

# **Development A 3R-Integrated Project Based Learning Model: Fostering Ecological Awareness And Pro-Environmental Behavior In Early Childhood**

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DOI: [10.31004/obsesi.v10i5.8547](https://doi.org/10.31004/obsesi.v10i5.8547)

## **Abstract**

This study was motivated by low ecological awareness among early childhood and the absence of structured learning models addressing environmental issues in PAUD institutions. The study aimed to develop a 3R-based (Reduce, Reuse, Recycle) Project Based Learning model that is valid, practical, and effective in stimulating ecological awareness in children aged 5–6 years, using Research and Development adapting the ADDIE model. A small-scale trial involved 13 children and a field trial involved 34 children in Ogan Ilir Regency. Data were collected through needs analysis questionnaires, expert validation sheets, a 22-item observation instrument measuring children's ecological awareness across knowledge, attitudes, and 3R behavior dimensions, and a teacher practicality questionnaire; analyzed using Aiken's V, Mi+SDi, Wilcoxon Signed-Rank Test, and N-Gain. The model was rated highly feasible by media experts (score 82) and feasible by material experts (score 74.33), with instrument validity  $V = 0.92$ . The model proved effective (N-Gain 0.47 and 0.46, Wilcoxon  $p < 0.05$ ) and highly practical (544/600), with notable improvements in children's ability to reduce waste usage, sort waste by type, and creatively reuse materials into functional items. This model is recommended as a structured and practical guide for teachers implementing 3R-based environmental learning in early childhood education.

**Keywords:** *3r based project based learning; ecological awareness; early childhood*

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Received 7 August 2026, Accepted 7 September 2026, Published 7 September 2026

## **Introduction**

This condition places environmental issues not merely as ecological issues, but as a civilizational crisis that demands responses from various aspects of life, including the education sector, which has a strategic role in shaping the character and behavior of future generations. Based on this problem, ecological awareness needs to be instilled in every individual, especially from an early age encompassing three interrelated dimensions, namely knowledge, attitude, and behavior toward the environment, so that efforts to build it cannot be carried out separately but must be integrated and comprehensive (Stavreva Veselinovska et al., 2025; Utara et al., 2024). (Anggereni & Azizy (2025) in their recent study on strategies for introducing environmental and sustainability concepts in early childhood education, found that ecological understanding developed during the early years of a child's life serves as a strong foundation for the formation of environmentally friendly behavior in adulthood. The urgency of fostering environmental awareness in early childhood education is not merely a concern in Indonesia but has long been a serious priority on the global education agenda focused on sustainable development.

Early childhood, spanning the prenatal period to six years of age, is the most strategic group for receiving stimulation of ecological awareness, as children at this stage experience rapid physical and cognitive growth that makes any stimulation highly effective for optimizing their overall development. Approximately 90% of total human brain development occurs before the age of six, meaning that values and habits instilled during

this period tend to persist into adulthood (Kencono & Winarsih, 2021). In line with (Siregar et al., 2020; Yulisetiani, 2024) research, instilling ecological values in children enhances their attention and fosters their understanding of the importance of protecting the environment through storytelling, also found that introducing environmental values in a fun and interactive way during early childhood can significantly shape children's attitudes and concern for nature. Environmental education at the early childhood education level is included in national education policy as part of the development of children's moral, religious, and social-emotional values. In the Merdeka Curriculum for Early Childhood Education, this integration is strengthened through the Learning Outcomes of the Foundation Phase, encompassing religious and moral values, self-identity, and the fundamentals of literacy and STEAM Jayawardana et al. (2022). Unlike the previous curriculum, which positioned environmental content merely as an implicit dimension within broader moral and social-emotional competencies, the Merdeka Curriculum explicitly regulates environmental education through specific, measurable learning outcomes embedded across all three Foundation Phase elements, granting teachers greater flexibility to design contextual, project-based environmental activities rather than relying on a single standardized topic of instruction.

A direct connection to ecological awareness is found in the self-identity element, which states that children are expected to recognize and exhibit positive behaviors toward their environment and adapt to prevailing norms. This approach aligns with international efforts to embed sustainability principles into competency-based curricula through contextual, project-based learning, as demonstrated by Purnomo et al. (2023) in their study on integrating Sustainable Development Goals into the Merdeka Curriculum through project-based activities. Thus, the three elements of the learning outcomes Foundation Phase collectively support the development of ecological awareness in early childhood, and the stimulation of ecological awareness is not merely an additional component but an official competency requirement that must be fulfilled by every early childhood education institution in the implementation of the Merdeka Curriculum.

Although the urgency of environmental education for young children has been widely recognized and is included in national policy, its implementation in Indonesian early childhood education institutions remains far from optimal (Adawiyah, 2022). Septianingrum et al. (2024) who analyzed 44 early childhood education institutions in Malang, revealed that the majority lack consistent and structured environmental programs, with inhibiting factors including limited teacher understanding, scarce resources, and low parental support. Based on a questionnaire distributed to seven teachers from four kindergartens in Ogan Ilir Regency, TK ABA Lorok, TK Negeri Pembina Indralaya Utara, TK Annisa, and TK Al-Falaah, children's ecological awareness was found to require more structured and consistent cultivation.

