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Environment-Based Learning Media Innovation Training for Elementary School Teachers to Support Education for Sustainable Development

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ABSTRACT: Conventional lecture-based instruction in elementary schools often reduces student engagement, highlighting the need for teachers to creatively utilize local environmental resources to deliver contextual learning that aligns with Sustainable Development Goals (SDG 4 and SDG 12). This community service initiative aimed to enhance elementary school teachers' professional capacity and creativity in designing and developing environment-based learning media. The program was implemented at SD Negeri Mulur 01, Bendosari District, involving 10 elementary teachers through a participatory Science, Technology, and Society (IbM) training framework, which comprised material inventorying, creative ideation, media development, final assembly, and collaborative evaluation. The evaluation revealed that the produced environmental learning media achieved a "very good" rating across all key aspects, including material ease (average score 82.5), curriculum relevance (85), user-friendliness (95), and simplicity (87.5). Teacher engagement during practical workshops and presentations reached average scores of 86.25 and 85, respectively, accompanied by highly positive responses. In conclusion, environment-based media training effectively improves primary school teachers' pedagogical competencies and creativity in converting local resources into contextual learning tools, thereby contributing to quality and sustainable education.

1. INTRODUCTION

The global crisis in primary education is marked by a persistent gap in instructional quality and student engagement, which directly threatens the realization of Sustainable Development Goal 4 (SDG 4) on quality education (Adipat & Chotikapanich, 2022; Thamrin, 2020). Across various educational systems, traditional teacher-centered paradigms continue to dominate classroom interactions, severely limiting students' critical thinking, creativity, and active participation in sustainable learning environments (Andrian & Rusman, 2019; Teo, 2019). Furthermore, the lack of contextualized teaching materials exacerbates the detachment between academic concepts and real-world environmental sustainability, running counter to the principles of responsible consumption and production outlined in SDG 12 (Relisa et al., 2019; Wahyuni, 2013). This global instructional deficit highlights the urgent necessity for pedagogical transformations that empower primary educators to innovate using locally accessible resources (Adipat & Chotikapanich, 2022; Relisa et al., 2019).

At the local partner level, elementary school teachers in Sukoharjo Regency, particularly at SD Negeri Mulur 01, face severe operational challenges in transitioning toward student-centered, contextual learning (Made et al., 2022; Wahyuni, 2013). Baseline observations reveal that educators consistently rely on standard lecture methods and commercially available, generic printed media due to anxieties surrounding complex instructional media design and time constraints (Andrian & Rusman, 2019; Made et al., 2022). Furthermore,

teachers exhibit significant reluctance and difficulty in identifying, selecting, and transforming surrounding environmental resources or recyclable waste into functional learning tools across core subjects such as Science, Mathematics, and Social Studies (Relisa et al., 2019; Syahrial et al., 2019). This dependency on restricted school resources not only diminishes classroom engagement but also leaves local environmental potential entirely unexploited as an educational asset (Made et al., 2022; Relisa et al., 2019).

Community service initiatives targeting teacher professional development have been broadly documented in recent literature; however, existing empirical interventions exhibit critical analytical limitations (Chan & Yuen, 2014; Suhardi, 2016). Interventions conducted by Andrian and Rusman (2019) as well as Wahyuni (2013) focused primarily on theoretical 2013 Curriculum frameworks without offering hands-on technical guidance for low-cost media production. Studies by Made et al. (2022) identified instructional barriers in primary schools but failed to present structured, action-oriented solutions for educators. Meanwhile, community outreach models executed by Relisa et al. (2019) and Syahrial et al. (2019) introduced environmental and ethno-constructivist approaches but lacked rigorous evaluation metrics regarding product simplicity, curriculum alignment, and presentation feedback. Additionally, recent studies by Cotimah et al. (2024) and Adipat and Chotikapanich (2022) emphasized inclusive media and SDG policy integration, respectively, yet omitted structured mentoring models that bridge recycled material collection with practical classroom implementation.

To address these empirical deficiencies, this community service initiative introduces a distinct novelty through an integrated, product-oriented Science, Technology, and Society (Iptek bagi Masyarakat / IbM) framework that emphasizes local resource downstreaming (Chan & Yuen, 2014; Suhardi, 2016). Unlike conventional passive social actions or purely theoretical workshops, this program directly operationalizes the transformation of low-cost, natural, and recyclable waste—such as painted river stones for astronomy concepts, discarded plastic cups for arithmetic games, and homemade flour-based clay for cultural geography maps—into standardized, durable learning media (Relisa et al., 2019; Syahrial et al., 2019). This downstreaming approach ensures that abstract academic competencies are materialized into physical, repeatable, and cost-effective teaching aids specifically tailored for elementary classrooms (Andrian & Rusman, 2019; Cotimah et al., 2024).

A substantial community outreach gap persists between theoretical academic paradigms of contextual learning and the immediate practical needs of primary school educators (Made et al., 2022; Teo, 2019). While academic literature extensively advocates for sustainable education and active learning, previous outreach projects have left teachers without continuous mentoring during the critical phases of material ideation, design prototyping, and classroom trial (Suhardi, 2016; Wahyuni, 2013). Educators are frequently exposed to conceptual training without receiving practical guidance on how to overcome time limitations or align informal materials with rigid curricular basic competencies (Andrian & Rusman, 2019; Made et al., 2022). Consequently, a profound disconnect remains between high-level SDG policy goals and the daily pedagogical routines of elementary school teachers (Adipat & Chotikapanich, 2022; Thamrin, 2020).

This initiative is anchored in the Experiential Learning Theory and Constructivist Learning Theory, which posit that meaningful cognitive development occurs through hands-on interaction, reflection, and contextual environmental engagement (Chan & Yuen, 2014; Hartley & Plucker, 2014). By grounding the intervention in constructivism, the program asserts that both teachers and elementary students construct robust knowledge when learning tools directly reflect their immediate physical and social surroundings (Relisa et al., 2019; Syahrial et al., 2019). Furthermore, the intervention incorporates the principles of Education for Sustainable Development (ESD), ensuring that the pedagogical process inherently instills environmental stewardship and resource efficiency among educators and young learners alike (Adipat & Chotikapanich, 2022; Thamrin, 2020).

