prototype can make that arrangement available for testing; a worksheet can retain selected observations; and a presentation can make the product available to an audience. Whether learners experienced these relationships in a particular way remains unknown. The retained record lacks the talk and successive artifact versions needed to trace individual meaning-making in detail.

The distinction is relevant to arts integration. STEAM scholarship cautions against assuming disciplinary integration from an acronym or the presence of an artistic product (Liao, 2016; Perignat & Katz-Buonincontro, 2019; Sanz-Camarero et al., 2023). Here, visual representation is treated as a possible contribution to the organisation and communication of the task, without inferring artistic achievement. Implementation research also distinguishes intended content, delivery, and responsiveness (Carroll et al., 2007; Century, Rudnick, & Freeman, 2010). These perspectives help separate three layers: what the project intended, what the record depicts, and what the analyst can reasonably interpret. The evidenced layer is especially important when institutional reports preserve an account of activity but not a complete record of enactment.

2.2 Documentary authority and interpretive limits

Document analysis requires attention to the purposes and contexts in which records were produced (Bowen, 2009). Secondary analysis adds questions about the fit between inherited materials and new research questions (Irwin, 2013; Mauthner, Parry, & Backett-Milburn, 1998). Research on Malay-Islamic manuscript digitisation similarly argues that archival visibility depends on material form, local custody, and access (Iskandar & Sabri, 2025). In this case, the photograph of a learner handling an object can support a description of visible action, but it cannot determine the learner's explanation or the activity's typicality. The report may organise images into a coherent account even when the archive cannot establish continuous chronology. These limitations matter because the analyst's writing can inadvertently give documentary fragments the authority of comprehensive observation.

Provenance records where support for a claim comes from and how that support can be inspected. Data-stewardship principles emphasise accessible metadata and accountable reuse (Wilkinson et al., 2016); in an incomplete archive, provenance also needs to record what is missing. EPCCP distinguishes retained sources, reported but unavailable records, and unverified reconstructed descriptors. It then assigns the strongest permissible claim status: directly evidenced, supported with limitations, reported only, or not evidenced/excluded. A statement about visible material activity cannot become a statement about learning gain merely because the latter was an original project objective.

The protocol addresses both the exaggeration and the premature dismissal of partial evidence. Static drawing cannot stand for animation, a paper record cannot stand for learner digital competence, and visible group work cannot stand for durable moral development. Yet the same drawing, record, and group arrangement can remain valuable for interpreting how a task was represented. Figure 1 shows the protocol. Its categories make interpretive decisions open to scrutiny; they do not remove judgement or certify the truth of every coding decision. The ethics of evidence, as used here, concerns the researcher's obligation to represent both support and uncertainty faithfully.

2.3 Digital mediation and the status of a trace

A photograph stored digitally and a child's purposeful use of a digital resource are different objects of analysis. Digitisation can make an archive accessible without demonstrating learner digital competence. DigCompEdu addresses educators' pedagogical engagement with digital resources and learner competence (Redecker, 2017), while Nichols and Stornaiuolo (2019) situate digital literacies within social, material, and institutional relations. These perspectives support examining tools in context, but they do not justify classifying every information practice as digital. In this study, the distinction is between a stated digital intention, a documented non-digital practice, and a trace of learner digital activity.

Sudigdo et al. (2026) describe adaptive prompts, learner-generated writing, feedback, and interaction analytics within a digital learning system. These are examples of the kinds of records through which a claim about digital mediation becomes inspectable. They are not evidence that such mechanisms operated in the water-filtration project. Similarly, Indarti et al. (2026) associate digital transformation with educator competencies and institutional arrangements. The comparison identifies questions for the present archive about recorded practice and documentation, without transferring findings between subjects, populations, or levels of analysis.

2.4 Participation and the limits of moral interpretation

Project-based learning can organise shared activity around a task and its products (Kokotsaki, Menzies, & Wiggins, 2016). A situative perspective relates participation to available tools, classroom organisation, and immediate goals (Greeno & Middle School Mathematics through Applications Project Group, 1998). The relevant interpretive distinction is between a condition that affords valued conduct and evidence that a learner has acquired a stable disposition. A shared prototype offers a setting for coordination, but a photograph cannot establish equal participation, willingness to cooperate, or lasting responsibility. A completed worksheet makes an account available, but its existence alone does not establish honesty or the accuracy of every entry.

Accordingly, references to cooperation, procedural care, and accountability are restricted to task demands and visible or documented arrangements. The retained label "curiosity" is interpreted only as close attention to testing, not as a measured motivational state. Developmental claims would require evidence across occasions and contexts. This restriction also protects children's interpretive standing: the analysis does not attribute feelings, beliefs, or moral identities that they have not expressed in an available record.