The questionnaire results revealed that many children remain indifferent to the environment, such as those who are reluctant to dispose of trash directly into trash bins, and some even throw it out the window onto the school grounds. Children's concern for classroom cleanliness also still requires constant guidance from teachers; they continue to pull up plants on school grounds and use water wastefully without considering the consequences. Teachers at TK Annisa noted difficulties implementing environmental-based learning due to resource limitations, particularly in methods, models, and available educational materials. This situation underscores that the primary issue is not merely children's low ecological awareness but also the absence of structured, tested, and implementable learning models for teachers (Ali et al., 2024). This is consistent with Fitri & Hadiyanto (2021), who found that environmental literacy among children aged 4–6 years remains generally low across different regions of Indonesia, showed that environmental literacy skills among children are generally still low; children lack empathy toward nature, show little interest in caring for plants, often use water wastefully, and carelessly cut plants both at school and in their residential environments.

Halida et al. (2024) found that environmental concern among 5–6-year-old children remains very low, with children failing to notice waste scattered around the school environment. Oktamarina (2021) similarly reported that in one early childhood center in Palembang, 8 out of 10 children showed no concern for environmental cleanliness and were unwilling to engage in planting or plant-care activities. Research by Indra & Eliza (2024), involving 109 PAUD teachers in Yogyakarta, found that although 92.7% recognized the urgency of instilling environmental behavior, implementation remains hindered by children's limited understanding and lack of parental support. Rahmani & Rahiem (2023) further confirmed that environmental education in early childhood settings is still implemented in a rudimentary manner without integration into a systematic learning model.

The project based learning model is a proven alternative solution for fostering early childhood development in a contextual and meaningful way, positioning children as active agents who solve problems through interconnected, complex activities and thereby develop into more creative, skilled, and confident individuals (Sinta et al., 2022). Zulkarnaen et al. (2023) emphasize its alignment with the Merdeka Curriculum,

noting that PjBL encourages critical thinking, collaboration, communication, and meaningful work production in line with the Pancasila learner profile. Atmoko et al. (2025), through a systematic literature review, further confirmed that PjBL at the early childhood level effectively develops children's learning motivation and early critical thinking skills through exploratory and motivational implementation strategies.

The effectiveness of PjBL in fostering environmental care in young children has been empirically demonstrated: Aisyah et al. (2023) found a significant increase in Group B children's environmental care through PjBL at TK Negeri Pembina Subang; Suminar et al. (2022) successfully developed a PjBL model proven to enhance young children's environmental care attitudes; Indra & Eliza (2024) demonstrated that 62.8% of PjBL implementations had a tangible effect on environmental care character at TK Pertiwi 1 in Padang; Ali et al. (2024) noted that PjBL application in early childhood institutions remains rare due to the absence of a structured, ready-to-use model for teachers Integrating the 3R principles (Reduce, Reuse, Recycle) into the project model offers tremendous potential for instilling ecological awareness through contextual, enjoyable, and immediately meaningful learning experiences. Gutiawati et al. (2022) demonstrated that the 3R method effectively fosters creativity in early childhood, while Habe & Ahiruddin (2023) demonstrated the success of implementing the 3R method in fostering environmental literacy among children at TK Nasional KPS Balikpapan, and Abidin et al. (2022) affirmed its effectiveness in empowering young children's creativity in early childhood institutions. Purnami (2021) further found that 3R based waste management in the school environment significantly increased students' ecological awareness and fostered a more environmentally friendly school culture.

The integration of the active and contextual PjBL model with the concrete 3R principles, which are relevant to children's lives serves as a strong foundation for developing an innovative and effective learning model to foster ecological awareness in early childhood. Although various studies have presented environmental education approaches for early childhood such as project-based models without explicit 3R integration and standalone 3R programs without a systematic learning model framework. Faridy & Rohendi (2021) research that specifically develops a PjBL model integrated with the 3R principles as a single, structured, and empirically tested model complete with a validated guidebook remains very limited. This gap is further reinforced by systematic reviews confirming that rigorous R&D-based environmental education research for early childhood remains scarce both in Indonesia and internationally.

This study addresses that gap by designing, validating, and testing such an integrated model. The novelty lies in three aspects: first, an original project learning syntax integrating the 3R principles across three deep learning stages Understanding (Mindful), Applying (Joyful), and Reflecting (Meaningful) an approach never previously developed in the early childhood education context; second, a comprehensive, ready-to-use printed guidebook implementable independently by teachers without special training; and third, a systematic empirical evaluation covering validity, practicality, and effectiveness, tested across two schools to ensure consistency of findings. This study developed a 3R-Based Project-Based Learning Model to Stimulate Ecological Awareness in Children Aged 5–6 Years, with three aims: (1) to identify the needs for model development; (2) to produce a validated guidebook suitable based on expert evaluation; and (3) to determine the model's effectiveness in fostering ecological awareness in children.

## Methodology

This study employs a mixed-methods research and development (R&D) approach adapting the ADDIE model. The population consisted of teachers and children aged 5–6 years enrolled in early childhood education institutions across Ogan Ilir Regency, South Sumatra. The sample was determined using purposive sampling, selecting institutions that had not yet implemented a structured 3R-based environmental learning model and were willing to participate in the study. Four kindergartens were involved: TK Negeri Pembina Indralaya Utara and TK ABA Lorok participated in the needs analysis and small-scale trial, while TK Annisa and TK Islam Al Falaah participated in the field trial. Overall, seven teachers completed the needs analysis questionnaire, nine experts participated in the validation stage, five teachers completed the practicality questionnaire, and forty seven children participated in the effectiveness testing (thirteen in the small-scale trial; thirty four in the field trial).