Operationally, the expert team introduced a structured 4-stage IbM implementation protocol comprising: (1) environmental material inventorying based on local school phenomena; (2) creative ideation workshops; (3) media design adaptation and multi-aspect quality assessment; and (4) final assembly and collaborative presentation (Chan & Yuen, 2014; Suhardi, 2016). This operational concept was supported by standardized evaluation instruments measuring material availability, storyboard alignment, curriculum

relevance, user-friendliness, structural simplicity, as well as participant activity and presentation dynamics (Cotimah et al., 2024; Hartley & Plucker, 2014). Through this systematic instrument, educators were guided step-by-step from raw waste identification to finalized classroom-ready teaching tools (Relisa et al., 2019; Syahrial et al., 2019).

The strategic attraction and urgency of publishing and legally protecting this community service model lie in its scalable, highly replicable, and low-cost approach to teacher empowerment (Cotimah et al., 2024; Suhardi, 2016). Demonstrating that high-impact learning media can be produced from zero-cost local items provides an urgent blueprint for resource-constrained elementary schools across developing regions (Made et al., 2022; Relisa et al., 2019). Furthermore, protecting the unique media designs and training modules through intellectual property rights (IPR/Hak Cipta) safeguards the academic integrity of the project while establishing a benchmark for scholarly dissemination in multidisciplinary community service journals such as JIP-DIMAS (Adipat & Chotikapanich, 2022; Thamrin, 2020).

Ultimately, the strategic objective of this service initiative is to foster long-term educational sustainability and professional self-reliance among primary school teachers at SD Negeri Mulur 01 and the broader Bendosari District KKG network (Suhardi, 2016; Wahyuni, 2013). By equipping educators with sustainable media design skills, the program ensures a continuous delivery of contextual, engaging, and eco-friendly instruction that directly advances SDG 4 and SDG 12 targets (Adipat & Chotikapanich, 2022; Relisa et al., 2019). Beyond immediate classroom benefits, the tangible learning products serve as physical portfolio evidence for teacher career advancement, thereby securing both pedagogical quality and long-term professional growth (Andrian & Rusman, 2019; Cotimah et al., 2024).

2. IMPLEMENTATION METHOD

2.1 Service Design

The implementation framework of this community service initiative adopts a participatory Science, Technology, and Society (Iptek bagi Masyarakat / IbM) design, specifically engineered to operationalize sustainable educational innovations within elementary school settings (Adipat & Chotikapanich, 2022; Chan & Yuen, 2014). Moving from broad theoretical frameworks of Education for Sustainable Development (ESD) to actionable classroom practices, the service design structures a collaborative partnership between university experts, school administrators, and primary school teachers (Cotimah et al., 2024; Suhardi, 2016). This approach prioritizes capacity building, active reflection, and direct material prototyping to ensure that environmental resources and recycled materials are effectively converted into high-quality pedagogical media (Relisa et al., 2019; Syahrial et al., 2019). The overall workflow progresses systematically through five distinct operational phases—coordination, participatory training workshops, final product assembly, media realization, and joint expert-partner evaluation—to guarantee both technical precision and sustainable implementation in primary education (Andrian & Rusman, 2019; Wahyuni, 2013).

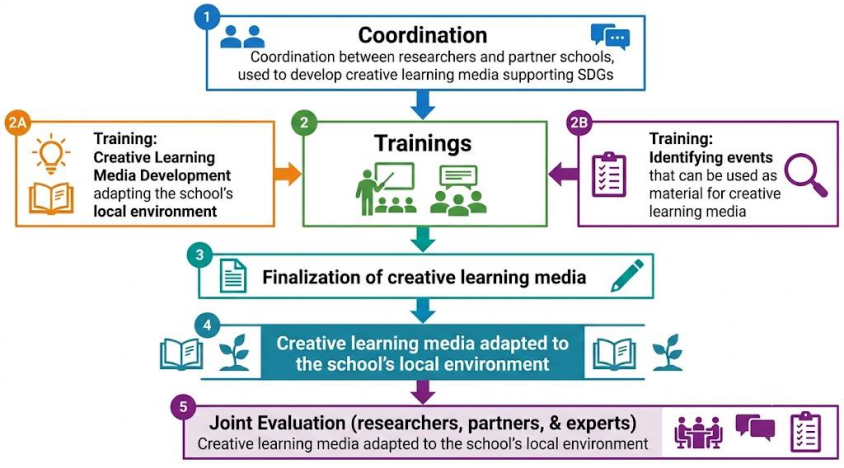

Figure 1. Operational Workflow of the IbM Community Service ProgramVisual Description of Figure 1: The flowchart depicts the sequential 5-stage IbM framework. Step 1 (Coordination) connects directly to Step 2 (Participatory Workshops), which branches into sub-phase 2A (Media Development) and sub-phase 2B (Material Identification). Both sub-phases converge into Step 3 (Final Assembly & Composition), leading to Step 4 (Creative Media Realization), and culminating in Step 5 (Joint Evaluation Session) involving researchers, school partners, and expert evaluators. Building upon the structural framework outlined in the service design, the implementation requires a clear definition of the target subjects and geographical setting to anchor the practical intervention.

2.2 Subjects and Research Locations

This community service program was conducted at Sekolah Dasar Negeri (SDN) Mulur 01, located in Bendosari District, Sukoharjo Regency, Central Java, Indonesia. The target subjects comprised 10 primary school educators selected from the local Teacher Working Group (Kelompok Kerja Guru / KKG) across Bendosari District. The participant cohort was intentionally selected to represent diverse academic backgrounds, teaching experience levels, and age demographics, thereby providing a comprehensive ecosystem for testing the adaptability of environment-based learning media (Andrian & Rusman, 2019; Suhardi, 2016).