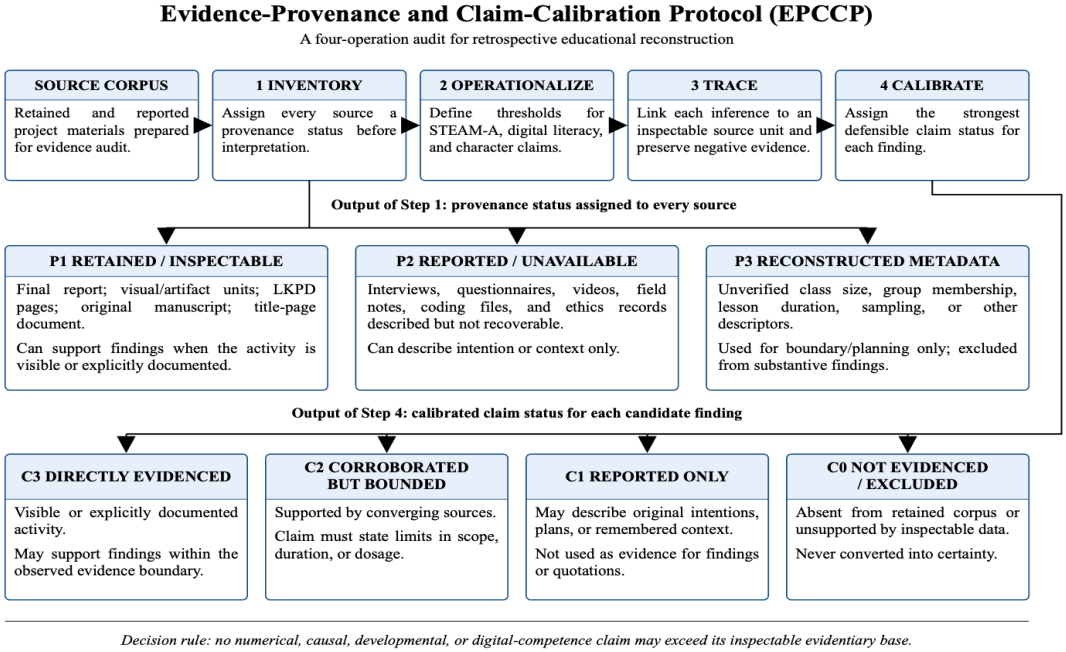


Figure 1. Evidence-Provenance and Claim-Calibration Protocol for documentary interpretation.

The protocol keeps source status separate from claim status. "Not evidenced" describes the surviving record; it does not establish that an activity never occurred. Multiple images embedded in the same institutional report remain dependent sources and cannot be treated as independent corroboration of the report's entire narrative.

3. Materials and methods

3.1 Design and case boundary

The study uses retrospective documentary reconstruction to examine one elementary water-filtration project in Semarang. Its object is the recorded learning activity and the representations through which it is accessible. The visual and material reading is interpretive and bounded by the retained inventory; it is not a new intervention, participant study, full multimodal interaction analysis, or reanalysis of unavailable mixed-methods data. No additional participant sample is inferred from photographs. The revised interpretation concerns relationships already documented in the source ledger and does not introduce new interviews, observations, or artifact codes. Descriptions of visible activity are separated from interpretations of representational function. An interpretation is retained only when its source and uncertainty can be identified. Alternative explanations are considered where a visible arrangement could support more than one reading. The approach follows qualitative reporting principles of contextualisation, transparency, and coherence (Levitt et al., 2018; Tracy, 2010). It cannot resolve uncertainties that would require participant testimony, the complete recording history, or missing primary files.

3.2 Corpus and provenance

The corpus comprises three documentary units: the 50-page final report (D1), an earlier manuscript (D2), and a title-page/project document (D3). Eleven visual or artifact units embedded in D1 are designated V1–V11: nine classroom photographs and two photographed LKPD pages. Thus, the inventory contains 14 indexed units, but not 14 independent documents. The embedded units preserve selected actions, a sketch, material and volume-related entries, observations, and brief reflections. Table 1 distinguishes this material from records reported in project documents but unavailable for analysis. Appendix A identifies the individual units and their limits.

Table 1. Provenance classes and permitted analytical uses

Evidence class	Material/status	Permitted analytical use	Boundary
P1: retained and inspectable	3 documents and 11 embedded visual/artifact units; 14 indexed units in total	Sequence reconstruction; observable material-practice coding; component comparison; source-to-claim tracing	Selected records; embedded units are not independent sources
P2: reported but unavailable	Interviews, questionnaires, discussions, videos, complete field notes, coding files, and ethics records described in project documents	Description of intended design only	No quotations, frequencies, participant perceptions, reliability, triangulation, or validity claims
P3: unverified reconstructed metadata	Working estimates of class size, grade, group counts, session duration, attendance, and sampling	Planning the future data package	Excluded from abstract, findings, and substantive conclusions
Negative evidence	No retained learner-created digital artifact; no moving or time-based Animation artifact; no baseline, follow-up, or comparison measure	Code the relevant claim as not evidenced or excluded	Does not prove that the activity never occurred; it establishes only what the retained corpus cannot support

The distinction in Table 1 governs subsequent interpretation. The existence of an interview mentioned in a report cannot supply interview findings when its recording or transcript is unavailable. Reconstructed class size, attendance, grouping, sampling, and lesson duration are not used as empirical observations.

3.3 Analytic procedure

EPCCP uses four operations. Inventory assigns provenance before substantive interpretation. Operationalisation defines the minimum support required for each component or practice. Tracing links each candidate claim to the identified sources and records missing or contrary support. Calibration assigns a claim status and an interpretive limit. These operations retain the manuscript's unit identifiers and component matrix so that interpretive reframing does not change the empirical denominator.