The ADDIE model was selected because it is systematic and evaluative at every stage, ensuring development decisions are based on prior evaluation results rather than assumptions (Hidayat & Nizar, 2021). and because it allows iterative revision based on validator and user feedback, ensuring the product aligns with field needs. This study adapts its five stages: (1) Analyze, field needs analysis; (2) Design, model and guidebook design; (3) Development, product development and expert validation; (4) Implementation, small-scale and field trials; and (5) Evaluation, comprehensive evaluation of validity, practicality, and

effectiveness. Four types of data were collected: (1) field needs data on children's ecological awareness and teachers' challenges in environmental education; (2) product validity data from media and content expert assessments of the guidebook, and instrument expert assessments of the observation tool; (3) practicality data from teachers' evaluations of the model's ease and feasibility of implementation; and (4) effectiveness data comprising children's ecological awareness scores before and after model implementation, measured through structured observation.

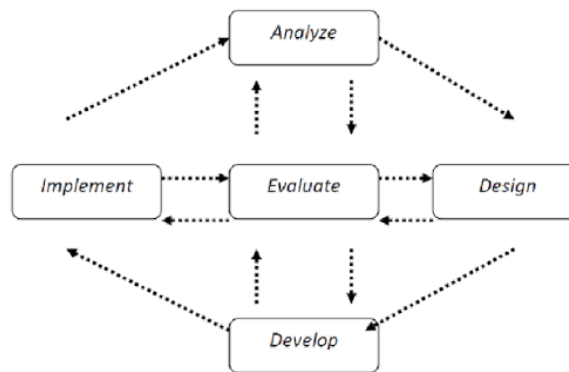


**Figure 1. ADDIE Model**

This study used four main instruments. A needs analysis questionnaire (12 items) identified teachers' learning needs and children's ecological awareness status. A media validation sheet (22 items) and subject-matter expert validation sheet (23 items) evaluated content, instructional, technical, and presentation aspects. A child ecological-awareness observation instrument (22 items; domains: knowledge, attitudes, and skills) used a 1–4 rating scale and was content-validated by three experts, yielding Aiken's  $V = 0.92$ ; content validity through expert judgment was selected over internal-consistency reliability testing because the trial samples ( $n = 13$  and  $n = 34$ ) were too small for stable reliability estimates. A teacher practicality questionnaire (30 items) assessed material suitability, clarity, and ease of implementation.

**Table 1. Summary of Research Instruments, Techniques, and Data Sources**

| No | Data Type               | Instrument                              | Number of Items | Data Source              | Technique         |
|----|-------------------------|-----------------------------------------|-----------------|--------------------------|-------------------|
| 1  | Requirement field       | Analysis questionnaire needs            | 12 items        | Preschool Teachers       | Field online      |
| 2  | Validity media          | Validation sheet media experts          | 22 items        | 3 media experts          | Expert validation |
| 3  | Validity subject matter | Validation sheet subject matter experts | 23 items        | 3 subject matter experts | Expert validation |
| 4  | Validity instrument     | Validation sheet instrument             | 22 items        | 3 validators             | Formula Aiken's V |
| 5  | Practicality model      | Questionnaire practicality teachers     | 30 items        | 5 preschool teachers     | Questionnaire     |
| 6  | Effectiveness           | Instrument                              | 22 items        | 47 preschool students    | Observation       |

**Table 2. Framework for the Observation Instrument on Children's Ecological Awareness**

| Aspect               | Indicator                                                                                                                                     | Item No. |
|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|----------|
| Knowledge Ecological | Understands the concepts of reduce, reuse, recycle;<br>Know types and impact of waste; understanding how to care for the environment          | 1–7 7    |
| Ecological Attitude  | Concern for environmental cleanliness; responsibility for disposing of trash; a sense of empathy toward nature; motivation to the environment | 8–15 8   |

| Aspect            | Indicator                                                                                                   | Item No.    |
|-------------------|-------------------------------------------------------------------------------------------------------------|-------------|
| Skills Ecological | Ability sorting types of utilizing recycled; carrying out environmentally friendly activities independently | 16– 7<br>22 |
| Total             | -                                                                                                           | 1–22 22     |

Data analysis was performed differently for each type of data. For validity data, descriptive statistics were used with the following category conversions:

**Table 3. Descriptive Statistics Category**

| No | Score Interval                            | Criteria          |
|----|-------------------------------------------|-------------------|
| 1. | $(Mi + 1,5 SD) \leq X \leq (Mi + 3,0 SD)$ | Very Acceptable   |
| 2. | $Mi \leq X \leq Mi + 1,5 SD$              | Acceptable        |
| 3. | $Mi - 1,5 SD \leq X \leq Mi$              | Fairly Acceptable |
| 4. | $Mi - 0,3 SD \leq X \leq Mi - 1,5 SD$     | Not Acceptable    |

For instrument validity data, Aiken's V formula is used:

$$V = \frac{\sum s}{n(c - 1)}$$

Explanation:

V = Aiken's validity index

s = the score given by the validator minus the lowest score on the scale ( $s = r - lo$ )

r = the score given by the validator

lo = the lowest score on the rating scale

n = the number of validators

c = number of categories on the rating scale

For practicality data, the same conversion as for validity data is used. For effectiveness data, the first step is the Shapiro-Wilk normality test (selected because  $n < 50$  in the limited test). If the data are not normally distributed, the nonparametric Wilcoxon Signed Rank Test is used with the hypotheses

