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Innovation in Developing Creative Games Using Recycled Materials to Enhance Teachers' Understanding at KB-TK Aisyiyah 25 Wage: Implementation of SDG 4 Quality Education

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Abstract: This study aims to develop innovative creative games based on recycled materials as learning media that support teachers' understanding of sustainable education, particularly Sustainable Development Goal (SDG) 4 on Quality Education, at KB-TK Aisyiyah 25 Wage. The study employed a Research and Development (R&D) approach using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). The analysis stage showed that most teachers had limited experience in utilizing recycled materials as educational play tools. The products developed included a number board, a smart syllable wheel, and three-language labels made from recycled materials. Field implementation showed that 95% of teachers considered the tools easy to use and engaging, while the children demonstrated high enthusiasm during learning activities. The final evaluation indicated an average 42% increase in teachers' understanding of sustainable learning media. These findings demonstrate that recycled-material-based games can provide effective and economical learning media while fostering teachers' awareness of environmentally responsible approaches in early childhood education.

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1. Introduction

Quality education under Sustainable Development Goal (SDG) 4 is a global priority for preparing future generations to address social, economic, and environmental challenges [1]. In the Indonesian education context, strengthening educators' basic literacy and instructional capacity is also closely related to efforts to achieve quality education [2]. In early childhood education (ECE), teacher creativity is an important factor in improving the quality and variety of learning experiences [3]. One practical innovation is the use of recycled or discarded materials to develop educational games that are accessible, contextual, and attractive to young children [4]. Such materials not only support environmental sustainability but can also provide opportunities for teachers and children to practice creative and innovative thinking through meaningful play activities.

Early childhood education is a crucial phase for establishing children's character and the foundations of cognitive, social, language, and motor development [5]. In ECE learning, instructional media have a strategic role in supporting children's understanding, participation, and learning experiences, particularly when they are presented through educational play [6]. However, in many ECE institutions, including KB-TK Aisyiyah 25

Wage, learning media are still dominated by commercially manufactured tools that may be costly, repetitive, and less connected to children's immediate environment. This condition can limit teachers' opportunities to design creative learning activities that make use of locally available resources.

The participants empowered through this study were teachers at KB-TK Aisyiyah 25 Wage in Sidoarjo Regency. Initial observations indicated that teachers faced challenges in creating creative and environmentally friendly learning media. Limited facilities and insufficient knowledge of innovative teaching methods were identified as important constraints. The use of recycled materials for educational games can provide a low-cost alternative that supports children's cognitive development through play [6]. Limited access to continuous professional development can further restrict teachers' ability to design innovative media. Therefore, this study included training and field practice in which teachers learned to transform discarded materials into creative educational games. Play-based educational activities are expected to make basic concepts easier to understand in an enjoyable and interactive manner [7].

Sustainable education, as emphasized in SDG 4, requires learning that is inclusive, equitable, relevant, and supportive of sustainable development [1]. The development of educational play tools can serve as a practical strategy for translating child-centered learning principles into classroom activities [8]. Using recycled materials as the main components of educational play tools offers an innovative way to produce inexpensive and readily available media while fostering creativity, environmental responsibility, and collaboration between teachers and children [9]. This approach also supports a learning ecosystem that is connected to children's everyday lives. Moreover, improving learning quality requires teachers to act as active designers and facilitators of meaningful educational media and play experiences [10]. Accordingly, this study was designed to strengthen teachers' creativity, practical skills, and understanding while supporting the implementation of SDG 4 at KB-TK Aisyiyah 25 Wage.

The use of educational play tools in early childhood education has been examined in various studies, particularly in relation to children's developmental outcomes [11]. Creative and traditional games can support language development and provide meaningful opportunities for interaction in early childhood settings [12]. Contextual and nature-based educational play also demonstrates how locally available resources can be integrated into learning activities [13]. These findings indicate that teachers can adapt simple materials into learning tools that are relevant to children's developmental needs. In addition, sustained learning innovation requires teacher capacity-building, instructional planning, and the systematic development of learning resources [14]. Therefore, strengthening teachers' ability to create recycled-material-based educational games is relevant not only to classroom innovation but also to broader efforts to improve the quality and sustainability of early childhood education.