The source classes are P1, retained and inspectable; P2, reported but unavailable; and P3, unverified reconstructed metadata. The claim classes are C3, directly evidenced within a defined documentary boundary;

C2, supported with limitations; C1, reported only; and C0, not evidenced or excluded. C3 requires a visible action or artifact relevant to the claim, rather than a general statement that an activity was intended. C2 permits a bounded inference across retained traces, while acknowledging their common documentary origin. P2 supports only statements about what was reported; P3 supplies no substantive findings.

The visual and material reading asks, for each relevant unit, what resource is represented, what action or product is visible, what relation to another stage is defensible, and what remains unknown. Sketching, prototype handling, worksheet recording, and presentation are interpreted through these questions in Table 3. This is an interpretive crosswalk over the existing ledger, not a second dataset or an independently validated coding scheme. No historical intercoder record or new independent audit is available. The explicit thresholds, source ledger, coding matrix, and examples of excluded claims make the analysis challengeable without implying reliability that has not been assessed.

3.4 Operational definitions and sequence reconstruction

Table 2. Operational definitions and minimum evidentiary thresholds

Construct	Operational meaning	Minimum evidentiary threshold
Science	Observation, comparison, or explanation of filtration phenomena and material functions	Visible observation; before/after comparison; written or reported explanation linked to the prototype
Technology	Functional use of physical or digital tools; digital use coded separately	Tool or material manipulation; digital device/source/content required for a digital code
Engineering	Problem representation, sketching, material arrangement, construction, testing, and redesign when evidenced	At least one design-build-test relation; redesign claimed only if a second documented iteration exists
Arts	Visual representation and communication associated with the task	Sketch or public visual communication; no inference of artistic quality or achievement
Mathematics	Measurement, volume, sequence, comparison, quantification, and data organisation	Numerical or volume-related entry, quantified comparison, or structured data record
Animation	Moving, time-based, or sequential learner-created visual representation	Simulation, stop-motion, animated slide, moving diagram, or equivalent artifact; static images do not qualify
Learner digital activity	Purposeful engagement with digital information, data, content, communication, safety, or problem solving	Inspectable learner interaction with a digital source, device, application, file, data record, media product, or platform
Participation affordance	Task conditions or documented arrangements associated with valued conduct	Visible coordination, care, recording, or close observation; no inferred motive or developmental change

The thresholds distinguish evidence of an artifact or practice from evidence of achievement. In particular, the arts code records a representational trace and does not measure artistic quality; the mathematics code does not measure mathematical understanding. Animation requires a learner-created time-based artifact, and digital activity requires a learner-related digital trace. Table 2 preserves these boundaries when interdisciplinary labels are applied.

Sequence reconstruction uses the report narrative and dependencies among the described artifacts. The proposed order is pedagogically coherent: a design can guide assembly, an assembled object can be tested, and observations can be recorded and presented. The archive does not supply a timestamped or continuous chain showing every transition for the same group. Sequence claims therefore concern the reconstructed task structure, not an observed learning trajectory. Exact timing, frequency, lesson dosage, universal participation, and undocumented redesign are not inferred.

Photographs are read first for visible persons or body parts, objects, tools, actions, and spatial arrangements. The subsequent interpretation remains at the activity or document level because authorship and group mapping for the LKPD pages are unavailable. Teacher talk, pupils' intentions, emotional states, social background, and cognitive change are not inferred from appearance. These exclusions apply equally to favourable claims about agency and character and to unfavourable judgements about learners.

3.5 Descriptive audit and interpretive transparency

The component audit uses the existing binary, multi-label matrix for the 11 visual or artifact units. A value of 1 indicates that the stated threshold is met in the retained unit; 0 indicates that qualifying support is not inspectable. Components are science, material technology, engineering, arts, mathematics, animation, and learner digital activity; teacher scaffolding is also recorded. Appendix B supplies the unit-level matrix. Participation-related descriptors are reported as documentary affordances rather than psychological measures.

Frequencies use 11 as the denominator and describe archival coverage. A unit may receive several codes, so percentages are not additive. Units are selectively retained, temporally incomplete, and embedded in a common report; no inferential tests, confidence intervals, effect sizes, or causal estimates are justified. Drucker (2011) argues that humanistic displays should make their interpretive construction visible. Here, the ledger and thresholds accompany the counts so that precision in arithmetic cannot be mistaken for completeness of observation or objectivity of categorisation.

3.6 Ethics and responsible representation

No new participant recruitment, interaction, or data collection was undertaken. The retained inventory does not contain verifiable records of institutional ethics approval or exemption, parental permission, child assent, or image-publication consent. This manuscript therefore does not assert that these requirements were satisfied. Classroom photographs are not reproduced in the revised article; their analytical roles are described through source identifiers and a text-based matrix. Removing public images does not resolve permission for secondary use. The authors must establish the applicable institutional basis for that use before submission and retain access controls for materials involving children.

4. Results

4.1 From prospective representation to documentary record

The archive represents an eight-phase task structure: orientation, sketching, material preparation and layer assembly, functional testing, observation, worksheet recording, reflection, and presentation. Opening images depict teacher-led orientation. V4 records hand-drawn design; V5–V8 concern prototype handling, assembly, and testing; V9–V10 preserve photographed worksheet pages; and V11 depicts presentation. These traces permit a reading of relationships among representations and objects while leaving the exact chronology and group-level continuity unresolved.