H0: there is no significant difference between the pretest and posttest;

Ha: there is a significant difference, with the testing criterion that H0 is rejected if Asymp. Sig. (2-tailed)  $< 0.05$

The second step is calculating the N-Gain to measure the magnitude of improvement:

$$N - Gain = \frac{Posttest\ Score - Pretest\ Score}{Maximal\ Score - Pretest\ Score}$$

**Table 4. N-Gain Category**

| Range of N-Gain         | Category |
|-------------------------|----------|
| $N \geq 0,70$           | High     |
| $0,30 \leq N \leq 0,70$ | Moderat  |
| $N \leq 0,30$           | Low      |

## Result and Discussion

### Needs Analysis

The needs analysis was conducted by distributing an online questionnaire to seven teachers from four kindergartens in Ogan Ilir Regency (TK Annisa, TK Negeri Pembina Indralaya Utara, TK ABA Lorok, and TK Al Falaah Islamic). The 12-item questionnaire explored children's ecological awareness, teachers' understanding of the 3Rs and PjBL, and field challenges. Results showed that all respondents had a basic understanding of the 3Rs, and five of the seven had used project-based learning, though none had specifically designed it to integrate the 3Rs or systematically stimulate ecological awareness. Other findings indicate low ecological awareness among 5–6-year-old children: six out of seven teachers reported careless behaviors such as littering, and children's interest in environmental activities remained limited without active teacher facilitation, though enthusiasm increased when activities were enjoyable and involved recycled materials. The main challenges include time constraints, limited resources, and teachers' uneven understanding of the 3Rs. All respondents expressed an urgent need for a structured project-based learning model complete with clear activity steps, child-appropriate content, facilitative teacher roles, and parental involvement.

The findings reveal a pattern widely documented in the literature: teachers possess a basic conceptual understanding of environmental principles, yet this rarely translates into structured classroom practice. This gap between awareness and implementation is consistent with Natsheh et al. (2025) whose study of 50 kindergarten teachers in Jerusalem found that teachers' environmental practices remained largely confined to general hygiene routines rather than substantive engagement with environmental issues, with very few teachers integrating environmental topics into other subject areas or involving families in environmental activities. Similarly, Septianingrum et al. (2024) in their analysis of 44 early childhood institutions in Malang, found that most institutions lacked a consistent and structured environmental program despite general awareness of its importance, a finding that mirrors the incidental, non-systematic use of the 3Rs reported by teachers at TK ABA Lorok and TK Annisa in the present study.

The finding that five of seven teachers had prior PjBL experience yet had never designed it to integrate the 3Rs or stimulate ecological awareness aligns with international evidence on the gap between teachers' general pedagogical exposure and their capacity to operationalize it for specific thematic goals. Pratami et al. (2024) found that even after structured PjBL training, teachers struggled without explicit, reproducible guidance, underscoring the importance of detailed procedural scaffolding over conceptual exposure alone. These findings suggest that children's low ecological awareness is not merely a matter of insufficient teacher knowledge, but a structural problem rooted in the absence of operational, replicable classroom models. The low ecological awareness evidenced by littering behaviors reported by six of the seven teachers corroborates a consistent body of evidence on early childhood environmental behavior. Marin & Rusu (2023), found that kindergarten teachers consistently identified the absence of structured, age-appropriate activity sequences rather than children's incapacity as the primary barrier to fostering environmentally friendly behaviors in preschoolers. Collectively, these findings suggest that children's low ecological awareness reflects insufficiently structured learning opportunities rather than a fixed developmental limitation.

### Design

Based on the results of the needs analysis, a 3R based PjBL learning model was designed and is presented in the following specification table:

