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CHILDREN'S CONSTRUCTION LEARNING WITH AUTOMATA PAPERTOY AT MUTIARA CHILDREN LEARNING CENTER

A community service initiative integrating creative design and construction learning for kindergarten students

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ABSTRAK
Pembelajaran anak usia dini membutuhkan aktivitas interaktif dan praktik langsung yang merangsang kreativitas, keterampilan motorik, dan perkembangan kognitif. Namun, banyak kegiatan pembelajaran di taman kanak-kanak masih mengandalkan metode yang membatasi permainan konstruktif anak. Program pengabdian masyarakat ini memperkenalkan pembelajaran konstruksi melalui mainan burung kertas kepada anak- anak di Pusat Belajar Anak Mutiara (MCLC). Kegiatan ini diselenggarakan oleh *Visual Communication Design* (VCD) Jakarta International University (JIU), melibatkan 4 dosen dan 28 peserta. Dilaksanakan pada 11 Maret 2026, program ini membimbing anak-anak usia 3-6 tahun untuk merakit mainan burung kertas sederhana sesuai dengan tingkat kelas mereka dengan bantuan dosen dan mahasiswa. Melalui proses memotong, melipat, dan merakit automata, anak-anak mempelajari konsep konstruksi dasar sambil mengembangkan keterampilan motorik halus dan kreativitas. Hasilnya, setiap anak berhasil membuat mainan burung kertas automata yang dapat dibawa pulang, memperkuat pembelajaran melalui hasil yang nyata. Kegiatan ini menunjukkan bahwa permainan konstruktif secara efektif mendukung pembelajaran kreatif anak usia dini..

Kata kunci — Mainan Kertas Automata, Pembelajaran Konstruksi, Pendidikan Anak Usia Dini, Pembelajaran Kreatif, Desain Komunikasi Visual

ABSTRACT
Early childhood learning requires interactive and hands-on activities that stimulate creativity, motor skills, and cognitive development. However, many kindergarten learning activities still rely on methods that limit children's with constructive play. This community service program introduced construction learning through paper bird toys to children at Mutiara Children Learning Center (MCLC). The activity was organized by the Visual Communication Design (VCD) of Jakarta International University (JIU), involving 4 lecturers and 28. Conducted on March 11, 2026, the program guided children aged 3–6 years to assemble simple bird papertoy according to their class levels with the assistance of lecturers and students. Through cutting, folding, and assembling automata processes, children learned basic construction concepts while developing fine motor skills and creativity. As result, each child successfully created automata paper bird toy that could be taken home, reinforcing learning through tangible outcomes. This activity demonstrates constructive play effectively supports early childhood creative learning.

Keywords — *Automata Papertoy, Construction Learning, Early Childhood Education, Creative Learning, Visual Communication Design*

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1. Introduction

Fine motor skill development is a fundamental aspect of early childhood education, particularly during the kindergarten stage when children begin to refine hand (eye coordination and manipulation abilities. Activities that involve cutting, folding, assembling, and controlling simple mechanisms help children strengthen finger muscles and improve precision in movement. In addition, introducing simple automation concepts) such as mechanical movement or cause and effect motion can stimulate children's cognitive and sensorimotor development. Educational researchers emphasize that hands-on constructive activities allow children to understand basic mechanical principles while simultaneously developing coordination and spatial awareness (Howard et al., 2022; Liu & Wu, 2023). Through practical learning experiences, children can explore how objects move and interact, forming early foundations for engineering thinking and creative problem-solving skills.

Despite the importance of motoric and mechanical exploration in early childhood learning, many kindergarten curricula still prioritize passive or worksheet-based activities. In many early childhood institutions, children spend more time coloring pre-drawn images or listening to teacher explanations rather than engaging in hands-on construction activities. Such learning approaches may limit opportunities for children to develop spatial understanding and mechanical curiosity. Studies in early childhood education have noted that a lack of interactive learning experiences can reduce children's engagement and limit the development of creative and exploratory behaviors (Edwards & Bird, 2021; Kiewra & Veselack, 2021). As a result, the integration of playful construction-based activities remains relatively limited in many kindergarten environments.