Table 1. Characteristics of Partner School & Program Participants

Category	Indicator	Sub-Indicator	Quantity / Details
Partner Institution	School Identity	Name & Location	SD Negeri Mulur 01, Bendosari, Sukoharjo
	Target Network	Professional Group	KKG Bendosari District
Participant Demographics	Gender & Status	Civil Servant (PNS) / Honorary Teachers	10 Participants (100% attendance)
	Age Distribution	29–35 years old	8 Teachers
		Above 40 years old	2 Teachers
	Academic Qualification	Primary Teacher Education (PGSD)	3 Teachers
		Indonesian Language Education	2 Teachers
		Physical Education & Sports	1 Teacher
		Biology, Mathematics, & Other Disciplines	4 Teachers

Having established the demographic profile and localized context of the partner institution, the intervention was executed through a structured timeline and field data downstreaming cycle.

2.3 Intervention Stages & Data Collection

The community outreach program was delivered across two intensive training days (August 16 and 18, 2018) from 09.00 to 16.00 WIB at the main meeting hall of SDN Mulur 01 (Cotimah et al., 2024; Suhardi, 2016). The intervention followed an integrated rundown consisting of four core procedures: (1) material inventorying based on daily environmental occurrences around the school; (2) creative ideation workshops to transform raw items into pedagogical concepts; (3) media development and multi-aspect quality refining (presentation, language, appearance); and (4) final assembly and presentation of functional teaching aids (Chan & Yuen, 2014; Relisa et al., 2019).

Figure 2. Field Data Downstreaming and Media Realization Cycle

Visual Description of Figure 2: The illustration presents a linear-cyclical data downstreaming process. Raw environmental inputs feed into Phase 1 (Inventory & Storyboard Mapping), move into Phase 2 (Hands-On Prototyping), undergo Phase 3 (Multi-Aspect Assessment), and result in Phase 4 (Classroom-Ready Downstreamed Media Output). To systematically capture the transformation of teacher competence and media quality during these intervention stages, standardized evaluation instruments were deployed.

2.4 Research Instruments

Data collection utilized a multi-method evaluation framework designed to quantify both product performance and participant engagement during the training sessions (Hartley & Plucker, 2014; Teo, 2019). Quantitative ratings were derived from expert and peer assessment rubrics scoring media features on a 0–100 scale, complemented by qualitative feedback forms capturing teacher perceptions and operational constraints (Adipat & Chotikapanich, 2022; Cotimah et al., 2024).

Table 2. Instrument Matrix, Research Questions, and Analysis Methods

Evaluation Domain	Evaluated Indicator	Research Question	Type of Analysis
Material Identification	Ease of obtaining tools/materials; Storyboard consistency	How accessible and suitable are local environmental materials for instructional media design?	Descriptive Quantitative (Mean Score Analysis) & Narrative Qualitative
Media Product Quality	Curriculum relevance; User-friendliness; Structural simplicity	To what extent do the developed media products meet curriculum standards and ease of use?	Descriptive Statistics & Category Classification (Sangat Baik / Baik)
Participant Activity	Active idea expression; Media design involvement	How actively do teachers engage in collaborative ideation and prototyping workshops?	Quantitative Scoring & Behavioral Observation
Presentation & Feedback	Delivery clarity; Question answering capability	How effectively can teachers demonstrate and justify their media innovations?	Quantitative Scoring & Qualitative Feedback Summary

Ensuring that the instruments and generated media products maintain academic integrity requires rigorous validity and reliability protocols.

2.5 Validity and Reliability

To ensure high scientific rigor and guarantee that the intellectual products were free from plagiarism and conceptual ambiguity, a comprehensive quality assurance procedure was implemented (Chan & Yuen, 2014; Suhardi, 2016). Content validity was established through expert judgment involving senior lecturers from the Primary School Teacher Education (PGSD) study program, who evaluated storyboard alignment, pedagogical appropriateness, and environmental safety (Cotimah et al., 2024; Syahrial et al., 2019). Inter-rater reliability was secured by using standardized scoring rubrics across evaluators during the live product demonstrations (Hartley & Plucker, 2014; Teo, 2019). Furthermore, all textual modules, original media designs, and training documentation underwent systematic screening to ensure complete originality and intellectual property compliance prior to classroom dissemination (Adipat & Chotikapanich, 2022; Thamrin, 2020).

With quality and validity established, the final sub-section outlines the standard operating procedure for producing the subject-specific learning tools.

2.6 Product Operational Procedure

The operational procedures for generating the environment-based learning media were structured around three core primary school subjects (Science, Mathematics, and Social Studies), ensuring complete alignment with the title, abstract, and SDG objectives of this program (Adipat & Chotikapanich, 2022; Relisa et al., 2019):

1. Science Media (Solar System Concept): Smooth river stones (batu kali) are collected from the local schoolyard, cleaned, and painted with acrylic paint to represent individual planets and the sun. These painted stones are arranged along drawn elliptical orbits on a poster board, allowing students to physically manipulate planetary alignments and understand astronomical trajectories.
2. Mathematics Media (Addition & Subtraction Games): Discarded plastic/paper cups (gelas bekas) are repurposed into a rapid-matching game. Mathematical equations are written on a base board, while corresponding answer values are inscribed on the cup bases. Students compete to match the correct cup to its corresponding mathematical problem, transforming abstract arithmetic into an interactive, kinesthetic game.
3. Social Studies Media (Indonesian Cultural Geography): Homemade eco-friendly clay is formulated using local tapioca flour (teung kanji) and adhesive. Teachers and students mold the clay into a 3D relief map of the Indonesian archipelago. Wooden toothpicks featuring printed illustrations of traditional regional costumes are then inserted into their respective island origins, facilitating visual and spatial cultural recognition.