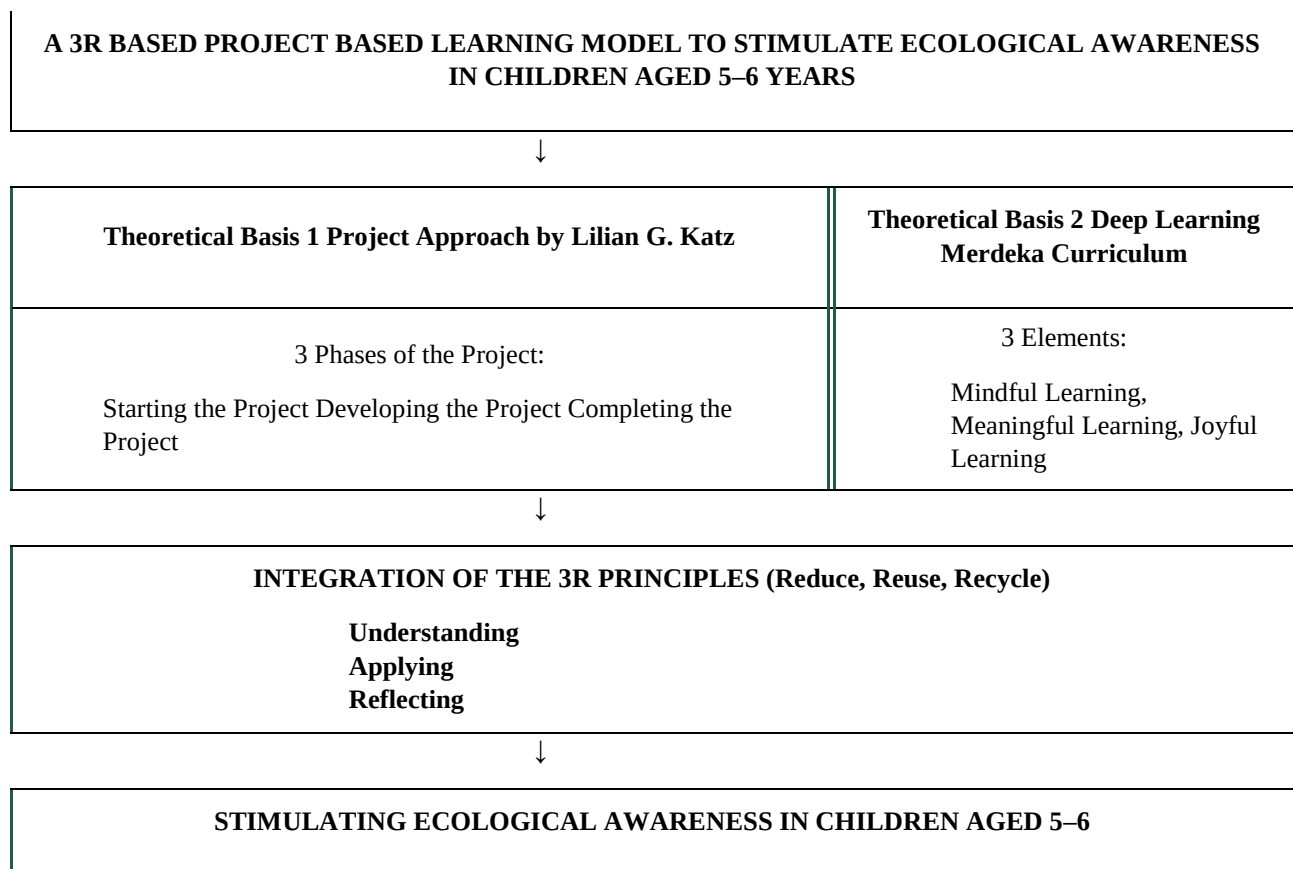
**Table 5. Model Product Specifications**

| Aspek Spesifikasi     | Keterangan                                                                                         |
|-----------------------|----------------------------------------------------------------------------------------------------|
| Model Name            | 3R-Based Project-Based Learning Model to Stimulate Ecological Awareness in Children Aged 5–6 Years |
| Product Format        | Learning Models and Early Childhood Education Teacher's Guide (56 pages, full color)               |
| Target Audience       | Early childhood and the teachers                                                                   |
| Learning Theme        | Theme: Environment   Sub- theme: Waste Recycling                                                   |
| Stimulation Focus     | Ecological awareness through the 3R principle (reduce, reuse, recycle)                             |
| Theoretical Framework | Lilian G. Katz's Project Approach + Deep Learning from the Merdeka Curriculum                      |
| Model Syntax          | Understanding(Mindful) - Applying (Joyful) - Reflecting (Meaningful)                               |

| Aspek Spesifikasi  | Keterangan                                                                                                                       |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------|
| Project Activities | ((1) Reduce: Paper Pulp Collage; (2) Reuse: Trash Bin from Used Water Bottles; (3) Recycle: Pencil Holder from Used Milk Cartons |

The model is designed in three main phases. The Understanding Phase (Mindful): children build an understanding of the 3Rs through probing questions, environmental observation, and discussion. The Application Phase (Joyful): children are directly involved in three sequential 3R-based project activities. The Reflection Phase (Meaningful): children present their work through a collective exhibition. The three designed project activities are: (1) Reduce Project: creating a collage from used paper pulp; (2) Reuse Project: making a trash can from a used gallon jug; and (3) Recycle Project: making a pencil holder from a used milk carton. Each project is carried out in five stages: concept introduction, material collection, production process, project completion, and reflection.

**Table 6. Design of the Learning Model**



By adopting Lilian G. Katz's three-phase project approach as its procedural backbone, the model provides the step-by-step, reproducible activity sequence that teachers reported lacking in their initial PjBL encounters (Pratami et al., 2024). The integration of the Merdeka Curriculum's three deep learning elements (mindful, joyful, meaningful) ensures pedagogical alignment with national curriculum mandates, consistent with Purnomo et al. (2023) findings on embedding sustainability principles through project-based activities. Each project (Reduce, Reuse, Recycle) is structured around concrete, hands-on tasks using readily available materials, Gutiawati et al.'s (2022) and Abidin et al.'s (2022) recommendation that 3R based learning is most effective when tied to tangible, age-appropriate outcomes.

## Development

The learning model adopts the deep learning approach and project model from Lilian G. Kartz; the model is designed as a guidebook for teachers to implement this learning model.