Creative development in early childhood is closely linked to opportunities for experimentation, exploration, and constructive play. When children are given the opportunity to manipulate materials and assemble objects, they develop imagination, divergent thinking, and creative expression. Construction-based learning activities, such as building paper toys, encourage children to think about form, movement, and structure while expressing their own artistic ideas through coloring and decoration. Research shows that creative play and maker-based activities significantly contribute to children's cognitive flexibility, problem-solving ability, and innovative thinking (Marsh et al., 2022; Resnick & Rosenbaum, 2023). Therefore, integrating art, design, and simple mechanical construction can create a holistic learning experience that nurtures both creativity and technical curiosity in young learners.

One of the major challenges in early childhood education is the lack of learning models that simultaneously integrate creativity, motor skill development, and mechanical understanding. Many educational programs emphasize artistic expression without connecting it to constructive or functional design processes. Consequently, children may not experience how artistic forms can also serve as moving objects or functional toys. This gap highlights the urgency of introducing creative construction learning that combines art, design, and simple motion mechanisms. Recent educational studies suggest that integrating design-based learning at an early age can improve children's engagement, curiosity, and collaborative learning behaviors (Tissenbaum et al., 2021; Kangas et al., 2022). While the mechanical principles employed in this study, such as string and straw based actuation, are not novel and have been widely used in basic papertoy constructions, the contribution of this work lies in its contextual application in structured community service program and its integration with VCD pedagogy. Previous studies have explored construction-based learning using various media, such as building blocks and modular kits (like LEGO products), yet limited attention has been given to low-cost, paper-based automata as a medium for combining visual design, mechanical exploration, and collaborative learning in kindergarten settings. Therefore, this study addresses this gap by demonstrating how simple papertoy constructions can be effectively adapted as an accessible and pedagogically integrated learning tool for childhood education.

To address these educational challenges, the Visual Communication Design (VCD) Study Program of Jakarta International University organized a community service program (Pengabdian kepada Masyarakat / PkM) titled Children's Construction Learning with Paper Bird

Toys at Mutiara Children Learning Center (figure 1). This activity introduced kindergarten students aged 3–6 years to construction-based creative learning through the making of paper bird toys. Two paper toy types constructions were designed: atwo-dimensional front-view dove with string-driven wing movement for younger children, and a three-dimensional side-view dove with straw-based wing movement for older students. By assembling and operating these toys using simple materials such as paper, strings, straws, and wooden sticks, children were able to experience the relationship between design, structure, and motion. This program aimed to enhance fine motor skills, creativity, and early mechanical understanding through interactive and playful learning activities guided by lecturers and university students.



Figure 1. Mutiara Child Learning Center. Source: Author's Documentation

2. Identification Problem Formulation

Early childhood education institutions, including kindergartens, play a crucial role in supporting children's cognitive, creative, and motor development. However, as previously discussed, many learning activities still emphasize passive or repetitive tasks such as coloring worksheets or memorization-based exercises. While these activities may contribute to basic learning, they often fail to stimulate children's curiosity about how objects work or how creative ideas can be transformed into functional forms (Darmawan, 2025). The absence of hands-on constructive learning can limit children's opportunities to explore mechanical movement, spatial reasoning, and collaborative problem solving. Therefore, there is a clear need for innovative educational activities that integrate creative design, simple construction, and also playful experimentation in order to enrich the learning experience at kindergarten education.

The community service program (PkM) conducted by the Visual Communication Design (VCD) Study Program of Jakarta International University was designed as a practical educational intervention to address these limitations. Through the introduction of paper bird toys that combine artistic design with simple mechanical movement, the program demonstrates how creative construction activities can be implemented in early childhood classrooms. The activity provides a learning model in which children not only color or observe visual forms but also assemble and operate their own moving toys. This approach encourages active participation, hands-on experimentation, and interaction between children, teachers, and university mentors. As such, the program serves as an example of how creative design-based learning can be integrated into kindergarten education through simple materials and accessible methods.