Four representational functions can be distinguished within those recorded relationships. The sketch provides a prospective form: an arrangement can be considered before or alongside its material construction. The prototype provides a demonstrative form: an arrangement becomes available for handling and testing. The worksheet provides a documentary form: selected features and observations can persist beyond the immediate action. Presentation provides a public form: a product is displayed in a classroom setting. These functions are analytical descriptions of available resources. They do not establish what an individual learner intended, understood, or communicated verbally.

Table 3 locates each interpretation in the original ledger. The distinction between support and inference is consequential: the existence of a sketch and a prototype is documented, whereas their precise correspondence and any revisions between them cannot be reconstructed. The worksheet preserves an account but cannot establish who supplied each entry. The presentation image supports public display but not the content or quality of an explanation. Reflection is mentioned in the report and represented in worksheet material, but the archive is too sparse to evaluate its depth.

Table 3. Visual and material resources, representational functions, and interpretive limits

Resource and source	Documented support	Bounded interpretation	What cannot be inferred
Design sketch (V4; V9)	A drawn arrangement associated with the task	Prospective representation of a possible construction	Individual intention; design ownership; the exact transfer from drawing to prototype

Resource and source	Documented support	Bounded interpretation	What cannot be inferred
Prototype and testing (V5–V8)	Material assembly, handling, and observation	A represented arrangement becomes available for material demonstration	Conceptual understanding; unrecorded revisions; measured purification or safety
Worksheet record (V9–V10)	Design, material/volume entries, observations, and brief reflections	Selected activity is stabilised in an inspectable written or visual account	Authorship; accuracy of every entry; reflection depth; digital competence
Presentation setting (V11)	A group displays a product in front of the class	Public availability of the product and a setting for explanation	The actual speech; audience interpretation; equal participation; communicative competence

The progression in Table 3 is therefore a reconstruction of the task's representational organisation. It should not be read as direct access to children's interpretations. The distinction allows the project to be examined as a relationship among media and materials while preserving the limits of the available evidence.

4.2 Teacher guidance and the visibility of participation

The record depicts a guided project. Teacher-led orientation, circulation near groups, support during testing, and presence during presentation are consistent with procedural scaffolding (van de Pol, Volman, & Beishuizen, 2010). Four of the 11 visual or artifact units record teacher orientation or scaffolding. The available still images do not establish the quality, contingency, duration, or withdrawal of support. Consequently, scaffolding is a bounded description of visible guidance rather than a validated account of instructional interaction.

Learner material or representational action is recorded in eight units. Drawing, handling, arranging, testing, recording, and displaying make learners visible as participants in producing the project. Yet visibility is uneven: the record does not show whether decisions were shared, how contributions were negotiated, or whether some pupils were marginalised. The strongest warranted interpretation is participation within a guided task. Claims about autonomous inquiry or equitable agency would require further evidence of decision-making and interaction.

4.3 Interdisciplinary configuration and representational work

Science and engineering have the broadest substantive support in the reconstructed activity. Testing and observing a filter link a material arrangement to a phenomenon, while the design-and-build task organises preparation and use of that arrangement. Engineering meets its coding threshold in V4–V8; science in V7–V10. The record includes no second documented design cycle, conceptual interview, or measured assessment of scientific understanding. The results concern the practices represented in the archive, not mastery of either discipline.

Technology is evidenced through physical tools and filter materials. Arts is represented in the design sketch and public communication, while mathematics is represented in worksheet entries and the organisation of numerical or comparative information. These contributions should not be equated with subject-specific attainment. In particular, a sketch can perform consequential representational work even though only two units meet the arts threshold. Documentary frequency does not determine the educational or cultural value of a mode of expression.

No retained unit satisfies the threshold for learner-created animation. Static sketches, research photographs, a material prototype, and a presentation image do not demonstrate a moving or time-based artifact. This is an archival limit rather than proof of non-occurrence. It qualifies the original STEAM-A designation as an instructional intention whose components have uneven documentary support.

4.4 Distribution of evidence within the archive

Table 4 retains the documentary counts from the source matrix. Nine of the 11 embedded units are classroom photographs and two are worksheet photographs. Engineering is coded in five units (45.5%); science and material technology in four each (36.4%); and arts and mathematics in two each (18.2%). Animation and verified learner digital activity have no qualifying unit. The separate participation descriptors identify opportunities or recorded arrangements associated with cooperation, care, recording, and observation. They do not count students who possess the corresponding qualities.

Table 4. Descriptive coverage of the retained visual and artifact units

Domain	Observable code	n	% of 11	Interpretive boundary
Archive	Classroom photographs	9	81.8	Selected moments; not representative sampling
Archive	Photographed LKPD pages	2	18.2	Artifact evidence; authorship/group mapping unavailable
Participation	Student direct action	8	72.7	Material, representational, recording, or presentation action
Participation	Teacher orientation/scaffolding	4	36.4	Teacher presence or guidance; quality and fading unknown
STEAM-A	Engineering	5	45.5	Sketch-build-test chain; no retained redesign iteration
STEAM-A	Science	4	36.4	Observation, test, and paper-based result records
STEAM-A	Technology - material	4	36.4	Bottles, media, containers, and functional tools
STEAM-A	Arts	2	18.2	Static sketch and public visual/oral communication
STEAM-A	Mathematics	2	18.2	Volume-related entries, sequence, and comparison
STEAM-A	Animation	0	0.0	No learner-created moving or time-based artifact
Digital	Verified learner digital enactment	0	0.0	No inspectable learner digital source, file, device trace, or product
Situated affordance	Cooperation	5	45.5	Shared prototype or group presentation; not a trait measure
Situated affordance	Procedural care/discipline	4	36.4	Ordered assembly and water handling; not developmental change
Situated affordance	Accountable recording/presentation	3	27.3	LKPD and presentation traces
Situated affordance	Close observation	2	18.2	Visible attention to testing; no inferred motivational state