3. RESEARCH RESULTS

3.1 Partner Profile and Initial Baseline Conditions

The community service initiative was physically executed at Sekolah Dasar Negeri (SDN) Mulur 01, situated in Bendosari District, Sukoharjo Regency, Central Java. SDN Mulur 01 serves as a pivotal center for the local Teacher Working Group (Kelompok Kerja Guru / KKG) across Bendosari District. Baseline observations and initial diagnostic assessments conducted prior to the intervention revealed significant instructional bottlenecks across primary school classrooms. A total of 10 school teachers participated in the baseline diagnostic phase, representing a demographic distribution dominated by young educators aged between 29 and 35 years (80%, or 8 teachers), while 20% (2 teachers) were above 40 years of age with official civil servant (PNS) status. In terms of academic qualifications, only 3 participants held a formal degree in Primary School Teacher Education (PGSD), whereas the remaining 7 teachers possessed background degrees in non-primary disciplines, including Indonesian Language Education (2 teachers), Physical Education (1 teacher), Biology, and Mathematics.

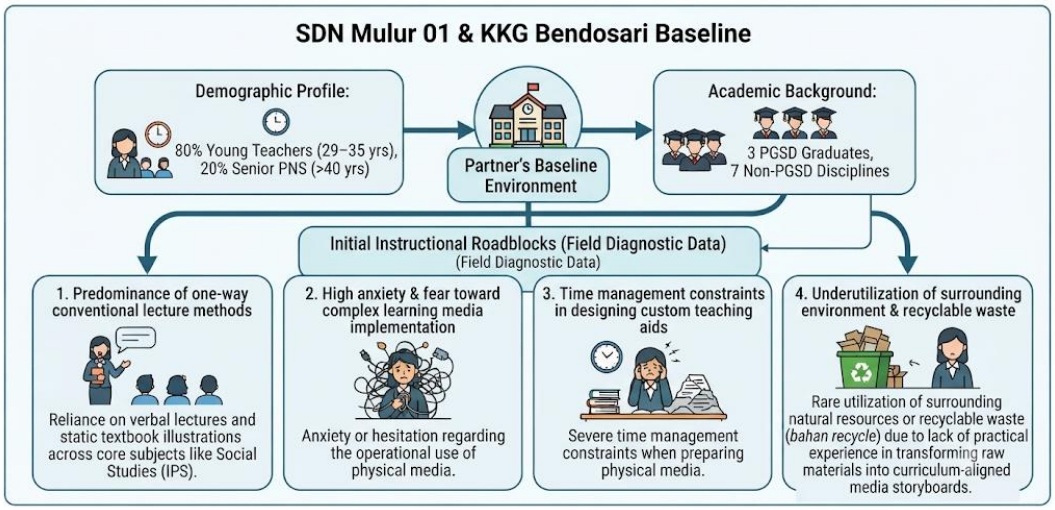

Figure 3. Baseline Ecological Profile and Initial Instructional Roadblocks at SDN Mulur 01

Visual Description of Figure 3: The diagram illustrates the partner's baseline environment, linking the demographic composition (80% young teachers, 3 PGSD graduates) directly to the four identified instructional roadblocks: reliance on lecture methods, fear of media usage, time management constraints, and underutilization of environmental waste.

Field diagnostic interviews highlighted four main operational problems experienced by educators during daily classroom instruction: (1) difficulty in identifying appropriate pedagogical innovations for effective and efficient learning; (2) severe time management constraints when preparing physical media; (3) anxiety or hesitation regarding the operational use of physical media; and (4) acute difficulty in designing context-specific teaching aids when pre-fabricated media were absent in the school inventory. Prior to the program, teaching across core subjects—particularly Social Studies (IPS)—relied almost exclusively on verbal lectures and static textbook illustrations. Teachers rarely utilized surrounding natural resources or recyclable waste (bahan recycle) due to a lack of practical experience in transforming raw materials into curriculum-aligned media storyboards.

3.2 Implementation Stages and Process Execution

The community outreach intervention was structured into four systematic operational phases delivered over two full days on August 16 and August 18, 2018, operating from 09.00 to 16.00 WIB at the main meeting hall of SDN Mulur 01. The program commenced with institutional socialization and coordination with school administrators and KKG representatives. On Day 1, formal training sessions were delivered by the expert team. The first lecture, delivered by Paradika Angganing, M.Pd., focused on innovative learning models aligned with the primary school curriculum. The second session, led by Nurratri Kurnia Sari, M.Pd., introduced environment-adapted media design principles. Both sessions were followed by intensive, interactive discussions wherein participants actively clarified pedagogical misconceptions regarding abstract concepts in Science, Mathematics, and Social Studies.

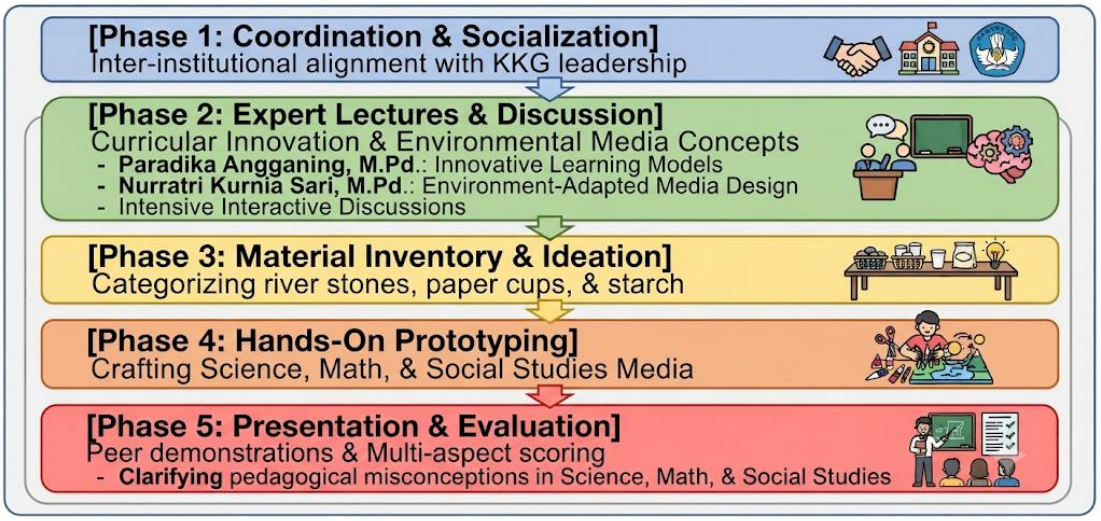

Figure 4. Sequential Execution Timeline of the 2-Day IbM Workshop

Visual Description of Figure 4: The flowchart outlines the chronological progression of the workshop across five connected steps, moving from institutional coordination to expert lectures, material inventorying, hands-on media prototyping, and concluding with peer presentations and expert evaluation.