Based on the educational context and challenges identified above, the community service activity addresses the following research and implementation questions:

1. How can construction-based creative learning be introduced effectively to kindergarten students through simple paper toy activities?
2. How does the process of assembling and operating paper bird toys contribute to the development of children's fine motor skills and creativity?
3. How can collaborative mentoring between university lecturers, students, and kindergarten teachers support interactive learning experiences for early childhood students?

Targets and Outputs

The target of this community service program is kindergarten students aged 3–6 years at Mutiara Children Learning Center (MCLC), specifically those in the Sheep (3–4 years old), Eagle (4–5 years old), and Whale (5–6 years old) classes. The activity aims to introduce early childhood learners to creative construction learning through simple paper toy mechanisms that stimulate fine motor skills, creativity, and basic understanding of movement. In addition, the program also targets teachers and university students by providing a practical example of how interactive and design-based learning can be implemented in early childhood education. The expected outputs of this activity include the creation of paper bird toys by each participating child as a tangible learning outcome, documentation of the activity as educational material, and the production of an academic article that disseminates the results of the community service program as part of scholarly contribution and knowledge sharing in the field of creative learning and early childhood education.

Objectives and Benefits

The community service program aims to introduce creative and constructive learning activities for kindergarten children through hands-on educational experiences. Specifically, the objectives of this activity, including:

1. To introduce basic construction learning using simple paper toy mechanisms to kindergarten students.
2. To enhance children's fine motor skills through activities such as cutting, assembling, and manipulating toy structures.
3. To stimulate children's creativity and imagination through visual design and coloring activities.
4. To introduce simple cause-and-effect mechanical concepts through moving paper toys.
5. To encourage collaborative learning interactions between children, teachers, lecturers, and university students.

The implementation of this program provides several educational and social benefits, including:

1. Supporting early childhood learning through interactive and engaging play-based educational activities.
2. Improving children's coordination, concentration, and confidence in completing creative multi-discipline tasks.
3. Providing teachers with practical examples of integrating art, design, and simple construction into classroom learning.
4. Strengthening collaboration between higher education institutions and early childhood education centers.
5. Producing educational outcomes that can be documented and disseminated as academic research and community engagement practices.

Relationships and Alignment

The implementation of this community service program is aligned with national educational priorities in Indonesia, particularly the development of early childhood education (Pendidikan Anak Usia Dini / PAUD), including kindergarten education. The Indonesian government emphasizes the importance of holistic child development, which includes cognitive, social, emotional, and motoric growth. Educational programs that promote play-based learning, creativity, and experiential exploration are strongly encouraged in order to support children's developmental needs. Activities such as construction-based creative play provide opportunities for children to engage in meaningful learning experiences that combine artistic expression with practical problem-solving skills. Therefore, initiatives like this community service program contribute to broader

educational goals that promote innovative and child-centered learning environments in early childhood institutions.

In addition to supporting early childhood education development, this activity also reflects the implementation of the Tri Dharma Perguruan Tinggi, which consists of education, research, and community service. The participation of lecturers and university students in the program not only provides educational support for the kindergarten community but also creates opportunities for experiential learning for higher education participants. Through this activity, academic knowledge from the field of Visual Communication Design is applied in a real-world educational context. Furthermore, the outcomes of the program are documented and analyzed as part of academic research, resulting in scholarly outputs such as journal articles. In this way, the community service program simultaneously fulfills the mission of higher education institutions to contribute to society while advancing academic knowledge and educational innovation.

3. Methods and Materials

The community service program began with a preliminary discussion between the Visual Communication Design (VCD) team from Jakarta International University (JIU) and the principal of Mutiara Children Learning Center (MCLC). This discussion aimed to identify the learning needs of the kindergarten students and to understand the developmental characteristics of each class group. The children were categorized into three learning groups based on their age levels: the Sheep class (3–4 years old), the Eagle class (4–5 years old), and the Whale class (5–6 years old). Through this initial consultation, the team gathered information regarding the children's cognitive readiness, fine motor skill levels, and their familiarity with creative craft activities. The discussion also helped determine the level of complexity appropriate for each class so that the learning activity could remain engaging, safe, and developmentally suitable. It should be noted that this assessment was based on observational insights and informal discussions with educators, rather than standardized measurement instruments. Consequently, the evaluation of outcomes in this program remains qualitative and descriptive in nature. In addition, the activity involved a single kindergarten setting (n=31), without the use of a control group or a pre-test/post-test design. While these methodological limitations restrict the generalizability and causal interpretation of the findings, the approach remains appropriate for the exploratory and community service-oriented nature of the program, aiming to provide practical insights into the implementation of construction-based learning in early childhood education.