Based on this background, the present study aimed to develop a model of creative games made from recycled materials that teachers can use as learning media at KB-TK Aisyiyah 25 Wage. The study was intended not only to produce educational play tools but also to improve teachers' understanding and ability to design sustainable learning media. Through a Research and Development (R&D) approach organized using the ADDIE model, the study is expected to contribute to the practical implementation of quality education in early childhood settings.

2. Materials and Methods

This study employed a Research and Development (R&D) approach to produce innovative educational play tools made from recycled materials while simultaneously improving teachers' understanding of sustainable learning. The R&D approach was selected because the study focused not only on data collection but also on the systematic development, implementation, and evaluation of products in an early childhood education setting. The development process was organized through the ADDIE framework, which provides a structured sequence for analyzing needs, designing and

developing learning products, implementing them, and evaluating their effectiveness [15].

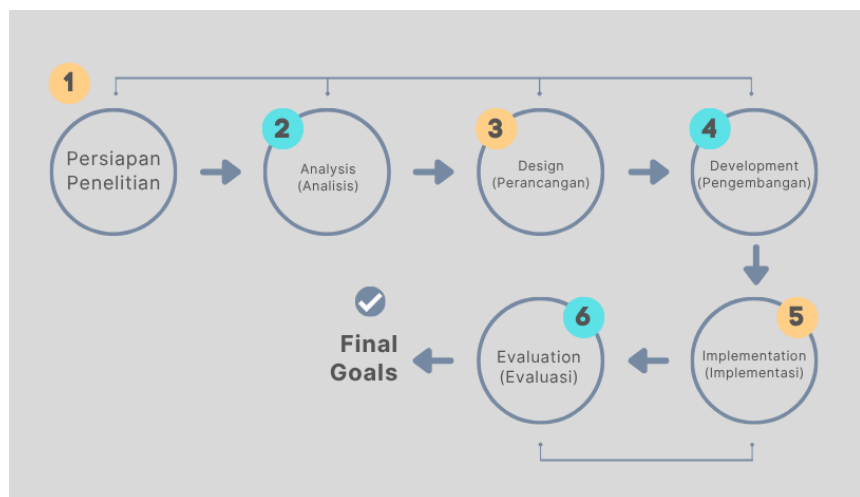


Figure 1. ADDIE Model

The development model used in this study was ADDIE, which consists of five main stages: Analysis, Design, Development, Implementation, and Evaluation [15].

1. Analysis was conducted to identify teachers' needs and the difficulties they experienced in using learning media. This stage involved observations and interviews with teachers at KB-TK Aisyiyah 25 Wage.
2. Design focused on planning educational play tools that were appropriate for young children's characteristics and aligned with the principles of sustainable education.
3. Development was the stage in which the game products were produced using discarded materials such as cardboard, plastic bottles, bottle caps, and fabric scraps.
4. Implementation involved field testing the products with teachers and children and observing how the tools were used during learning activities.
5. Evaluation was conducted to assess product effectiveness through group reflection with teachers and questionnaires administered before and after implementation.

The ADDIE approach enabled the development process to be conducted in a structured yet flexible manner so that the resulting products could be adapted to actual needs in the field. The model also provided opportunities for continuous evaluation to ensure the effectiveness and relevance of the products in improving learning quality.

3. Result

Research Stages and Implementation Results:

1) Analysis

During the analysis stage, direct observations and interviews were conducted with 23 teachers at KB-TK Aisyiyah 25 Wage to identify their understanding of the use of recycled materials as educational play media. The results showed that most teachers had not yet gained sufficient experience in optimally utilizing discarded materials in learning activities.

The analysis results are summarized in the following table:

Table 1. Analysis Results

No.	Statement	Number of Teachers (n=23)	Percentage (%)
1	Teachers who had never received training on the use of recycled materials	20	87%
2	Teachers who had difficulty creating economical educational play tools	18	78%
3	Teachers accustomed to using commercial/ready-made learning media	19	83%
4	Teachers interested in participating in learning-media development training	23	100%

The data indicate a clear need for training and mentoring to help teachers design creative play media that are contextual, economical, and environmentally friendly. The fact that 100% of the teachers expressed interest in participating in media-development training demonstrates strong motivation to strengthen their professional capacity, particularly in support of sustainable learning principles consistent with SDG 4 (Quality Education).