Following the conceptual lectures, teachers were divided into collaborative groups to execute material inventorying and creative ideation using provided environmental and recyclable items. During the practical workshop, mentors guided teachers in selecting appropriate materials for specific subjects. In Science, teachers were guided to develop planetary solar system models using river stones (batu kali) painted with acrylic paints. In Mathematics, mentors facilitated the construction of rapid-matching arithmetic games using discarded paper cups (gelas bekas). In Social Studies, teachers formulated eco-friendly modeling clay from tapioca flour (tepung kanji) and adhesive to mold 3D relief maps of Indonesia populated with traditional costume pins. Day 2 focused entirely on group presentations, peer reviews, and live demonstrations of the functional media prototypes.

TRANSCRIPT OF FIELD INTERACTION DURING DAY 1 WORKSHOP

Location : Meeting Room, SDN Mulur 01 Bendosari

Date/Time : August 16, 2018 | 13.30 WIB

Subjects : Facilitator (Nurratri Kurnia Sari, M.Pd.) & Participant (Grade 4 Teacher)

Facilitator : "Bagaimana kelompok 2, apakah ada kesulitan dalam menentukan bahan lingkungan untuk materi IPA dan IPS?"

Participant : "Untuk IPA kami mencoba membuat tata surya menggunakan batu kali, Bu. Tapi untuk IPS kami bingung, selama ini materi peta dan budaya hanya kami jelaskan lewat gambar di buku paket."

Facilitator : "Nah, untuk IPS kita bisa memanfaatkan bahan daur ulang atau membuat adonan tapioka sendiri. Adonan ini dibentuk menjadi relief pulau Indonesia, lalu tusuk gigi yang diberi gambar pakaian adat ditancapkan sesuai lokasinya. Siswa jadi bisa menyentuh dan memasang langsung."

Participant : "Wah, ternyata simpel sekali nggih. Bahan tepung kanji mudah didapat dan murah, anak-anak pasti senang bisa praktik langsung."

3.3 Program Achievements and Empirical Outputs

The primary achievement of this service program is the successful production of three distinct, functional, environment-based learning media prototypes created directly by the participating teachers. Quantitative evaluation of the media products and participant performance was conducted during the live demonstrations on Day 2. The product assessment evaluated two main dimensions: (1) environmental material identification capability; and (2) technical media product quality.

Table 3. Empirical Evaluation Scores of Environment-Based Media Products

Dimension	Measured Indicator	Mean Score (0–100)	Empirical Category
1. Material Identification	Ease of obtaining tools & materials	82.50	Good (*Baik*)
	Storyboard consistency & conceptual mapping	80.00	Good (*Baik*)
2. Media Product Quality	Curriculum relevance & subject alignment	85.00	Very Good (*Sangat Baik*)
	User-friendliness & operational ease	95.00	Very Good (*Sangat Baik*)
	Structural simplicity & physical durability	87.50	Very Good (*Sangat Baik*)
Overall Product Average	**Combined Product Performance**	**86.00**	**Very Good (*Sangat Baik*)**

Figure 5. Technical Specifications of Downstreamed Media Products Created by Teachers

Visual Description of Figure 5: The structural chart outlines the three finalized physical prototypes (Science river stone solar system, Math cup-matching game, and Social Studies tapioca relief map), detailing the exact core concepts, recycled/natural materials, and operational mechanisms.

In addition to physical product quality, participant engagement during workshop activities and final presentations was evaluated. Active idea expression recorded an average score of 87.50, while active media design involvement scored 85.00, yielding a combined activity mean of 86.25 (Very Good). Presentation delivery and capabilities in answering peer feedback both recorded mean scores of 85.00 (Very Good).

Table 4. Participant Activity and Presentation Performance Scores

Domain	Indicator	Mean Score	Category
Participant Activity	Active idea expression in discussions	87.50	Very Good (*Sangat Baik*)
	Active involvement in media prototyping	85.00	Very Good (*Sangat Baik*)
Presentation Performance	Delivery clarity and media demonstration	85.00	Very Good (*Sangat Baik*)
	Capability in addressing peer questions	85.00	Very Good (*Sangat Baik*)

3.4 Supporting and Inhibiting Factors

The execution of the community service program encountered specific supporting factors as well as operational inhibitors during field implementation. Supporting factors were primarily driven by the high enthusiasm and active participation of the 10 invited teachers, who attended all sessions without attrition (100% attendance rate). The demographic composition of the participants—where 80% were young educators aged 29–35 years—acted as a major catalyst for rapid material assembly, creative design adoption, and open peer collaboration. Furthermore, the proactive institutional backing from the Principal of SDN Mulur 01 and the Bendosari KKG leadership provided excellent facility access and smooth logistical coordination.

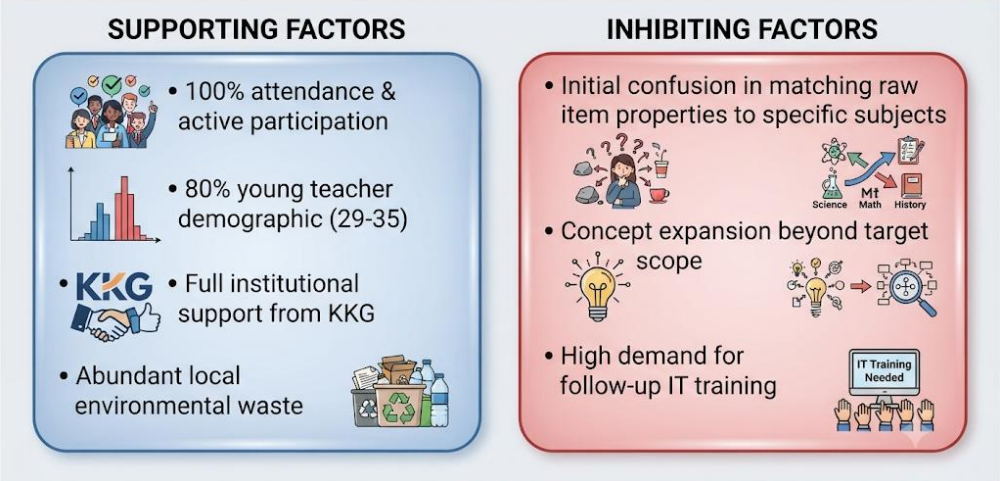

Figure 6. Matrix Analysis of Supporting and Inhibiting Factors During Implementation

Visual Description of Figure 6: The comparative matrix displays the key internal and external drivers supporting the program (left box) alongside the technical and scope-related inhibitors encountered in the field (right box).