As a result, the papertoy construction activity was designed with different levels of difficulty to accommodate the varying abilities of the children in each age group.

Table 1. Automata Papertoy Level Categorized. Source: Author's Formulation

Category	Age	Piaget's Cognitive Level	Papertoy
Sheep Class	3-4 Years old	Sensorimotor (0-3 years old)	Type 1 (2 Dimensional)
Eagle Class	4-5 Years old	Preoperational (3-7 years old)	Type 2 (3 Dimensional)
Whale Class	5-6 Years old	Preoperational (3-7 years old)	Type 2 (3 Dimensional)

Following the needs assessment stage, the VCD JIU team conducted an internal academic discussion, particularly from the lecturers' point

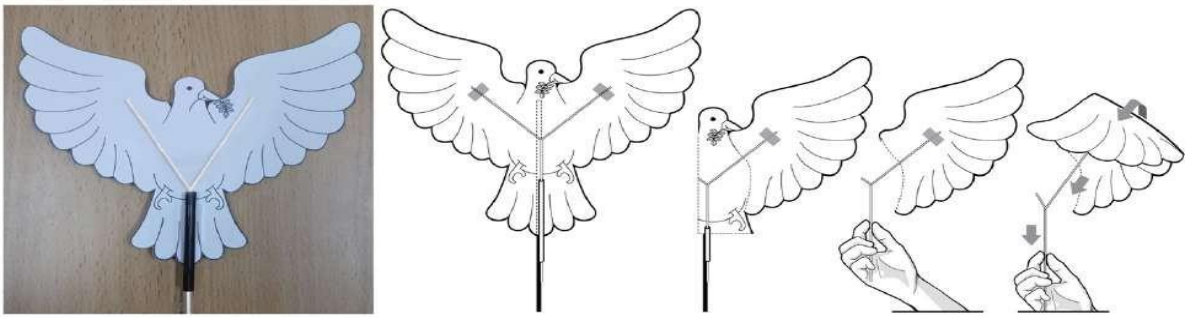


Figure 2. Automata Papertoy Type 1. Source: Author's Design Work

of view, design the most appropriate instructional approach for the activity. During this process (table 1), the team decided to combine the same papertoy learning material for both the Eagle class (4–5 years old) and the Whale class (5–6 years old). This decision was based on the cognitive development theory proposed by Jean Piaget, which explains that children progress through several stages of cognitive growth (Piaget, 2023). According to this theory, younger children are generally associated with the sensorimotor stage (0–3 years), while children aged approximately 3–7 years enter the preoperational stage, characterized by the development of symbolic thinking and imaginative. Considering at this developmental characteristics, Sheep class was given a simpler two-dimensional papertoy model with a basic pulling mechanism, while Eagle and Whale classes were introduced to a slightly more complex three-dimensional papertoy model with separated wings connected through a straw mechanism. This approach ensured that the learning materials remained aligned with cognitive and motor abilities of each age group while still promoting the creative construction learning.

The first paper toy (figure 2) mechanism operates as a planar automaton featuring a front-facing dove silhouette actuated by an internal, rigid Y-shaped lever system. The bird's body is anchored to a stationary guide sleeve, while the dual arms of the internal wire are adhered to mid-