**Table 7. Learning Model Sintaks**

|                                                 |                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>PHASE 1:<br/>UNDERSTANDING<br/>(Mindful)</b> | Starting the Project (Lilian G. Katz)                                                                                                                                                                                                                                                                                                                                                              |
|                                                 | <ul style="list-style-type: none"><li>• Determine the topic and formulate a sparking question</li><li>• Exploring children's prior knowledge about the 3Rs</li><li>• Screening an educational video on reduce, reuse, recycle</li><li>• Observing the school environment: identifying examples of waste</li><li>• Group discussion: the meaning and application of the 3Rs in daily life</li></ul> |
| ↓                                               |                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>PHASE 2: APPLYING<br/>(Joyful)</b>           | Developing & Completing Projects (Lilian G. Katz)                                                                                                                                                                                                                                                                                                                                                  |
|                                                 | <ul style="list-style-type: none"><li>• Project 1: Reduce—making a collage from used paper pulp</li><li>• Project 2: Reuse—making a unique trash can from a used water jug</li><li>• Project 3: Recycle—making a pencil holder from a milk carton</li><li>• Children work collaboratively in small groups</li><li>• Teachers act as active facilitators</li></ul>                                  |
| ↓                                               |                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>PHASE 3: REFLECTION<br/>(Meaningful)</b>     | Completing the Project — Exhibition & Evaluation (Lilian G. Katz)                                                                                                                                                                                                                                                                                                                                  |
|                                                 | <ul style="list-style-type: none"><li>• Students present their project work to their peers</li><li>• Sharing experiences and feelings during the activity</li><li>• Teachers provide follow-up reflective questions</li><li>• Joint evaluation: successes and areas for improvement</li><li>• Assessment: checklists, anecdotes, evaluation of work</li></ul>                                      |

During the understanding phase, the teacher introduces the concept of waste and the 3Rs through an educational video followed by guided discussion, then demonstrates waste sorting together with children using guiding questions. In the application phase, children practice the 3R concept through project-based activities in small groups to develop collaboration skills and complete projects together. This phase consists of three projects, each comprising five stages. The final phase is a reflection conducted through a showcase of works from the three completed projects. The teacher prompts children with guiding questions, and children reflect on their learning experiences by recounting the process of creating the "reduce" collage, the "reuse" trash bin, and the "recycle" pencil holder. The guidebook comprises an overview of the PjBL model and 3R concepts, ecological awareness theoretical framework, a deep learning-based project implementation design, and complete assessment tools including checklists, anecdotal records, and final project rubrics.



**Figure 2. View of the Guidebook**

### **Results of Media Expert Validation , Content Expert Validation, and Instrument Validation**

Media expert validation was conducted by 1 expert lecturer and 2 professional teachers, covering 22 indicators that assess content quality, instructional objectives, and technical aspects. The average score of the three validators was 82 out of a maximum of 88, ranging from 71.5 to 88, thus classified as Highly Acceptable.

The revised validator feedback includes: adding a color scheme to the cover, improving the header/footer, changing the font type, and fixing links to instructional materials. Content expert validation was conducted by 1 expert lecturer and 2 professional teachers ., covering 23 indicators assessing content appropriateness, syntax, grammar, and presentation. The average score of the three validators was 74.33 out of a maximum of 92, ranging from 57.50 to 74.75, thus falling into the Acceptable category. Validation of the ecological awareness assessment instrument (22 items) using Aiken's V formula yielded a value of 0.92 (high category), indicating excellent content validity of the instrument.

**Table 8. Summary of Media Expert Validation Results**

| Validator      | Content & Objective Quality | Instructional Quality | Technical Quality | Total     | Category               |
|----------------|-----------------------------|-----------------------|-------------------|-----------|------------------------|
| lecturer 1     | 20 (4,00)                   | 12 (4,00)             | 53 (3,79)         | 85        | Very Acceptable        |
| Teacher 1      | 18 (3,60)                   | 12 (4,00)             | 51 (3,64)         | 81        | Very Acceptable        |
| Teacher 2      | 18 (3,60)                   | 12 (4,00)             | 50 (3,57)         | 80        | Very Acceptable        |
| <b>Average</b> | -                           | -                     | -                 | <b>82</b> | <b>Very Acceptable</b> |

**Table 9. Media Validation Category Conversion (Max Score = 88)**

| Score Interval | Category          |
|----------------|-------------------|
| 71,5 - 88,0    | Very Acceptable   |
| 55,0 - 71,5    | Acceptable        |
| 38,5 - 55,0    | Fairly Acceptable |
| 22,0 - 38,5    | Not Acceptable    |

**Table 10. Summary of Expert Validation Results**

| Validator      | Content Alignment | Syntax    | Grammar   | Presentation | Total        | Validator         |
|----------------|-------------------|-----------|-----------|--------------|--------------|-------------------|
| Lecturer 2     | 31 (3,44)         | 20 (3,33) | 14 (3,50) | 16 (4,00)    | 81           | Very Acceptable   |
| Teacher 3      | 24 (2,67)         | 14 (2,33) | 8 (2,00)  | 12 (3,00)    | 58           | Acceptable        |
| Teacher 4      | 36 (4,00)         | 18 (3,00) | 16 (4,00) | 16 (4,00)    | 86           | Very Acceptable   |
| <b>Average</b> | -                 | -         | -         | -            | <b>74,33</b> | <b>Acceptable</b> |

**Table 11. Conversion of Material Validation Categories (Max Score = 92)**

| Interval Skor | Kategori          |
|---------------|-------------------|
| 74,75 - 92,00 | Very Acceptable   |
| 57,50 - 74,75 | Acceptable        |
| 40,25 - 57,50 | Fairly Acceptable |
| 23,00 - 40,25 | Not Acceptable    |

