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Observational Assessment in the Creation of a Miniature Human Digestive System Using Recycled Materials: A Systematic Literature Review (SLR)

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ABSTRACT

Observational assessment is an authentic technique widely employed in project-based learning to directly evaluate students' processes, skills, and attitudes. However, the implementation of observational assessment in science projects, particularly in the creation of miniature human digestive systems using recycled materials, has rarely been investigated in depth. This research aims to analyze the assessment frameworks, procedures, indicators, and challenges of observational assessment within the context of anatomy miniature creation projects utilizing a recycling approach, through a Systematic Literature Review (SLR) method. The SLR process analyzed 32 relevant articles published between 2013 and 2025, retrieved from the Scopus, ERIC, and Google Scholar databases using strict inclusion and exclusion criteria, followed by thematic analysis. The findings of this review indicate that observational assessment is effectively utilized in project-based learning, where the most frequently assessed indicators were collaboration, scientific communication, creativity, and procedural accuracy. Furthermore, the use of recycled materials in miniature projects has been shown to foster contextual learning and environmental awareness. The primary challenges identified pertain to assessor subjectivity and the time constraints during observation activities. This study contributes to the advancement of authentic assessment methodology and provides a practical framework for implementing sustainability-based project learning. This review provides recommendations for the development of more comprehensive observational instruments and the integration of continuous assessment in science projects at the primary education level.

INTRODUCTION

The demands of 21st-century learning mandate that students not only master core theoretical concepts but also cultivate critical thinking, creativity, collaboration, and scientific communication skills. To realize these competencies, the Indonesian *Merdeka* Curriculum, along with various global contemporary educational frameworks, highly emphasizes a scientific approach powered by Project-Based Learning (PjBL) to provide authentic learning experiences (Kurt & Akoglu, 2023). In the context of primary natural science (*IPA*) education, the project of creating a three-dimensional miniature human digestive system serves as an effective instructional vehicle. This experiential project successfully integrates abstract anatomical concepts with tangible psychomotor skills and practical engineering logic (Wahyudi & Lazulva, 2021).

By designing, assembling, and reconstructing biological organ structures using real-world items, students acquire a deeper spatial visualization of organ arrangements, understand structural functions, and observe the interconnectedness of systems within the human body. This concrete project approach is proven to be significantly more meaningful than traditional teacher-centered lecture methods because it directly engages motoric collaboration. Furthermore, when synchronized with environmental education, utilizing post-consumer waste or recycled materials such as plastic bottles, cardboard, and used straws adds strategic value. This eco-centric method not only addresses resource constraints in limited classroom settings but also trains creative resource optimization and instills ecological sustainability awareness in students from an early age (Suwarno et al., 2020; Kunci et al., 2022).

In addition to improving conceptual understanding and environmental awareness, project-based learning also requires appropriate, objective, and comprehensive assessment strategies. While product evaluation is widely implemented because teachers can easily grade the final physical miniature,

evaluating the student's learning process requires specialized tools. Therefore, authentic assessment becomes an essential component in evaluating student performance during project workflows. Within this framework, observational assessment emerges as a highly relevant diagnostic technique. Conducted through direct monitoring of students' actions and collaborative attitudes, this technique allows educators to evaluate essential soft skills such as interpersonal cooperation, systematic meticulousness, engineering creativity, and troubleshooting behaviors in real-time without disrupting the learning activities.

Despite its critical importance, the systematic execution of observational assessment in classroom projects remains heavily compromised by multiple operational bottlenecks. Previous literature indicates that many primary school teachers face significant difficulties in designing valid and reliable observational instruments (Luh Nyoman Gita Acyuta Dewi et al., 2024). A major recurring challenge is assessor subjectivity, where unstructured observations frequently succumb to the teacher's personal perceptions or "halo effects" due to poorly defined behavioral indicators. Moreover, severe classroom time constraints and large student ratios often force teachers to focus exclusively on highly active or disruptive students, leaving the development of average students unrecorded. To circumvent this, recent studies suggest deploying detailed descriptive rubrics for each performance tier rather than relying on simple binary checklists. However, standard protocols regarding how these rubrics should be structured for green-PjBL are still lacking.