One unit can support several categories, and the table must not be interpreted as a distribution of lesson time. The science and engineering profile is stronger in documentary coverage than the arts and mathematics profile; it does not establish that the former were more important to learners. Figure 2 visualises component coverage using the same denominator. The counts can be recalculated from Appendix B, although agreement on the underlying interpretation requires inspection of the original sources.

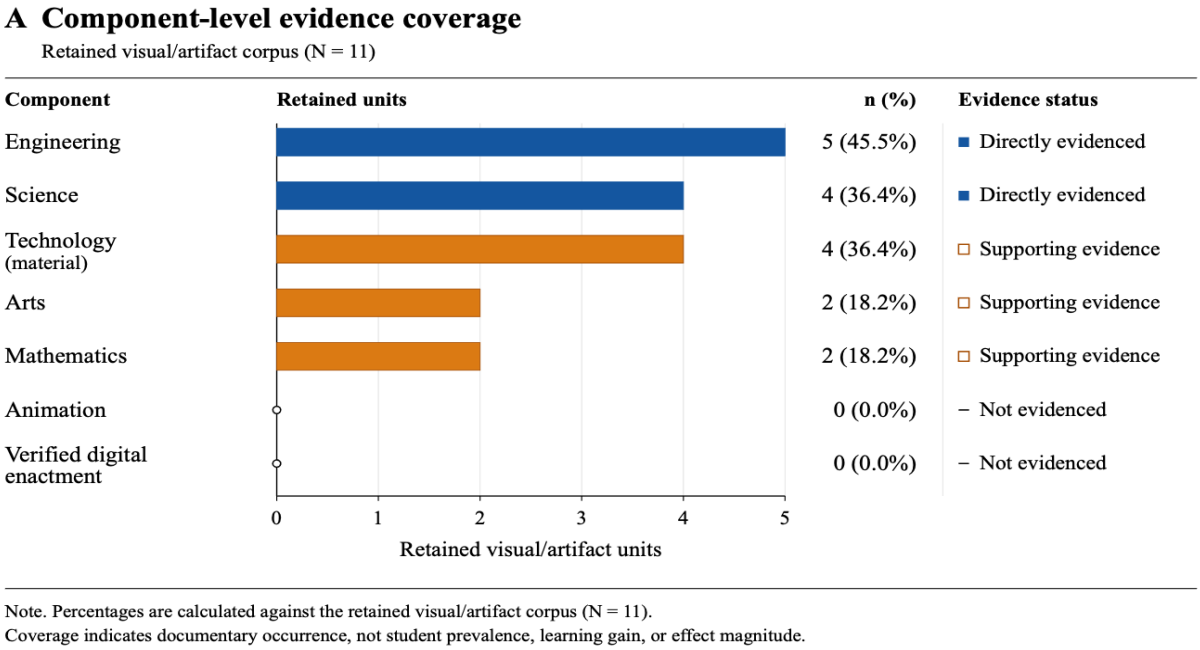


Figure 2. Component evidence coverage in the 11 retained visual and artifact units

The profile is strongest for material design and testing and weakest for learner digital and time-based production. This finding narrows the claims that can be made about the project while leaving the interpretive value of the surviving visual and written resources intact.

4.5 Recording and presentation without verified learner digital activity

The relationship between the worksheet and the prototype is particularly informative. The worksheet makes a design and selected observations available as an inspectable account, while the prototype supplies the material referent of that account. Their joint presence supports a reading of the task as involving both making and recording. The retained pages do not establish the accuracy, completeness, or authorship of every entry. A documentary record is an object for scrutiny rather than automatic evidence of truthful or scientifically adequate reporting.

No learner-generated digital presentation, source-evaluation record, spreadsheet, digital data log, animation, or platform interaction is retained. Photographic documentation by researchers or teachers cannot stand for pupils' digital participation. The records support non-digital representational practices that might inform later digital tasks, but their existence cannot establish digital literacy or its improvement. This boundary is essential to distinguish the medium used to preserve a classroom record from the medium in which the recorded learning activity took place.

4.6 Situated participation and moral language

The ledger associates shared prototype work and presentation with cooperation, ordered assembly and water handling with procedural care, worksheet use and display with accountable reporting, and attention to testing with close observation. These associations identify demands and opportunities organised by the task. They do not establish that all pupils acted cooperatively, that all records were accurate, or that close attention expressed a stable disposition of curiosity. The archive preserves appearances of participation more readily than the reasons participants had for acting.

The distinction constrains character-related interpretation. Without a baseline, repeated observation, a comparison condition, follow-up, or participant account, the archive cannot show moral internalisation or developmental change. Its defensible contribution is to specify settings in which responsibility and coordination could be practised. A future investigation would need to examine actual conduct and participants' perspectives over time, including cases that contradict the anticipated moral narrative.