**Table 12. Results of Instrument Validation Analysis using Aiken's V**

| Item   | Lecturer 3 | Teacher 5 | Teacher 6 | S1 | S2 | S3 | Total S | V    | Note |
|--------|------------|-----------|-----------|----|----|----|---------|------|------|
| 1 - 22 | 86         | 79        | 84        | 64 | 57 | 62 | 183     | 0,92 | High |

## Implementation

### Limited Trial (TK Negeri Pembina Indralaya Utara, n = 13)

Limited Trial was conducted over two weeks at TK Negeri Pembina Indralaya Utara, the results of the Shapiro-Wilk normality test indicated that the pretest data were not normally distributed (sig. 0.028 < 0.05) and the posttest data were normally distributed (sig. 0.202 > 0.05), so the Wilcoxon Signed Rank Test was used. The results showed Z = -3.213 with Asymp. Sig. = 0.001 < 0.05, proving a significant difference between before and after the implementation of the model. The average N-Gain value was 0.4715 (moderate category) with a small standard deviation (0.01506), indicating a consistent and even improvement across all students.

**Table 13. Results of the Wilcoxon Test & N-Gain for the Limited Trial**

| Statistics              | Value   | Description                              |
|-------------------------|---------|------------------------------------------|
| Z (Wilcoxon)            | -3,213  | Negative value: posttest > pretest       |
| Asymp. Sig. (2-tailed)  | 0,001   | Significant (< 0.05)                     |
| N-Gain (Mean)           | 0,4715  | Moderate Category ( $0.3 \leq g < 0.7$ ) |
| N-Gain (Std. Deviation) | 0,01506 | Very consistent improvement              |



**Figure 3. Understanding Phase – Limited Trial**



**Figure 4. Applying Phase - Limited Trial**

#### Field Trial (TK Annisa, n = 34)

The field trial was conducted at TK Annisa involving three classes. Normality test results indicated that the pretest was non-normal (sig. 0.044 < 0.05) and the posttest was normal (sig. 0.071 > 0.05). The Wilcoxon test yielded  $Z = -5.116$  with Asymp. Sig. = 0.000 < 0.05, proving the model's effectiveness on a larger scale. The average N-Gain value of 0.4693 (moderate category) with a standard deviation of 0.01849 indicates consistent and even improvement. A comparison of the two trials showed a highly consistent pattern (N-Gain 0.4715 vs. 0.4693), proving the reliability of the 3R-based PjBL model. The total practicality score from the five teachers was 544 out of 600 (average 108.8), falling into the Very Practical category ( $M_i=375$ ,  $SD_i=75$ , range 487.5–600).

**Table 14. Results of the Wilcoxon Test & N-Gain Field Trial**

| Statistics              | Value   | Description                              |
|-------------------------|---------|------------------------------------------|
| Z (Wilcoxon)            | -5,116  | Negative value: posttest > pretest       |
| Asymp. Sig. (2-tailed)  | 0,000   | Highly Significant (< 0.05)              |
| N-Gain (Mean)           | 0,4693  | Moderate Category ( $0.3 \leq g < 0.7$ ) |
| N-Gain (Std. Deviation) | 0,01849 | Consistent and uniform improvement       |

**Table 15. Comparison of Limited Trial and Field Test Results**

| Indicator                    | Limited Test (n=13)               | Field Test (n=34)  |
|------------------------------|-----------------------------------|--------------------|
| Location                     | TK Negeri Pembina Indralaya Utara | TK Annisa          |
| Sig. Pretest (Shapiro-Wilk)  | 0.028 (Not Normal)                | 0.044 (Not Normal) |
| Sig. Posttest (Shapiro-Wilk) | 0.202 (Normal)                    | 0.071 (Normal)     |
| Nilai Z (Wilcoxon)           | -3.213                            | -5.116             |
| Asymp. Sig. (2-tailed)       | 0.001 (< 0.05)                    | 0.000 (< 0.05)     |
| N-Gain (Mean)                | 0.4715 (Moderate)                 | 0.4693 (Moderate)  |

| Indicator             | Limited Test (n=13) | Field Test (n=34) |
|-----------------------|---------------------|-------------------|
| Std. Deviation N-Gain | 0.01506             | 0.01849           |



**Figure 5. Understanding Phase - Field Test**



**Figure 6. Reflection Phase – Project Exhibition in Field Test**

### Practicality Test

The practicality test was conducted to determine the extent to which the 3R-based PjBL model could be implemented by teachers independently and efficiently in the context of learning at early childhood education institutions. The practicality test involved five teachers from two institutions: two teachers from TK Indralaya Utara State and three teachers from TK Annisa. Each teacher completed the practicality questionnaire after the entire series of learning model activities had been, so that the assessments provided were based on real-world experience in applying the model in the classroom.