While research interest in authentic evaluation and project-based learning has increased over the last five years, a specific research gap remains largely unaddressed. Current academic literature predominantly focuses on the overall cognitive impact of PjBL or general student creativity, whereas studies systematically examining observational assessment practices are still rarely examined. More specifically, there is a distinct lack of empirical consensus regarding what specific behavioral indicators best capture "eco-creativity" when transforming trash into anatomical models, and how teachers can manage observational time constraints effectively in crowded primary science classrooms. Previous studies have failed to provide a unified framework or operational guidelines that integrate these variables systematically (Fukami, 2023; Nurfitriyana, 2017).

To address this methodological need, a Systematic Literature Review (SLR) is an ideal method to execute. An SLR allows for a rigorous review of diverse academic articles, tracking of finding patterns, and a critical look at the strengths and limitations of previous assessment rubrics (Marsakawati, 2014). By synthesizing prior empirical data, this systematic review evaluates indicator consistency, structural procedures, and instrument validity to establish evidence-based best practices for primary science teachers. Therefore, this study aims to systematically review previous literature concerning the implementation of observational assessment in project-based science learning, particularly in the creation of miniature human digestive systems using recycled materials.

RESEARCH METHODS

This study employed a Systematic Literature Review (SLR) method to identify, evaluate, and synthesize empirical findings concerning observational assessment practices in project-based science learning. Unlike primary field research, this review maps and interprets existing scientific publications to provide a comprehensive, evidence-based integration of the targeted pedagogical phenomenon (Kitchenham & Charters, 2007). To ensure operational rigor, transparency, and high replicability, the review strictly adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework (Page et al., 2021).

2.1 Search Strategy and Database Records

A comprehensive systematic literature search was conducted across multiple indexed academic databases: Google Scholar, ERIC, ScienceDirect, SpringerLink, Taylor & Francis Online, DOAJ, and the Indonesian national index Garuda. To maintain thematic relevance and temporal recency, the publication window was restricted to articles published between 2013 and 2025. The database search utilized specific combinations of Boolean operators (AND, OR) and wildcards, structured around the core parameters of the research question:

("observational assessment" OR "observation rubric" OR "authentic assessment") AND ("project-based learning" OR "PjBL") AND ("science model making" OR "digestive system model" OR "recycled materials" OR "alat peraga IPA")

2.2 Study Selection Criteria (PICO Framework)

To minimize selection bias and explicitly define the scope of the retrieved studies, the inclusion and exclusion parameters were systematically structured using the PICO (Population/Context, Intervention, Comparison, Outcome) framework, customized for educational research as detailed in Table 1.

Table 1. PICO Framework for Article Eligibility Criteria

Component	Inclusion Criteria	Exclusion Criteria
Population/ Context (P)	Science education contexts at the K-12 level, with a primary focus on primary school (*Sekolah Dasar*) or highly adaptable elementary learning environments.	Higher education, technical vocational tracks, or clinical anatomy training environments.
Intervention/ Focus (I)	Project-Based Learning (PjBL) models involving structural model-making, anatomy miniatures, or the utilization of post-consumer waste/recycled materials.	Traditional non-project instruction, purely theoretical classroom models, or digital simulations lacking physical construction elements.
Comparison (C)	Traditional product-only grading, diagnostic paper-and-pencil tests, or no explicit comparative assessment controls.	Not applicable (not restricted by comparative setups).
Outcome (O)	Empirical reporting on observational rubrics, behavioral indicators, soft skill measurement (collaboration, creativity), or structural assessment roadblocks.	Purely conceptual essays, opinion papers, editorial notes, or articles that evaluate cognitive test scores without detailing process rubrics.

Additionally, selected articles had to be peer-reviewed, written in English or Indonesian, and fully accessible in full-text format. Book chapters, conference abstracts lacking complete methodologies, and master's theses or doctoral dissertations were systematically excluded from the final sample.