4.7 Claims that survive the evidentiary threshold

Table 5 applies the claim categories to seven candidate conclusions. A reconstructable task sequence and a science–engineering core have direct documentary support within stated limits. Teacher guidance is supported with limitations. Improved digital literacy, enacted animation, character improvement, and overall effectiveness lack the required evidence.

Table 5. Candidate claims and their evidentiary limits

Candidate claim	Evidence base	Status	Interpretive boundary
A sketch–build–test–record–present task sequence is reconstructable	Report narrative + images V4-V11 + photographed LKPD	C3 directly evidenced	Task structure supported; chronology, same-group continuity, and universal participation unknown
Teacher scaffolding structured the activity	Orientation/circulation images + report narrative	C2 supported with limitations	Cannot assess questioning, contingency, fading, or quality
Science and engineering have the strongest substantive documentary support	Multiple material-action images + LKPD content	C3 directly evidenced	No retained redesign cycle or conceptual interview evidence
Digital literacy was strengthened	No retained learner digital artifact or validated measure	C0 excluded	Only non-digital evidence practices are defensible
Animation was enacted	No moving or time-based artifact retained	C0 not evidenced	Absence in corpus is not proof of absolute non-use
Character improved	No baseline, repeated measure, comparison, or follow-up	C0 excluded	Only situated character-related practices may be described

Candidate claim	Evidence base	Status	Interpretive boundary
The project was effective	No outcome measure or comparison condition	C0 excluded	No effect size, causal language, or generalisation

The strongest retained claims concern the form of the recorded activity. None concerns a measured learning effect. Direct support is local to the relevant trace: it cannot establish continuous observation, universal participation, or the authenticity of an entire institutional account. Table 5 therefore gives each positive conclusion its own boundary instead of allowing one well-documented artifact to validate unrelated objectives.

Of the seven candidate claims, two are classified C3, one C2, and four C0. No claim in this selected set is classified C1. These numbers summarise decisions within a deliberately specified claim set; they are not an estimate of how often educational projects overclaim. The point of the exercise is to make individual interpretive decisions accountable and revisable.

5. Discussion

5.1 The contribution of visual and material representation

The project's humanities significance lies in how an educational activity becomes representable through different resources. The sketch, prototype, worksheet, and presentation are linked without becoming interchangeable. A material object can be tested but does not preserve all the reasoning behind its design. A worksheet can retain an account but cannot reproduce the activity in full. Presentation makes a product visible to others, while the loss of speech prevents evaluation of what was said. The interpretation explains these differences without claiming access to an absent learner voice. It extends the documentary question from whether an activity occurred to how that activity is made available for later understanding.

This perspective also refines the role of arts within the project. The low archival count for arts does not settle the importance of drawing or display. A single representation may connect phases of a task in a way that repeated photographs of construction cannot. Nevertheless, this case supplies no basis for claiming advanced arts integration, creative achievement, or aesthetic development. The finding is compatible with STEAM reviews that distinguish the presence of an arts-related activity from a substantial arts contribution (Perignat & Katz-Buonincontro, 2019; Sanz-Camarero et al., 2023; Yim et al., 2025). It also complements the planned–enacted distinction (Quigley et al., 2020) by showing why the archived representation must be evaluated in its own right.

The regional setting provides context rather than an automatic cultural explanation. The archive documents an Indonesian classroom activity and a familiar environmental problem, but it does not document a local water-management tradition or learners' cultural identities. Astuti et al. (2026) demonstrate a different kind of design in which a named cultural artifact is integral to the learning task. That comparison identifies what would be needed to make a culturally grounded claim here: evidence connecting particular community practices, representations, and participants' interpretations. It does not license relabelling an ordinary filtration exercise as indigenous knowledge or cultural heritage.

5.2 Documentary authority and the ethics of interpretation

The central methodological contribution is the combination of an explicit provenance audit with a bounded interpretation of representational function. Water filtration is an established educational task (Ridlo, Nuha, Terra, & Afafa, 2020). EPCCP does not derive novelty from the object being constructed, and it does not constitute a validated theory of learning. Its practical contribution is to expose the inferential steps through which a surviving record becomes a scholarly claim. The resource–source–interpretation–limit relationship in Table 3 is particularly useful because it connects interpretation to an identifiable trace while preserving alternative explanations.

An incomplete archive creates an asymmetry between the institutional account and the people represented within it. The report can continue to speak when the children's words are unavailable. The present analysis identifies that asymmetry without claiming deliberate exclusion or an explanation for missing records. Archival scholarship's concern with the shaping of memory helps make this a legitimate object of scrutiny (Schwartz & Cook, 2002). In research with elementary pupils in Yogyakarta, children's poems were analysed alongside

interviews and observation to investigate their accounts of national identity (Sudigdo et al., 2024). For this case, the practical response is to describe visible resources and institutional claims separately, to avoid assigning unrecorded identities or intentions, and to keep missing testimony visible in the limitations.

Transparency also requires a distinction between reproducible arithmetic and reproducible interpretation. Readers can recover the reported component totals from Appendix B, but the matrix alone does not verify whether every classification is appropriate. Source access, a record of alternative readings, and independent auditing would strengthen that assessment. This is consistent with qualitative work on transparency and contextualised secondary analysis (Aguinis & Solarino, 2019; Irwin, 2013; Levitt et al., 2018; Mauthner et al., 1998; Tracy, 2010). Counts provide an audit trail only when their provenance and the judgements that produced them remain open to examination.