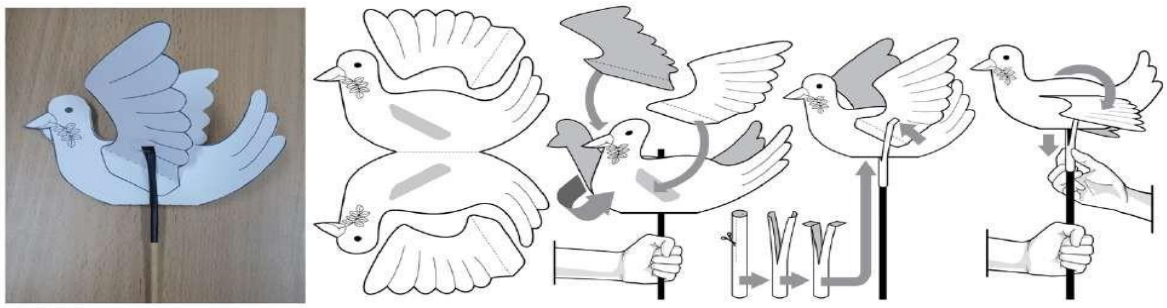


Figure 3. Automata Papertoy Type 2. Source: Author's Design Work

line. By applying a downward longitudinal force to the stem of the Y-rod, the user translates linear motion into synchronized angular displacement, forcing the wings to pivot toward the body. This configuration is characterized by its high structural symmetry and the use of a single internal frame to provide both mechanical support and a direct-drive flapping motion.

The second paper toy (figure 3) mechanism utilizes a profile-based 3D construction driven by a split-sleeve (forked) actuator mounted onto a central support dowel. In this design, the bird's body is a folded volumetric shell, and the wings are independent components attached to flexible tabs created by longitudinal incisions at the top of an outer sliding tube (using straw). The

flapping kinematics are achieved through the vertical translation of this outer sleeve; as the sleeve is pushed upward, the bifurcated tabs exert an upward force on the wing surfaces, causing them to rotate around a paper fold axis. This design emphasizes a lateral perspective and leverages the material's inherent flexibility to facilitate a more complex, multi-component assembly, and advance mechanism.

Implementation

The implementation of the community service activity began with a joint gathering of all participating classes at Mutiara Children Learning Center (MCLC). During this initial session, the lecturers and students from the Visual Communication Design (VCD) Study Program of Jakarta International University introduced themselves to the children and teachers (figure 4). This moment served as an ice-breaking activity to create a friendly and comfortable learning atmosphere. After the introduction, the facilitators briefly explained the activity that the children would perform, namely assembling and decorating paper bird toys. The explanation was delivered in a simple and engaging manner so that the children could easily understand the steps involved in the activity. This initial gathering aimed to build enthusiasm, curiosity, and motivation among the children before they began the hands-on learning session in each classroom.



Figure 4. Introduction and Early Briefing. Source: Author's Documentation



Figure 5. Sheep (Top Row), Eagle (Middle Row), and Whale (Below Row) Class Activities.
Source: Author's Documentation

Throughout the activity, the mentoring process was primarily conducted by VCD JIU students, where each student was assigned to assist one child individually. This one-to-one mentoring approach allowed the children to receive close guidance while assembling, coloring, and operating their paper bird toys. The lecturers acted as supervisors who monitored the overall learning process, provided additional explanations when needed, and ensured that the activity proceeded safely and effectively. This collaborative mentoring model between lecturers and university students created an interactive learning environment that encouraged children to actively participate in the construction process while maintaining a structured and supportive educational setting.

4. Results

The results of the activity were documented once each child successfully completed their paper bird toy (figure 6). Both the children and the assisting university students participated in documenting the finished works through photographs. This documentation process served not only as a record of the activity but also as a form of appreciation for the children's efforts and creativity. Each child proudly presented their completed papertoy,

demonstrating the movement of the wings through the simple mechanisms that had been assembled. In addition to individual documentation, group photographs were also taken for each class (Sheep, Eagle, and Whale) to capture the collaborative learning atmosphere between the kindergarten students, lecturers, and VCD JIU university students.