2.3 Selection Workflow (PRISMA Stages)

The systematic article selection process progressed linearly through the four designated PRISMA Stage in Figure 1:

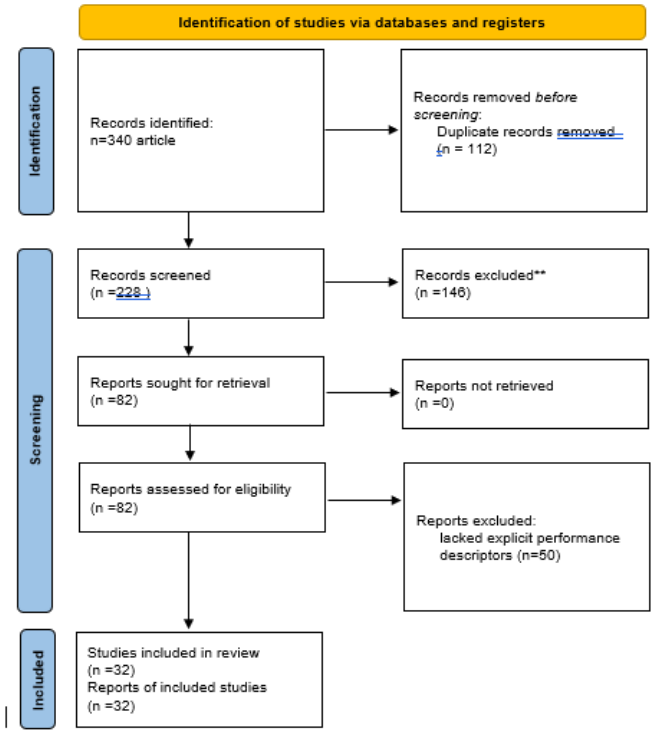

Figure 1. PRISMA Stage

a) **Identification:** The initial keyword execution across the designated electronic databases yielded a total body of literature consisting of 340 database records.
b) **Screening:** Automated and manual deduplication removed 112 duplicate entries, leaving 228 unique studies. The researchers subsequently screened the titles and abstracts of these 228 unique records, leading to the exclusion of 146 articles that did not isolate observational assessment or project workflows as active research variables.
c) **Eligibility:** The full text of the remaining 82 articles was retrieved and meticulously evaluated against the predetermined PICO eligibility criteria. During this phase, 50 articles were excluded because they lacked explicit performance descriptors or focused exclusively on final product evaluation without offering process-based observational data.
d) **Inclusion:** Following the exclusion steps, a final corpus of 32 empirical articles met all eligibility and quality parameters and was formally included in the analysis phase.

2.4 Data Extraction and Thematic Analysis

Data extraction from the 32 included studies was standardized using an analytical matrix that compiled key information: author(s), publication year, specific database source, core competencies measured, observational instrument design, implementation procedures, operational challenges, and explicit research recommendations.

The extracted data were analyzed using a thematic analysis approach to identify cross-study patterns and cluster findings into conceptual domains. To enhance the credibility, reliability, and validity of the analysis, the coding and theme categorization were conducted systematically based on recurring patterns across the selected studies. A double-coder methodology was applied, where two researchers independently executed the initial open coding (e.g., grouping specific behavioral indicators like "material modification" or "task negotiation"). Discrepancies in coding assignments or theme categorization were discussed thoroughly and resolved through consensus to achieve high inter-rater reliability. The emerging codes were ultimately synthesized into three definitive meta-themes: structural characteristics of science-PjBL observation instruments, adaptations for eco-centric projects, and operational challenges faced by assessors.

RESULTS AND DISCUSSION

3.1. Conceptual Framework and Synthesized Roles of Observational Assessment in PjBL

The thematic synthesis of the cross-study corpus demonstrates a unified consensus: observational assessment functions as the foundational mechanism that prevents project-based learning from devolving into unguided, unassessed activity. Traditional summative frameworks that exclusively evaluate final material products or written test outputs are structurally blind to the operational learning pathways of students. Conversely, the reviewed literature confirms that real-time observation allows educators to directly identify science process skills, interactive behaviors, and localized scientific attitudes as the project unfolds (Irianti & Noorhidayati, 2018; Kurt & Akoglu, 2023).

A comparative mapping of the literature shows that observational assessment is uniquely suited to capture implicit indicators that escape psychometric testing, such as engineering meticulousness, sustained perseverance, collaborative resource negotiation, and adaptive troubleshooting. In a project context, these behavioral milestones are captured mid-workflow. This enables teachers to track a student's cognitive processing and higher-order thinking skills (HOTS) by documenting how they make tactical adjustments when their physical designs face structural failure.