2) Design

Educational games made from recycled materials were designed according to early childhood learning themes. The proposed tools included:

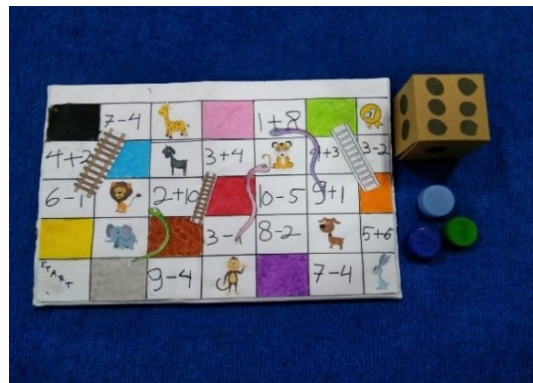


Figure 2. Snakes and Ladders Board



Figure 3. Interactive Number Board



Figure 4. Smart Wheel



Figure 5. Bilingual Fruit and Number Labels

3) Development

The educational game prototypes were developed by considering educational value, safety, sustainability, and age appropriateness.

The materials used included:

- Used cardboard
- Plastic bottles and bottle caps
- Fabric scraps
- Used paper and natural adhesive

4) Implementation

The implementation stage involved direct trials of the recycled-material-based educational play tools at KB-TK Aisyiyah 25 Wage. The trials involved 23 teachers and 65 young children from different age groups.

The educational play tools implemented included:

- Snakes and ladders board
- Smart syllable wheel
- Bilingual fruit and number label board
- Interactive number board

Teachers received brief training on how to use the tools, after which the children were invited to play and learn with them.

The observations and questionnaires administered after implementation showed highly positive responses, as summarized in the following table:

Table 2. Observation Results

No.	Implementation Evaluation Indicator	Number of Teachers Agreeing (n=23)	Percentage (%)
1	The tools were easy to use in learning activities	22	95%
2	The educational games attracted children's interest in learning	22	95%
3	Children showed enthusiasm when using the tools	-	Field observation: high
4	Teachers were inspired to create similar tools from other recycled materials	21	91%

In addition to the positive responses from teachers, observations showed that the children:

- a. Actively moved and interacted with peers while using the educational play tools
- b. Recognized letters, numbers, and colors more quickly through play-based activities
- c. Demonstrated vocabulary growth through fruit and vegetable labeling games.

Overall, the educational play tools developed in this study were relevant and contextual. They also increased the active involvement of teachers and children in the learning process while building awareness of recycling and creativity in early childhood education.

5) Evaluation

The evaluation stage used two approaches: group reflection with teachers and questionnaires administered before and after the implementation of the educational play tools. The evaluation was intended to measure the extent to which teachers' understanding of creative recycled-material-based learning media and sustainable education improved.

A total of 23 teachers completed questionnaires covering the following indicators:

- a. Understanding of SDG concepts in education
- b. Ability to design learning media from recycled materials
- c. Readiness to implement the tools in learning activities

The questionnaire results showed the following average scores before and after implementation:

Table 3. Questionnaire Results

No.	Assessed Aspect	Pre-Score (0-100)	Post-Score (0-100)	Improvement (%)
1	Understanding of sustainable learning-media concepts	58	82	41.4%
2	Skills in designing tools from recycled materials	55	79	43.6%
3	Awareness of the importance of using recycled materials in learning	62	87	40.3%

In addition to the quantitative results, group reflection with the teachers produced the following feedback:

- a. Teachers reported that the activity broadened their perspectives on creativity and environmentally responsible education
- b. All teachers recommended that similar training be conducted regularly and expanded beyond KB-TK Aisyiyah 25 Wage to other early childhood education institutions in the surrounding area
- c. Teachers also proposed the development of a practical guidebook or module that could serve as a sustainable reference.

The evaluation indicates that the development of creative games from recycled materials affected not only the children but also successfully strengthened teachers' pedagogical capacity to provide contextual and sustainable learning experiences.