5.3 Digital claims and their documentary requirements

The absence of a learner digital trace does not diminish the value of drawing, making, and paper recording. It changes which claim the archive can support. The distinction also guards against treating digitised classroom evidence as proof of digital learning. The article by Sudigdo et al. (2026) is useful as a comparator because its account explicitly links digital interaction with recorded learner production. Research on augmented reality in higher education has combined a quasi-experiment with interviews to examine emotional literacy and learner experience (Pamungkas et al., 2025), illustrating the additional evidence needed to assess digital learning outcomes. The present project would require its own learner-related artifacts before an analogous mediation claim could be made. No outcome or mechanism from the poetry-writing study can be transferred to the filtration activity.

Indarti et al. (2026) locate digital transformation within educator competencies and institutional arrangements. At the scale of this case, that connection suggests that documentation should be planned alongside task design and professional support. This is an implication for future work, not a measured relationship within the archive. The current evidence supports a distinction among intended technology use, material tool use, and verified learner digital activity, consistent with contextual approaches to digital literacy (Nichols & Stornaiuolo, 2019; Redecker, 2017). A future digital component should have a defined role and an identifiable record, rather than function as an additional label.

5.4 Participation without developmental overclaiming

The moral vocabulary surrounding project work needs the same discipline as its technological vocabulary. Shared materials and a common product can organise opportunities for cooperation and responsibility. They can also conceal unequal work, compliance with adult instructions, or disagreement that a still image does not show. A situative reading therefore asks what the task makes possible and what the record depicts before asking what kind of person the learner has become (Greeno & Middle School Mathematics through Applications Project Group, 1998). In this archive, the first two questions can receive bounded answers; the last cannot.

The analytical gain is a more specific account of the conditions for valued conduct. Coordination has an object in common assembly, care has a procedural setting in material handling, and accountability has a documentary form in recording and display. These are useful pedagogical interpretations, provided they remain distinct from demonstrated behaviour across occasions. A study of multiple-intelligence-based reading instruction examined character outcomes using pre- and post-tests, classroom observation, and interviews (Sholeh et al., 2025); this combination illustrates evidence that a collection of project photographs cannot supply. Future studies should seek pupils' accounts and contrary cases as well as teachers' assessments. That would allow moral language to be assessed against participation rather than attached to photographs after the event.

5.5 Implications for teaching and research practice

For teachers, the main implication is to preserve connections among representations. A dated sketch, an image of the resulting object, a record of testing, and an explanation of revisions would make the relationship between an intended arrangement and its development clearer. Repeated attempts should be identified as such, and the authorship of group artifacts should be documented without assuming that a group product represents identical

participation. These records would improve the interpretability of classroom work while giving learners opportunities to explain differences between what they planned and what they observed.

For researchers, each planned claim should be paired with a source that could support or challenge it. A claim about visual representation requires artifacts; a claim about explanation requires an appropriate record of communication; a claim about digital participation requires learner-related digital traces; and a claim about development requires observations over time. Recording those distinctions in advance can prevent the archive from being shaped solely around a successful final product. Retaining unsuccessful tests and conflicting accounts would make the inquiry more informative, not merely more extensive.

For institutions, preservation involves responsibility for context as well as file retention. Source identifiers, dates, relationships among artifacts, consent conditions, access permissions, and analytical decisions should remain connected to the materials. Open-data principles do not imply unrestricted publication of children's images (Wilkinson et al., 2016). A controlled source ledger and de-identified analytical materials can support scrutiny while the original records remain subject to appropriate restrictions. Ethical permission and documentary completeness are separate requirements; neither can be inferred from the other.

5.6 Limitations and transferability

The case is limited to a selective archive from one project. Its 11 visual or artifact units are embedded in a common institutional report and do not form an independent sample of classroom events. Participant metadata, exact chronology, artifact authorship, talk, continuous video, outcome measures, and a complete ethics package are unavailable. The visual and material interpretation is consequently limited to documented resources and relationships; it is not a full social-semiotic, discourse, ethnographic, or developmental analysis. There is no new participant validation or independent coding reliability estimate. The interpretive matrix clarifies the argument but cannot compensate for these missing sources.

Transferability concerns the proposed procedure for interpreting partial educational archives. Its usefulness would need to be assessed across other cases and by independent readers with access to underlying materials. Substantive findings cannot be generalised to Indonesian elementary education or to STEAM programmes as a whole. Even within this case, another surviving source could alter a claim's status. The protocol therefore treats conclusions as revisable within explicit evidence boundaries, while allowing the retained materials to contribute an account of representation and participation.

6. Conclusion

The water-filtration archive supports a bounded account of interdisciplinary activity through the relationship among a design sketch, a material prototype, worksheet records, and public display. Science and engineering have the broadest documentary coverage, while visual representation and recording make the task available for communication and later interpretation. Neither those relationships nor their frequencies establish learning gain, balanced disciplinary integration, cultural identity formation, digital competence, or character development. The absence of a learner-created animation and a verified digital trace sets a clear limit on claims made under the expanded STEAM-A label.