Figure 6. Sheep (Top Row), Eagle (Middle Row), and Whale (Below Row) Class Resluts.
Source: Author's Documentation

After all classroom activities were completed, the participants gathered again in a shared space for a closing session. In addition to documenting the final outputs, the implementation process revealed several practical considerations. As the facilitators also functioned as implementers and observers, there is a potential risk of observer bias, which should be acknowledged when interpreting the findings. During the activity, variations in task completion were observed; some children were able to complete the papertoy independently, while others required moderate to substantial assistance, particularly in assembling mechanical components such as string alignment and straw-based structures. Minor technical difficulties were also encountered, including at challenges in maintain structural balance and coordinating moving parts. To enhance the validity of the observations, informal triangulation was conducted through discussions with classroom teachers, who provided additional perspectives on children's engagement and learning responses. Although the data collected in this program were primarily qualitative, indicative quantitative observations—such as differences in completion time and levels of assistance required—were noted to provide a more nuanced understanding of the learning process. These findings suggest that while the activity was generally well-received, varying levels of support were necessary depending on the children's developmental stage, highlighting the importance of adaptive facilitation in early childhood construction-based learning.

This closing interaction reinforced the sense of collaboration and community between university and kindergarten institution. However, it is important to note that the present activity was conducted as a one-off intervention, and no longitudinal data were collected to assess long-term impacts such as skill retention among children or the sustained adoption of the proposed method by teachers. As such, while immediating engagement and participation were observed, the findings do not provide sufficient evidence to claim long-term effectiveness or sustainable changes in teaching practices. Future studies are therefore recommended to incorporate follow-up evaluations, repeated measures, or longitudinal designs to better assess the durability of learning outcomes and the integration of construction-based learning approaches in early childhood educational settings pedagogy.



Figure 7. Closing with Photo Group. Source: Author's Documentation

5. Conclusions

The community service program titled Children's Construction Learning with Paper Bird Toys at Mutiara Children Learning Center demonstrated that construction-based creative learning can effectively engage kindergarten students in meaningful educational activities. In response to the first research question, the findings indicate that effectiveness in implementation is reflected in the feasibility of the activity design, the ability of children to complete the tasks with varying levels of assistance, and the observed engagement during the learning process, rather than through standardized performance metrics. Regarding the second research question, while observational evidence suggests that the activity may support the development of fine motor coordination and creativity, the absence of pre- and post-intervention measurements limits the ability to draw definitive conclusions about skill improvement. For the third research question, the collaborative mentoring model involving lecturers, university students, and teachers was found to facilitate interactive learning experiences and provide immediate instructional support for children.

However, these conclusions should be interpreted with caution, as the study relies primarily on qualitative observations within a single implementation context. Future research is recommended to incorporate more rigorous evaluation methods learn, including pre and post assessment data, control group comparisons, and longitudinal follow-up, in order to more accurately measure learning outcomes and validate the effectiveness of construction-based learning approaches in early childhood education.

Through the process of assembling paper bird toys, children were able to develop fine motor skills, creativity, and basic mechanical understanding in a playful and supportive environment. The collaboration between lecturers, university students, and kindergarten teachers created an interactive learning atmosphere that encouraged active participation

and exploration among the children. The successful completion of the activity and the enthusiasm shown by the participants indicate that simple construction-based educational tools can become effective learning media for early childhood education.

Based on the results of this activity, similar community service programs are recommended to be implemented in other early childhood education institutions. Future activities could further expand the variety of creative construction materials and incorporate additional learning elements such as storytelling, environmental themes, or interactive design exploration. Moreover, continued collaboration between universities and early childhood education centers can contribute to the development of innovative teaching practices that integrate art, design, and creative construction learning. However, it is important to acknowledge several limitations of the present study to avoid overgeneralization of the findings. First, the implementation was conducted within a single kindergarten setting with a relatively small sample size, which limits the external validity of the results. Second, the study relied primarily on qualitative observations without the use of objective or standardized measurement instruments to assess learning outcomes. Third, the one-to-one mentoring model applied in this program, while effective for guided learning, may not be feasible in typical classroom conditions with limited teaching resources. Finally, the activity was conducted as a one-day intervention, which does not allow for assessment of long-term learning retention or sustained pedagogical impact. Therefore, future research is recommended to adopt broader samples, incorporate quantitative evaluation methods, and explore scalable implementation models over longer periods to strengthen the generalizability and validity of construction-based learning approaches in early childhood education. Such initiatives may also serve as valuable opportunities for university students to apply their academic knowledge in real-world educational contexts while contributing positively to community development.

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