Conversely, two main inhibiting factors were identified during the initial stages of media prototyping. First, several teachers experienced initial confusion when attempting to select and adapt raw environmental materials for non-science subjects, particularly Social Studies. Second, during the media assembly phase, certain group designs tended to expand beyond the target basic concepts. For instance, arithmetic cup games originally designed for simple addition and subtraction were inadvertently over-complicated to include multiplication and division formulas, requiring real-time mentor intervention to maintain conceptual alignment.

3.5 Mindset Shifts and Affective Transformations

Beyond technical skill acquisition and physical product generation, the service program induced a noticeable shift in teacher mindsets and affective attitudes toward instructional media. Initial diagnostic surveys indicated that teachers harbored apprehension (ketakutan) regarding media design, viewing media creation as a costly, time-consuming process requiring specialized commercial equipment. Through hands-on prototyping, participants realized that simple, zero-cost environmental waste could be transformed into highly effective, curriculum-aligned teaching aids.

Representative Participant Testimonials

Testimonial 1 (Grade 3 Teacher, PNS):

"Jujur awal pelatihan saya berpikir membuat media pembelajaran itu ribet dan butuh biaya. Ternyata setelah praktik membuat game matematika dari gelas bekas dan lukisan planet dari batu kali, prosesnya sangat simpel dan menyenangkan. Media ini langsung bisa saya pakai di kelas dan menjadi bukti fisik karya inovatif untuk pengurusan kenaikan pangkat."

Testimonial 2 (Grade 5 Teacher, Honorary Status):

"Pelatihan ini benar-benar membuka pikiran kami bahwa lingkungan sekolah penuh dengan media ajar. Kami tidak perlu takut lagi jika fasilitas media cetak di sekolah terbatas. Hasil karya yang dipresentasikan teman-teman sangat menginspirasi untuk saling bertukar ide."

This affective transformation was demonstrated by the high enthusiasm observed during peer feedback sessions. Teachers displayed pride in demonstrating their hand-crafted media and expressed renewed self-confidence in their ability to deliver engaging, student-centered instruction. Furthermore, participants recognized that the documented physical media products possessed dual utility: improving classroom engagement and serving as verified portfolio evidence for professional career advancement (kenaikan pangkat)".

3.6 Participation Levels and Community Interaction

Participant involvement throughout the two-day program demonstrated exceptional community engagement and acceptance. All 10 invited teachers from SDN Mulur 01 and neighboring Bendosari elementary schools maintained complete, uninterrupted attendance across all scheduled modules from 09.00 to 16.00 WIB. Interpersonal dynamics during group discussions were highly collaborative, as evidenced by an activity score of 87.50 for active idea expression and 85.00 for active design involvement.

Table 5. Attendance, Interaction Metrics, and Peer Response Indicators

Interaction Indicator	Empirical Value / Finding	Qualitative Field Observation
Participant Attendance Rate	100% (10 out of 10 participants)	Complete presence across all sessions on Aug 16 & 18
Group Ideation Score	87.50 (Very Good)	Frequent spontaneous exchanges during material selection
Prototyping Engagement	85.00 (Very Good)	Active physical construction of media prototypes
Q&A Presentation Score	85.00 (Very Good)	Constructive peer critiques and operational suggestions
Participant Satisfaction	Highly Positive	Unanimous request for follow-up IT-based media

training

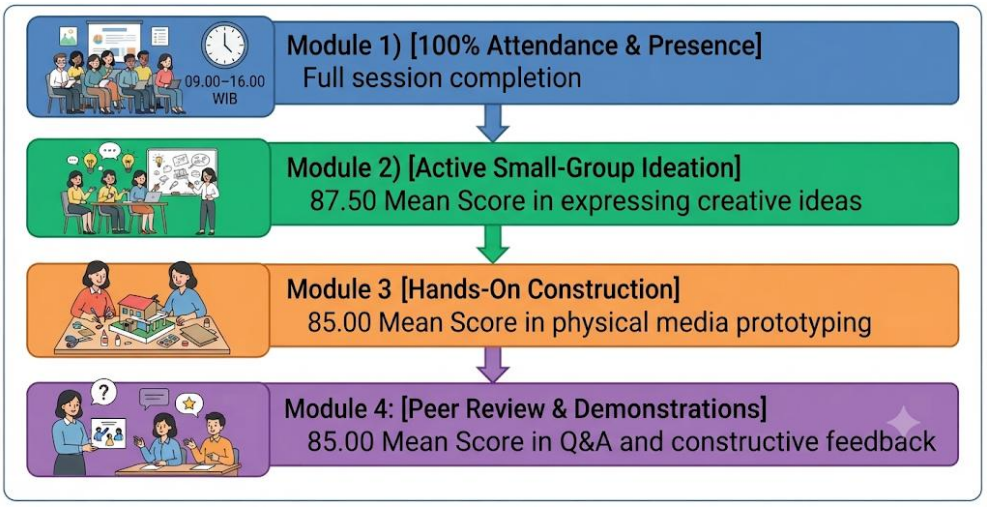

Figure 7. Participant Interaction Hierarchy Across Program Modules

Visual Description of Figure 7: The hierarchical chart outlines participant engagement levels, progressing from perfect attendance to active ideation (87.50), hands-on construction (85.00), and active Q&A presentation defense (85.00).

