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The Effect of Mini Foosball Tables Made from Recycled Materials on Fine Motor Skills and Force Control in Children Aged 5–6 Years

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ABSTRACT

Manipulative activities play an important role in developing young children's fine motor skills, particularly finger coordination, hand control, and visuomotor accuracy. However, motor stimulation in the digital era tends to decrease because children are increasingly engaged in passive screen-based activities. This study aimed to analyze the effect of a Mini Foosball game made from recycled cardboard on the fine motor skills and force control of children aged 5–6 years. The study used a quantitative quasi-experimental method with a one-group pretest-posttest design involving 16 children from Group B at Shandy Putra Telkom Kindergarten. Data were collected using an observation sheet covering pincer grasp, wrist flexibility, eye-hand coordination, and force control. Instrument validity was confirmed through expert judgment with an Aiken's V value of 0.86. The intervention was conducted in six play sessions. Data analysis included descriptive statistics, the Shapiro-Wilk normality test, and a paired-sample t-test. Results showed improvement in children's fine motor skills from 54.8% (pretest) to 84.6% (posttest). The t-test result ($t = 8.73$; $p < 0.05$) indicated a significant effect of the recycled-material Mini Foosball on fine motor development and force control. The findings suggest that recycled play media can provide effective and economical sensorimotor stimulation in early childhood education.

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ABSTRAK

Aktivitas manipulatif berperan penting dalam perkembangan motorik halus anak usia dini, terutama dalam koordinasi jari, kontrol gerakan tangan, dan ketepatan visuomotor. Namun, stimulasi motorik pada era digital cenderung menurun karena anak lebih banyak terlibat dalam aktivitas pasif berbasis layar. Penelitian ini bertujuan menganalisis pengaruh permainan Mini Foosball berbahan kardus daur ulang terhadap keterampilan motorik halus dan kontrol kekuatan anak usia 5–6 tahun. Penelitian menggunakan pendekatan kuantitatif dengan desain kuasi eksperimen one-group pretest-posttest yang melibatkan 16 anak Kelompok B TK Shandy Putra Telkom. Pengumpulan data dilakukan menggunakan lembar observasi yang mencakup indikator pincer grasp, fleksibilitas pergelangan tangan, koordinasi mata-tangan, dan kontrol kekuatan. Validitas instrumen diuji melalui expert judgment dengan nilai Aiken's V sebesar 0,86. Intervensi dilakukan melalui enam sesi permainan. Analisis data menggunakan statistik deskriptif, uji normalitas Shapiro-Wilk, dan paired-sample t-test. Hasil penelitian menunjukkan peningkatan keterampilan motorik halus anak dari 54,8% pada pretest menjadi 84,6% pada posttest. Hasil uji t menunjukkan nilai $t = 8,73$ dengan signifikansi $p < 0,05$, yang berarti permainan Mini Foosball berbahan daur ulang berpengaruh signifikan terhadap perkembangan motorik halus dan kontrol kekuatan anak. Temuan ini menunjukkan bahwa media bermain sederhana dari bahan daur ulang dapat menjadi alternatif stimulasi sensorimotor yang efektif dan ekonomis di pendidikan anak usia dini.

KATA KUNCI
Mini Foosball; Motorik Halus; Force Control; Media Daur Ulang; Anak Usia Dini

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Introduction

Fine motor development in early childhood occurs through various movement experiences involving the coordination of small muscles, sensory responses, and gradual movement control. At the age of 5–6 years, children experience rapid progress in hand and finger control, making this period crucial for providing stimulation that can strengthen coordination, movement accuracy, and control of manipulative actions. Activities such as grasping, pinching, pressing, twisting, and moving objects are not merely play activities, but also form an essential foundation for children's independence and academic readiness in later stages of development (Papalia & Feldman, 2015; Gallahue et al., 2019).

However, learning activities in many early childhood education (PAUD) settings still tend to emphasize conventional fine motor exercises, such as tracing, coloring, and pasting patterns.

Although these activities contribute to hand coordination, they often provide limited opportunities for children to develop dynamic movement control and the ability to regulate movement pressure during manipulative tasks. In fact, the ability to adjust the direction and strength of hand movements—commonly referred to as force control—is an important aspect of manipulative motor development because it is closely related to neuromuscular coordination and the regulation of motor responses.

Force control refers to an individual's ability to regulate the magnitude of pressure or motor force according to the demands of a particular activity. In early childhood, this ability develops through repeated sensorimotor experiences involving visual coordination, proprioceptive responses, and gradual movement adjustments (Schmidt & Lee, 2019). Children who possess good force control are generally more capable of performing manipulative activities in a directed, stable, and controlled manner. In this study, force control is defined as the child's ability to regulate hand pressure while rotating and sliding the game sticks in order to control the speed and direction of the ball during Mini Foosball play.