However, a significant contradiction emerges within the literature regarding the operational reality of this tool in primary classrooms. While global studies heavily praise the pedagogical flexibility of observational methods, a critical sub-cluster of local research warns of severe structural bottlenecks (Cahyono et al., 2023; Luh Nyoman Gita Acyuta Dewi et al., 2024). Specifically, when observation sheets are designed without detailed, multi-tiered performance rubrics, the assessment rapidly falls prey to extreme assessor subjectivity and the "halo effect" where highly vocal or naturally expressive students are systematically over-scored, while introverted students who contribute heavily to technical execution are under-recorded.

To mitigate these threats to instrument reliability, recent literature shows a strong shift toward combining analytical rubrics with multi-modal documentation, such as targeted anecdotal logs, sequential process photographs, or short video clips (Fukami, 2023; Setyawarno & Kurniawati, 2018). This integrated empirical tracking serves a dual purpose: it builds a solid evidence base that reinforces inter-rater reliability, and it creates a rich reflective framework for teachers to provide highly individualized feedback during formative milestones.

3.2 Synthesis of Anatomy Miniature Projects: Eco-Creativity, Psychomotor Skills, and Elementary Student Characteristics

When evaluating the integration of anatomy model-making with sustainability practices specifically the reconstruction of the human digestive system using post-consumer waste the literature reveals distinct thematic patterns regarding how observational metrics must adapt. This specialized educational cross-section challenges students to convert low-cost, disparate recycled items (e.g., plastic bottles, corrugated cardboard, discarded plastic tubes) into anatomically representative biological systems.

3.2.1 Cognitive Articulation and Concrete-Manipulative Learning

From a cognitive perspective, this review finds that creating three-dimensional models significantly improves spatial visualization and conceptual retention compared to traditional textbook learning (Setyawarno & Kurniawati, 2018). This finding aligns closely with the developmental characteristics of primary school students, who operate within Piaget's concrete operational stage. Because abstract internal anatomy cannot be viewed directly, primary students require tangible, manipulative activities to construct accurate mental models.

Observational data from the literature show that when students physically arrange recycled items into sequential order mapping the mouth to the esophagus, the stomach (using volumetric plastic containers), and the convoluted path of the intestines (using flexible hoses) they actively demonstrate their conceptual understanding of organ-to-function correspondence (Nurfitriyana, 2017; Suwarno et al., 2020). Teachers can observe and record these design choices as concrete evidence of functional anatomical comprehension.

3.2.2 Eco-Creativity vs. Psychomotor Constraints

The literature highlights a direct relationship between the forced constraints of using recycled materials and the development of student eco-creativity and divergent thinking (Kunci et al., 2022). Because students are restricted from using pre-fabricated commercial kits, they must look at waste items through a functional lens, assessing shapes, textures, and flexibility to mimic biological tissue.

However, this creative demand introduces a clear operational challenge concerning the psychomotor capabilities of primary school children, as summarized in the comparative matrix at Table 2 below:

Table 2. Summarized in the comparative matrix

Pedagogical Domain	Synergies in Eco-PjBL	Critical Roadblocks & Anomalies	Literature Synthesis & Consensus
Eco-Creativity & Divergent Thinking	Students reimagine waste items to mimic biological forms (e.g., bubble wrap for stomach texturing).	Forced constraints can frustrate younger students if materials fail to cooperate structurally.	Transforming waste develops high-level spatial and material innovation (Kunci et al., 2022; Suwarno et al., 2020).
Psychomotor Technical Proficiency	Hands-on manipulation of recycled materials improves fine motor control and tool coordination.	Children often struggle with the manual dexterity needed to cut, glue, and stabilize dense waste.	Observational rubrics must separate creative intent from physical dexterity to avoid grading bias (Setyawarno & Kurniawati, 2018).
Social Collaboration & Dynamics	Group work models real-world social interaction, task delegation, and collective problem-solving.	Peer exclusion, uneven task distribution, and communication breakdowns within teams.	Requires a structured observation matrix that focuses on equity and active listening (Irianti & Noorhidayati, 2018).

As a result, the compiled research emphasizes that observational rubrics must decouple pure mechanical dexterity from anatomical understanding and creative intent. This ensures that younger students are not penalized for age-appropriate psychomotor limitations when their structural models lack professional polish.