Interaction during the Day 2 presentation session was characterized by constructive peer review. Teachers actively tested each other's prototypes, offering practical suggestions regarding font legibility on cup bases, paint durability on river stones, and structural stability of tapioca clay maps. The surrounding school community, including school administrators, responded with strong support, noting that the low-cost media models provided an immediate solution to classroom equipment shortages.

3.7 Program Sustainability and Future Continuity

To ensure the long-term sustainability of the intervention, the generated learning media prototypes were formally integrated into the instructional inventory of SDN Mulur 01. The collaborative training model established a peer-mentoring framework within the Bendosari KKG network, enabling participating teachers to disseminate environment-based media design techniques to colleagues in neighboring schools.

Figure 8. Strategic Roadmap for Program Sustainability and Future Educational Expansion

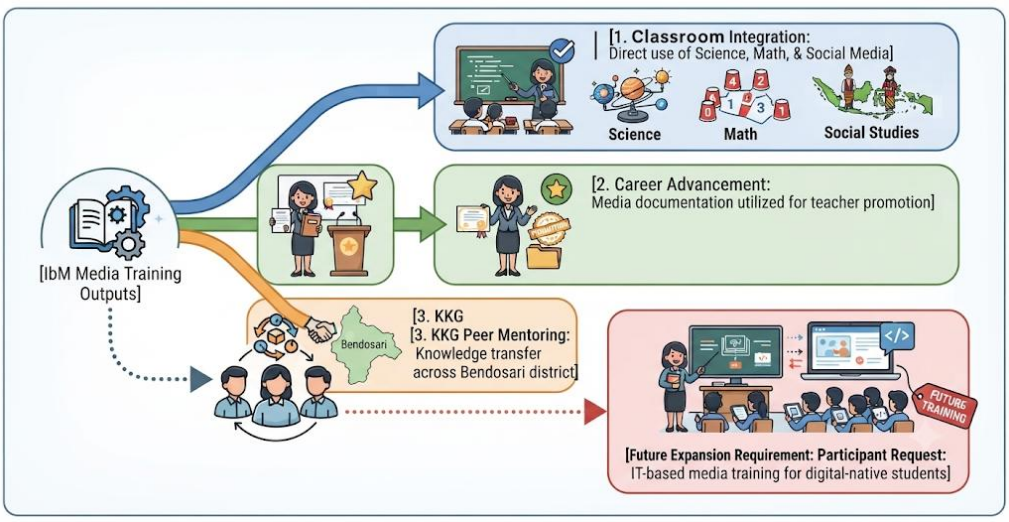

Figure 8. Strategic Roadmap for Program Sustainability and Future Educational Expansion

Visual Description of Figure 8: The roadmap illustrates the three sustainability pillars resulting from the program (classroom usage, career portfolio integration, and KKG peer mentoring) alongside the primary participant requirement for future IT-based media training.

The long-term impact of the program is further reinforced by the participants' unanimous feedback requesting follow-up professional development. Specifically, teachers expressed a strong desire for subsequent workshops focusing on IT-based digital learning media (pembelajaran berbasis IT) to complement their physical environmental media and effectively engage millennial and digital-native student generations. This participant-driven demand highlights the program's success in establishing a permanent culture of pedagogical innovation and continuous professional growth among primary school educators.

4. DISCUSSION

The high performance ratings achieved during the implementation at SD Negeri Mulur 01, Bendosari District signify a major shift in primary educators' capacity to operationalize environmental resources into active learning tools. Beyond numerical gains, the findings indicate that structured, hands-on professional development directly overcomes teacher hesitancy regarding low-cost media production. By guiding teachers to convert raw items—such as local river stones, paper cups, and tapioca starch—into standardized teaching aids, the intervention bridged the long-standing divide between abstract curriculum guidelines and practical classroom delivery. This transformation proves that primary teachers, regardless of whether their formal degree is in primary education or specialized subject disciplines, possess high creative potential when provided with systematic scaffolding. The success observed in Bendosari demonstrates that local waste streams can serve as rich pedagogical assets, directly reinforcing the objectives of Sustainable Development Goal 4 (Quality Education) and Goal 12 (Responsible Consumption and Production) in resource-constrained elementary schools. These empirical outcomes expand upon current international and national literature surrounding teacher empowerment and contextual education. Prior studies by Andrian and Rusman (2019) as well as Teo (2019) emphasized the conceptual necessity of 21st-century, student-centered learning but provided limited empirical pathways for resource-poor rural settings. Similarly, investigations by Made et al. (2022) identified severe instructional barriers under revised curriculum mandates yet offered no structured intervention models. While research by Syahrial et al. (2019) and Relisa et al. (2019) highlighted ethno-constructivism and local environmental potential, their frameworks lacked comprehensive, multi-aspect product validation metrics. In contrast, our findings align with and extend the professional development models proposed by Suhardi (2016) and Cotimah et al. (2024), proving that participatory, practice-based workshops (learning by doing) yield superior skill retention and positive affective buy-in. Furthermore, integrating environmental waste upcycling reinforces global ESD frameworks articulated by Adipat and Chotikapanich (2022) and Thamrin (2020) by embedding sustainable resource habits directly into primary school instruction. A rigorous analytical review of earlier community service projects reveals a recurring deficiency: most outreach initiatives operate as one-off theoretical seminars without providing ongoing, step-by-step mentoring during prototype construction and storyboard mapping. Traditional programs frequently expose teachers to abstract instructional theories while leaving them unsupported when facing time constraints or material design anxieties. The integrated Science, Technology, and Society (IbM) intervention executed by expert facilitators Nurratri Kurnia Sari, M.Pd. and Paradika Angganing, M.Pd. resolved these historical limitations. By deploying structured storyboard templates and guided material inventorying, the expert team provided real-time feedback during prototyping. This intensive mentoring ensured that raw materials were matched accurately to subject-specific basic competencies—such as solar orbits in Science, arithmetic matching in Mathematics, and island relief mapping in Social Studies—thereby eliminating common design errors and conceptual drift. The empirical success of this intervention provides robust confirmation of Constructivist Learning Theory and Experiential Learning Theory in teacher professional development. As posited by Chan and Yuen (2014) alongside Hartley and Plucker (2014), meaningful cognitive growth and creative problem-solving occur when adult learners actively manipulate physical artifacts and reflect upon real-