Alongside these developmental needs, changes in children's lifestyles in the digital era have also influenced the quality of motor stimulation they receive. Many children now spend more time engaging with gadgets and passive screen-based activities that provide minimal opportunities for active movement and direct object manipulation. As a result, children's finger muscle strength, wrist flexibility, and hand-eye coordination may not develop optimally (Mulyasa, 2022; Sujiono, 2023). This condition highlights the importance of creating learning experiences that encourage children to actively explore movement through enjoyable and meaningful play.

From a theoretical perspective, the development of manipulative movement skills can be explained through motor control theory, which emphasizes the integration of sensory, nervous, and muscular systems in producing coordinated movement. Schmidt and Lee (2019) explain that motor learning develops through continuous sensory feedback and repeated movement experiences. Likewise, Shumway-Cook and Woollacott (2017) emphasize that activities involving visual-hand coordination contribute significantly to the strengthening of sensorimotor integration and movement regulation in children. Therefore, manipulative play activities that require children to coordinate visual input with hand movements can become effective forms of motor stimulation.

One learning medium that can accommodate these needs is the Mini Foosball game made from recycled cardboard. This game adapts the concept of table soccer into a simple educational play tool using recycled materials such as cardboard, bamboo sticks, and clothespins. In playing the game, children rotate and slide the sticks to direct the ball toward the opponent's goal. Although simple in design, the activity involves various complex manipulative movements that stimulate fine motor development.

During the game, children are required to coordinate finger movements, regulate wrist flexibility, maintain hand-eye synchronization, and adjust the amount of force applied to the sticks so the ball remains under control. Pinching and gripping activities strengthen pincer grasp coordination, while rotating movements improve wrist flexibility. At the same time, children continuously train visual-motor responses as they observe and direct the ball's movement. These experiences make Mini Foosball not only an enjoyable play activity, but also a meaningful form of sensorimotor stimulation for young children.

In addition to its motor development benefits, the use of recycled materials in learning media also introduces children to environmental awareness and eco-education values. Utilizing used cardboard as a play medium teaches children that discarded materials can still be transformed into useful and meaningful objects (Wahyuni & Pratama, 2024; Suryana & Rizka, 2024). Thus, the game integrates educational, environmental, and developmental values simultaneously.

Previous studies have demonstrated that manipulative games involving hand-eye coordination can positively support fine motor development in young children (Hasanah, 2021; Pitriani, 2022). Nevertheless, studies specifically examining the use of recycled-material Mini Foosball games in relation to children's force control abilities are still limited. Based on these considerations, this study was conducted to analyze the effect of a Mini Foosball game made from recycled cardboard on the fine motor skills and force control of children aged 5–6 years.

Furthermore, the implementation of play-based learning media such as Mini Foosball is also aligned with the characteristics of early childhood learning, which emphasizes active exploration, enjoyment, and meaningful interaction with the environment. Children learn more effectively when they are directly involved in hands-on activities that stimulate curiosity and encourage movement experimentation. Through Mini Foosball play, children not only engage in repetitive manipulative

movements but also experience problem-solving situations, concentration, and social interaction during gameplay. These integrated experiences can strengthen children's motivation to participate in learning activities while simultaneously supporting holistic aspects of development, particularly in the physical-motor domain. Therefore, the use of innovative play media derived from simple recycled materials has the potential to become an alternative strategy for creating more engaging, affordable, and developmentally appropriate learning environments in early childhood education settings.

Method

This study employed a quantitative approach using a quasi-experimental method with a one-group pretest-posttest design. The design was selected to examine changes in children's fine motor skills before and after participating in Mini Foosball play activities made from recycled cardboard. Through this design, the researchers were able to compare children's motor development conditions at the beginning and end of the intervention.

The study was conducted at Shandy Putra Telkom Kindergarten involving 16 children from Group B aged 5–6 years, consisting of 9 boys and 7 girls. The participants were selected using purposive sampling based on the consideration that the children actively participated in classroom learning activities and were able to follow the stages of the game intervention effectively.

Data collection was carried out using an observation sheet developed based on manipulative skill indicators in early childhood and concepts from motor control theory. The instrument consisted of 12 observation indicators covering four main aspects of fine motor development, namely pincer grasp ability, wrist flexibility, eye-hand coordination, and force control. Each indicator was assessed using a scale of 0–2, where a score of 2 indicated that the child could perform the activity independently and accurately, a score of 1 indicated that the child could perform the activity with assistance or guidance, and a score of 0 indicated that the child was unable to perform the activity.

To ensure the appropriateness of the instrument, content validation was conducted through expert judgment involving two early childhood education experts and one expert in child motor development. The validation results showed an Aiken's V value of 0.86, indicating that the instrument possessed high content validity and was appropriate for use in this study.