4. Discussion

The findings show that teachers at KB-TK Aisyiyah 25 Wage faced substantial challenges in utilizing recycled materials as learning media. The initial data indicated that 87% of teachers had never participated in training on the educational use of recycled materials, while 78% experienced difficulty creating educational and economical play tools. This condition is consistent with the broader need to strengthen teacher creativity, professional capacity, and access to innovative learning resources in early childhood education [3], [10], [14]. Therefore, practice-oriented training focused on creativity and sustainability is important for helping teachers transform inexpensive local materials into meaningful learning media.

Through the ADDIE approach, the design and development of educational games from recycled materials were organized systematically, from needs analysis to evaluation [15]. Products such as the snakes and ladders board, smart wheel, number board, and bilingual fruit labels were designed to match the characteristics and learning needs of young children. The use of discarded cardboard, plastic bottles, bottle caps, and fabric scraps supported the creation of inexpensive and functional learning media. Similar work on educational play tools shows that simple and contextual materials can be adapted into developmentally meaningful learning resources [8], [9]. In this way, the developed products also support SDG 4 by promoting accessible, relevant, and sustainable learning practices [1].

The implementation trial produced highly positive responses. A total of 95% of teachers stated that the tools were easy to use and attractive, while 91% reported being inspired to create similar tools independently. Observations also showed active cognitive, motor, language, and social engagement among the children during play. These outcomes reinforce the importance of play as a central approach in early childhood learning. Previous studies similarly report that educational games can support children's motor, language, cognitive, and interactive learning experiences [4], [7], [12], [13]. Thus, recycled-material-based games can combine developmental learning objectives with enjoyable and child-centered activities.

Questionnaire evaluation showed a meaningful improvement in teachers' understanding and practical skills. The average increase in understanding of sustainable learning media was approximately 42%, indicating that training combined with direct practice had a positive effect on teachers' capacity. The reflection results also revealed strong interest among teachers in independently developing recycled-material-based learning media and continuing similar professional development activities. This finding is relevant to the broader importance of systematic planning and capacity-building in sustaining educational innovation [14]. The teachers' proposal for a practical module or guidebook further indicates that the program generated not only immediate practical benefits but also a desire for continued pedagogical development.

Overall, the innovation in developing educational games from recycled materials achieved the study objectives in terms of both product outcomes and perceived benefits for teachers and children. The approach can serve as a contextual good-practice model for other early childhood education institutions. Strengthening periodic training, replicating adaptable designs, and documenting procedures through modules or video tutorials may help extend the sustainability and transferability of the program. These efforts are consistent with the broader direction of SDG 4, which emphasizes inclusive and equitable quality education and learning opportunities that support sustainable development [1].

5. Conclusion

This study concludes that the innovation of developing educational games from recycled materials can substantially improve early childhood teachers' understanding and practical skills, particularly at KB-TK Aisyiyah 25 Wage, in creating contextual, creative, and environmentally friendly learning media. The high proportion of teachers who had never previously received related training indicates a capacity gap that can be addressed through practice-based professional development programs.

The ADDIE model provided a systematic approach for designing, developing, implementing, and evaluating the learning media. The stages of analysis, design, development, implementation, and evaluation produced educational play tools that were relevant to the characteristics of young children. The use of discarded materials such as cardboard, plastic bottles, and fabric scraps also introduced sustainability values through learning activities.

The implementation results showed highly positive responses from both teachers and children. Teachers reported that the tools were helpful and inspired them to become more creative, while the children demonstrated high enthusiasm during the activities. Games such as the smart wheel, interactive number board, and bilingual label board provided enjoyable opportunities to stimulate cognitive, motor, and language development.

The evaluation also showed an average increase of more than 42% in teachers' understanding. This result indicates that the training and mentoring activities provided more than short-term exposure; they also encouraged greater awareness of creative, low-cost, and sustainable learning approaches. Teacher reflection further emphasized the importance of replicating the program in other early childhood education institutions and supporting implementation with practical guidance materials.

In general, this study contributes to the implementation of SDG 4 on Quality Education by offering a locally grounded and innovative approach to improving learning quality in early childhood education. Educational games made from recycled materials can respond to the need for contextual and environmentally responsible learning while strengthening teachers' capacity as the main facilitators and designers of learning. Future implementation should include the development of a practical module and wider dissemination so that this good practice can be adopted at regional and national levels.

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