3.2.3 Affective Collaboration and Environmental Stewardship

In the affective domain, group-based model making provides a valuable sandbox for developing early childhood social skills and ecological responsibility. The analyzed studies show that when students collaborate on green projects, they demonstrate measurable growth in active listening, consensus building, and shared accountability (Irianti & Noorhidayati, 2018; Wahyudi & Lazulva, 2021).

Furthermore, using post-consumer waste introduces a vital environmental education dimension. Observational indicators designed to track eco-awareness reveal that students frequently internalize concepts of waste reduction, material efficiency, and resource sustainability as a direct result of these projects (Suwarno et al., 2020).

3.3 Critical Analysis of Systemic Challenges and Evaluator Constraints

Despite the clear pedagogical benefits, this Systematic Literature Review reveals a significant gap between theoretical ideals and classroom realities. The literature shows that primary school teachers regularly face severe structural constraints when implementing observational assessment at scale.

1. The Crisis of Evaluator Bandwidth (Time Scarcity): The most prominent issue across the literature is the unmanageable time demand placed on teachers (Luh Nyoman Gita Acyuta Dewi et al., 2024). In a standard primary science classroom containing 30 to 40 students divided into

multiple project groups, a single teacher cannot continuously observe and record nuanced behavioral indicators for every individual. This acute shortage of time often forces teachers to log entries only during major milestones or when a group experiences severe behavioral disruptions, making the data fragmented and unrepresentative of the overall class progress.

2. Cognitive Overload via Over-Engineered Rubrics: A recurring methodology failure identified in the literature is the design of over-complicated observation tools. Well-meaning researchers frequently supply teachers with massive evaluation sheets containing 15 to 20 detailed behavioral indicators per student. In an active classroom setting, attempting to track this many metrics simultaneously induces immediate evaluator fatigue, forcing teachers to abandon the rubrics mid-project or revert to shallow, subjective generalizations (Cahyono et al., 2023; Fukami, 2023).
3. The Limitation of Binary Checklists: Conversely, to save time, many schools resort to simple binary checklists (e.g., tracking collaboration as a simple "Yes/No" mark). The consensus across the SLR corpus indicates that these checklist designs strip away qualitative depth, rendering the assessment incapable of capturing true student growth or distinguishing between different levels of mastery (Setyawarno & Kurniawati, 2018).

3.4 Methodological Recommendations for Classroom Standardization

To address these systemic bottlenecks and answer our primary research questions, the synthesized literature points toward a standardized, dual-strategy mitigation framework:

1. Strategic Reduction of Observational Metrics: Rubrics must prioritize a streamlined set of maximum 4 to 5 core competencies (such as Procedural Accuracy, Interpersonal Collaboration, Material Transformation, and Safety). Each competency must be anchored to explicit, highly measurable performance descriptions rather than vague numerical scores (Cahyono et al., 2023).
2. Implementation of a Staged Observation Matrix: Teachers should not attempt to evaluate every competency simultaneously throughout the project. Instead, the observational workload should be distributed across three distinct, consecutive phases aligned with the project's natural progression:By dividing the assessment workload into localized phases, teachers can drastically reduce cognitive clutter, protect their evaluation bandwidth, and generate highly reliable process logs that capture true learning trajectories in primary science education.

CONCLUSION

This Systematic Literature Review (SLR) concludes that observational assessment is a highly effective, authentic evaluation strategy for sustainability-driven science project learning, specifically in the creation of miniature human digestive systems from recycled materials. The synthesis reveals that when anchored to clear analytical rubrics with explicit performance descriptors, observational assessment successfully measures multi-dimensional competencies including procedural anatomical accuracy, eco-creativity in waste modification, interpersonal collaboration, and psychomotor skills which are invisible to traditional testing. While the integration of post-consumer waste elevates concrete-manipulative learning and ecological literacy among elementary students, its execution faces severe operational bottlenecks, including single-assessor time scarcity and subjective scoring bias. To maximize reliability, this study highlights the necessity of implementing a staged, continuous observation matrix (Planning, Construction, Presentation) to preserve teacher evaluation bandwidth. Ultimately, this review contributes a practical, low-bias evaluation framework for educators, bridging the gap between rigorous scientific evaluation and environmental stewardship in primary science education.

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