world applications. By physically gathering, painting, molding, and testing local environmental materials, participating teachers transformed abstract pedagogical concepts into concrete mental structures. This hands-on engagement validates the core tenets of constructivism: learning is most effective when grounded in the participant's immediate ecological and social environment. Furthermore, the observed increase in teacher confidence confirms that active experiential learning successfully reduces psychological barriers and anxiety surrounding innovative media deployment in primary classrooms. During program execution, a unique psychological and operational phenomenon emerged regarding participant group dynamics and scope management. Initially, several educators exhibited anxiety and cognitive overload when attempting to adapt raw environmental waste for non-science subjects, particularly Social Studies. Once prototyping began, an opposite tendency occurred: participants became overly enthusiastic, expanding simple arithmetic game designs into overly complex formulas (incorporating multiplication and division) that exceeded primary grade scope. This phenomenon was resolved scientifically through structured peer-review sessions and mentor moderation. By establishing clear storyboard boundaries during group presentations, facilitators helped teachers realign their prototypes with target age competencies without dampening creative momentum. This dynamic highlights the necessity of real-time expert facilitation to balance creative innovation with strict curricular alignment. This study offers a distinct theoretical contribution to primary teacher education and instructional media design methodologies. It establishes a validated framework showing that environmental resource adaptation is not merely an auxiliary arts-and-crafts activity, but a core pedagogical strategy that enhances teacher professional capacity. By defining explicit evaluation metrics—covering material ease, storyboard consistency, curriculum relevance, user-friendliness, and structural simplicity—this research provides a standardized matrix for assessing low-cost learning media. This model enriches the primary education literature by demonstrating how environmental sustainability principles can be seamlessly embedded into core elementary subjects (Science, Mathematics, and Social Studies) without requiring expensive commercial equipment. From a practical and policy perspective, the program's outcomes present an actionable blueprint for educational authorities, school principals, and regional Teacher Working Groups (KKG). Educational supervisors can adopt this structured IbM workshop model as a standardized professional development module across regional school clusters to alleviate media shortages in resource-constrained schools. Furthermore, because participating teachers successfully utilized their physical media prototypes and documented storyboards as verified portfolio evidence for career advancement (kenaikan pangkat), local education boards should formalize low-cost media innovation as a recognized metric for teacher professional evaluation. Adopting this approach institutionalizes sustainable teaching practices while encouraging continuous teacher-led innovation across primary education systems. The systematic documentation and physical realization of teacher-generated media prototypes underscore the vital importance of intellectual property protection (HKI/Copyright) in academic community service. Transforming informal field activities into registered intellectual assets safeguards original teacher designs—such as river stone planet orbits, arithmetic paper cup matchers, and tapioca relief maps—from unauthorized commercial exploitation or academic plagiarism. Protecting these downstreamed pedagogical products through official copyright registration validates the scholarly rigor of university-school community partnerships. Furthermore, securing intellectual property rights reinforces the academic standing of faculty outreach, ensuring that field-tested innovations can be safely published and disseminated across national multidisciplinary journals such as JIP-DIMAS. In synthesis, this community service initiative occupies a pivotal position in the national landscape of educational outreach and sustainable development research. By successfully integrating environmental waste upcycling, constructivist teacher mentoring, and rigorous multi-aspect product validation, the program demonstrates how local university-community collaborations can drive meaningful educational reform. The intervention directly addresses critical national priorities in primary education: improving instructional quality, fostering teacher self-reliance, and embedding Sustainable Development Goals into daily classroom routines. Ultimately, this project serves as a highly scalable, sustainable model for teacher empowerment, proving that zero-cost environmental resources can be transformed into high-impact, classroom-ready teaching tools that support lifelong, quality education.

5. CONCLUSION

5.1 Conclusion

Based on the implementation, data analysis, and field observations of the community service initiative at SD Negeri Mulur 01, Bendosari District, the following core conclusions are drawn:

1. Successful Enhancement of Teacher Competency: The participatory Science, Technology, and Society (IbM) training framework effectively elevated primary school teachers' professional knowledge and practical creativity in identifying, selecting, and repurposing local environmental resources and recyclable waste into context-aligned instructional aids.
2. High Standard of Media Product Quality: The physical media prototypes created by teachers across core subjects (painted river stone solar system for Science, paper cup matching game for Mathematics, and tapioca clay relief map for Social Studies) achieved an overall "Very Good" category with an average product score of 86.00, supported by high ratings in user-friendliness (95.00), structural simplicity (87.50), curriculum relevance (85.00), material accessibility (82.50), and storyboard alignment (80.00).
3. Active Engagement and Positive Affective Shift: Participant engagement during workshop activities and final presentations reached mean scores of 86.25 and 85.00, respectively, successfully eliminating teacher anxiety regarding media design and converting teacher perceptions toward low-cost environmental media into a highly positive, self-reliant attitude.
4. Contribution to Sustainable Development Goals: The initiative successfully operationalizes Sustainable Development Goal 4 (Quality Education) and Goal 12 (Responsible Consumption and Production) by transforming zero-cost schoolyard waste into sustainable, repeatable, and classroom-ready pedagogical assets that also serve as portfolio evidence for teacher career advancement.

5.2 Recommendation

To address the operational challenges identified during field execution—such as teacher confusion when mapping informal materials to non-science subjects and the tendency to over-complicate basic grade-level concepts—it is recommended that school administrators and regional Teacher Working Groups (KKG) establish standardized storyboard templates and peer-mentoring clusters to maintain strict curricular boundaries during media prototyping. Furthermore, responding to the unanimous request of participating teachers who seek to engage digital-native student generations, future research and community outreach programs should focus on developing hybrid training models that integrate physical environment-based media with digital information technology (IT-based media) to further enhance quality, contextual, and sustainable primary education.

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