The practicality questionnaire consisted of 30 items covering aspects of content appropriateness, syntactic clarity, language simplicity, the quality of the guidebook presentation, and technical quality. Each item was rated using a 1–4 Likert scale. The evaluation results from the five teachers showed a total score of 544 out of a maximum of 600, with an average score per teacher of 108.8. Based on data conversion using the Ideal Mean ( $M_i = 375$ ) and Ideal Standard Deviation ( $SD_i = 75$ ), this score falls within the range of 487.5–600, thus falling into the “Very Practical” category. These results demonstrate that the 3R-based PjBL model is easy for teachers to understand and implement independently; its activity steps are detailed and operational; and the developed guidebook provides clear enough guidance for teachers to manage the entire project learning sequence without requiring special training or mentoring. The complete guidebook containing the application of the developed model is available as supplementary material, follow this link: [https://drive.google.com/file/d/1wrUk\\_-cyL05APMt2SyxJKA-H3cXW30hI/view?usp=sharing](https://drive.google.com/file/d/1wrUk_-cyL05APMt2SyxJKA-H3cXW30hI/view?usp=sharing)

**Tabel 16. Results of The Practicality Test by Teachers**

| Teacher        | School                            | Score (X)    | Max Score  |
|----------------|-----------------------------------|--------------|------------|
| Teacher 7      | TK Negeri Pembina Indralaya Utara | 115          | 120        |
| Teacher 8      | TK Negeri Pembina Indralaya Utara | 111          | 120        |
| Teacher 9      | TK Annisa                         | 109          | 120        |
| Teacher 10     | TK Annisa                         | 104          | 120        |
| Teacher 11     | TK Annisa                         | 105          | 120        |
| <b>Total</b>   | -                                 | <b>544</b>   | <b>600</b> |
| <b>Average</b> | -                                 | <b>108,8</b> | -          |

**Table 17. Practicality Category Conversion (Max Score = 600)**

| Score Interval | Category         |
|----------------|------------------|
| 487,5 - 600,0  | Very Practical   |
| 375,0 - 487,5  | Practical        |
| 262,5 - 375,0  | Fairly Practical |
| 150,0 - 262,5  | Less Practical   |

## Evaluation

In terms of validity, the media validation score of 82 (highly acceptable) and the material score of 74.33 (acceptable) indicate that the product meets academic standards, consistent with the views of Joyce and Weil in Khoerunnisa et al. (2020) that a good learning model serves as an effective guide for teachers. The validity of the Aiken's V instrument ( $V = 0.92$ ) ensures the measurement tool can accurately assess children's ecological awareness. In terms of effectiveness, the moderate N-Gain consistency (0.47 and 0.46) in both trials demonstrates the model's reliability. These results align with Aisyah et al. (2023) and Indra & Eliza (2024), who demonstrated the positive effects of PjBL; Gutiawati et al. (2022) on the effectiveness of the 3Rs; and Nur Asri et al. (2025), who confirmed the positive impact of PjBL on children's environmental concern. The very small standard deviation of N-Gain (0.015 and 0.018) indicates a uniform improvement across all children, not just a subset. From a practical standpoint, the highly practical score (544/600) demonstrates that teachers can implement the model independently without specialized training, which is the primary advantage of this product compared to similar studies.

## Research Limitations

This study has several limitations that should be acknowledged. First, the needs analysis relied on a relatively small number of teachers ( $n = 7$ ) from only four kindergartens within a single regency, which may not capture the full diversity of teacher understanding and field conditions found across other regions of Indonesia or in other national contexts. Second, the trial stages involved a total of 47 children from only two of the four participating kindergartens, with the small-scale trial ( $n = 13$ ) and field trial ( $n = 34$ ) both falling below the sample sizes typically recommended for stable reliability estimation, which limits the extent to which the instrument's consistency across repeated measurements could be statistically established beyond its established content validity. Third, the effectiveness test relied on a one-group pretest-posttest design without a control group, meaning that improvements in children's ecological awareness, while statistically significant, cannot be fully isolated from maturation effects, novelty effects, or concurrent classroom activities unrelated to the model. Fourth, the practicality assessment was based solely on teachers' self-reported perceptions collected through questionnaires, without triangulating these reports with classroom observation data or children's direct feedback. Finally, the relatively short implementation period (two weeks) limits conclusions regarding the long-term retention of children's ecological awareness and behavior after the model is no longer actively facilitated by researchers.

## Recommendations for Further Development

Several recommendations are proposed for future research and practice. First, future studies should replicate this model across a larger and more geographically diverse sample to test generalizability across different regional and sociocultural contexts. Second, future research should employ a randomized controlled or quasi-experimental design with a comparison group to more rigorously establish the model's effectiveness. Third, subsequent studies should incorporate reliability analysis such as test-retest or inter-rater reliability once a larger sample is available. Fourth, future implementations should extend the observation period beyond two weeks and include a delayed post-test (four to eight weeks post-intervention) to assess the durability of children's ecological awareness. Fifth, practicality data should be enriched by triangulating teacher questionnaires with classroom observation and child-friendly feedback tools. Finally, given that teacher training is a determining factor in successful PjBL implementation (Pratami et al., 2024; Wulan Suci et al., 2025), future development should include a structured training module to accompany the guidebook.

## Conclusion

This study concludes that the developed 3R-based Project Based Learning model effectively addresses teachers' limited capacity to stimulate ecological awareness in early childhood settings. Needs analysis confirmed that teachers in Ogan Ilir Regency understand 3R principles but lack a structured implementation model. Validation scores (media: 82; content: 74.33; Aiken's V = 0.92) confirmed high feasibility. The model demonstrated moderate effectiveness (N-Gain: 0.47–0.46; Wilcoxon  $p < 0.05$ ) and strong practicality (544/600). It offers a ready-to-use, empirically tested guidebook bridging pedagogical competence and environmental teaching. Future research should explore digital adaptation, integration with other developmental domains, and experimental designs with control groups.

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