The study contributes to humanities inquiry by making the authority and limits of classroom representation explicit. EPCCP connects provenance with interpretation, and the visual–material matrix shows how each proposed meaning depends on a particular resource and source. The resulting account preserves the interpretive value of incomplete records while refusing to speak beyond them. Its wider implication is that responsible educational representation requires attention to what an archive makes visible, whose accounts remain unavailable, and which additional records would be needed to justify a stronger conclusion.

Data availability

The analysis refers to three project documents and 11 visual or artifact units embedded in the final report. The source ledger and binary component matrix are provided in Appendices A and B. Interviews, questionnaire data, continuous video, complete field notes, historical coding files, and reconstructed participant metadata are not available for independent analysis and are excluded from substantive findings. The underlying materials involve minors and are not deposited publicly. Any controlled access to original records requires the authors to establish institutional permission and an appropriate basis for secondary use.

Ethics statement

This retrospective documentary study involved no new participant recruitment or data collection. The available record does not verify the original ethics approval or exemption, parental permission, child assent, or publication consent. No approval number or consent claim is therefore supplied. The revised manuscript does not reproduce classroom photographs or report individual outcomes. Institutional confirmation of the applicable basis for secondary analysis remains necessary before submission; restricted reporting alone does not establish that permission.

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Conflict of interest

The authors declare no conflict of interest.

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Appendix A. Source-level evidence ledger

Table A1 identifies the documentary and embedded visual units. It records analytical uses without implying that all classroom moments were retained.

Table A1. Retained-source ledger and interpretive boundaries.

ID	Source unit	Recorded content	Permitted claim / boundary
D1	Final report, 50 pages	Institutional narrative, planned methods, activity sequence, embedded images	Supports context and sequence when corroborated; planned methods do not become completed methods
D2	Original manuscript	Intended mixed-methods framing; digital literacy and character claims	Supports analysis of intended claims only; overclaims are not carried into findings
D3	Title page/project records	Project title and institutional context	Project context; author-identifying information is supplied separately
V1	Classroom image: opening orientation	Teacher at front of class; students oriented toward board	Teacher-led opening; cannot infer attention, comprehension, or dosage
V2	Classroom image: whole-class explanation	Teacher presentation and classroom organisation	Task orientation; cannot reconstruct exact explanation or questions
V3	Classroom image: teacher circulation	Teacher near student groups during activity	Guided implementation; cannot assess scaffolding quality or contingency
V4	Classroom image: sketching	Student hand drawing a prototype design	Static design representation; supports Arts/Engineering, not Animation
V5	Classroom image: prototype handling	Students handling bottle-based apparatus and water	Material Technology and construction; cannot identify all roles
V6	Classroom image: layer assembly	Students arranging charcoal, gravel, sand, cotton or related media	Engineering assembly and group coordination; exact layer rationale not fully recoverable
V7	Classroom image: functional observation	Water passes through assembled bottle filter; students observe output	Functional test and observation; no measured water-quality outcome
V8	Classroom image: supported testing	Teacher/student handling near prototype during testing	Guided testing; cannot determine teacher talk or learner reasoning
V9	Photographed LKPD page 1	Sketch, material/volume-related entries, written responses	Paper-based evidence record; no verified student identity or digital literacy
V10	Photographed LKPD page 2	Tabular/ordered information and brief reflections	Comparison/organisation/reflection; completeness and authorship unknown
V11	Classroom image: group presentation	Students display product before class with teacher present	Public explanation and shared product; exact speech unavailable

The ledger is intentionally descriptive. It enables an independent reader to inspect the logic of the reconstruction without implying that the original project used this coding scheme or that all classroom moments were captured.

Appendix B. Unit-level coding matrix

Codes: S = science; T = material technology; E = engineering; Ar = arts; M = mathematics; An = animation; DL = verified learner digital activity; Sc = teacher scaffolding. A value of 1 records a qualifying trace, not a level of competence. Participation labels describe affordances or visible arrangements.

Table B1. Binary matrix for the 11 visual and artifact units

ID	Primary phase	S	T	E	Ar	M	An	DL	Sc	Participation affordance
V1	Opening orientation	0	0	0	0	0	0	0	1	-
V2	Whole-class explanation	0	0	0	0	0	0	0	1	-

ID	Primary phase	S	T	E	Ar	M	An	DL	Sc	Participation affordance
V3	Teacher circulation	0	0	0	0	0	0	0	1	-
V4	Design sketch	0	0	1	1	0	0	0	0	Task ownership
V5	Prototype handling	0	1	1	0	0	0	0	0	Cooperation; procedural care
V6	Layer assembly	0	1	1	0	0	0	0	0	Cooperation; procedural care
V7	Functional observation	1	1	1	0	0	0	0	0	Cooperation; care; close observation
V8	Supported testing	1	1	1	0	0	0	0	1	Cooperation; care; close observation
V9	LKPD page 1	1	0	0	0	1	0	0	0	Accountable recording
V10	LKPD page 2	1	0	0	0	1	0	0	0	Recording; reflection
V11	Group presentation	0	0	0	1	0	0	0	0	Cooperation; accountable reporting

Column totals are S = 4, T = 4, E = 5, Ar = 2, M = 2, An = 0, DL = 0, and Sc = 4. These totals reproduce the component and scaffolding frequencies in Table 4 and the component profile in Figure 2.