The research procedure was implemented in three stages: pretest, treatment, and posttest. During the pretest stage, observations were conducted to identify the children's initial fine motor abilities. The treatment stage involved Mini Foosball play activities conducted over six sessions, with each session lasting approximately 30–40 minutes. During the activities, children played in pairs while rotating and sliding the game sticks to direct the ball toward the opponent's goal. Through these activities, children practiced finger coordination, visual-hand synchronization, wrist movement flexibility, and force control while responding to the movement of the ball. After the intervention was completed, a posttest was conducted to identify changes in the children's fine motor development.

The collected data were analyzed using descriptive statistics, including means, percentages, and distributions of child development outcomes. Prior to hypothesis testing, the data were first tested for normality using the Shapiro-Wilk test. The results showed a significance value greater than 0.05, indicating that the data were normally distributed and met the assumptions for parametric testing. Therefore, the effect of the intervention was analyzed using a paired-sample t-test to determine differences between pretest and posttest results.

Result and Discussion

The findings of this study indicate that the implementation of the Mini Foosball game made from recycled cardboard provided a positive contribution to the development of children's fine motor skills and force control abilities. During the initial observation phase, many children still demonstrated limited control over hand movements when interacting with the game media. Several children appeared to move the sticks abruptly, apply excessive pressure, and struggle to direct the ball accurately toward the intended target. Some children also showed stiffness in wrist movements and tended to rely on broad palm movements rather than coordinated finger manipulation. These conditions illustrate that the children's manipulative motor control had not yet developed optimally prior to the intervention.

However, gradual changes were observed throughout the six intervention sessions. As children repeatedly engaged with the Mini Foosball activities, they became increasingly familiar with the movement patterns required in the game. The children began to show better hand stability, smoother wrist rotation, and more controlled finger movements when turning and sliding the sticks.

They also became more responsive in adjusting the direction of the ball and demonstrated greater accuracy in coordinating visual input with motor responses. The play activity not only stimulated children's motor performance but also increased their enthusiasm and active participation during learning activities.

Table 1. Results of Children's Fine Motor Development.

No	Indicator	Pretest Mean	Posttest Mean	Improvement
1	Pincer Grasp	56.2	85.4	29.2
2	Wrist Flexibility	52.8	83.7	30.9
3	Eye-Hand Coordination	54.1	86.2	32.1
4	Force Control	56.0	83.1	27.1
	Total	54.8	84.6	29.8

Based on Table 1, improvements were observed across all indicators of children's fine motor development after the intervention. The pincer grasp indicator increased from 56.2 in the pretest to 85.4 in the posttest, showing that children became more capable of coordinating thumb-and-index-finger movements during manipulative play. Wrist flexibility also showed a substantial increase from 52.8 to 83.7, indicating better control and smoothness in rotational hand movements. The highest improvement was found in eye-hand coordination, which increased by 32.1 points, from 54.1 to 86.2. This finding demonstrates that the children became more responsive and accurate in coordinating visual input with hand movements while directing the ball during gameplay. Meanwhile, the force control indicator increased from 56.0 to 83.1, suggesting that children learned to regulate movement pressure more effectively and maintain better control over the direction and speed of the ball. Overall, the total mean score increased from 54.8 to 84.6, reflecting a significant improvement in children's fine motor abilities following the intervention.

Table 2. Results of the Paired Sample t-Test.

Variable	Pre-test Mean	Post-test Mean	SD	t-value	Sig. (2-tailed)
Fine Motor Skills and Force Control	54.8	84.6	6.42	8.73	0.000

The statistical analysis further strengthened these findings. As shown in Table 2, the paired-sample t-test produced a t-value of 8.73 with a significance value of 0.000 ($p < 0.05$). These results indicate that there was a statistically significant difference between children's fine motor abilities before and after the implementation of the Mini Foosball intervention. Therefore, the recycled-material Mini Foosball game can be considered effective in improving fine motor skills and force control among children aged 5–6 years.

The improvement in fine motor skills occurred because the Mini Foosball game required children to perform repetitive manipulative movements involving finger coordination, wrist movement, and visual tracking. During gameplay, children continuously practiced grasping, rotating, pressing, and sliding the sticks while monitoring the movement of the ball. Such repetitive manipulative experiences stimulate the intrinsic muscles of the fingers and improve the flexibility of hand movements. These skills are important because they form the basis for more advanced academic activities such as writing, drawing, cutting, and using classroom tools effectively (Pratiwi, 2023).

At the beginning of the intervention, many children still used their entire palms when moving the sticks, causing the ball to move unpredictably and making it difficult for them to maintain directional control. This movement pattern indicated that the children had not yet mastered efficient manipulative coordination. Nevertheless, after repeated practice sessions, significant improvements became visible. The children gradually began to use more precise thumb-and-index-finger movements when rotating the sticks. Their grip became more stable, and their hand movements appeared more controlled and purposeful. This behavioral change reflects the development of pincer grasp ability, which is one of the essential components of fine motor maturation in early childhood.

The improvement in eye-hand coordination was also clearly observable during the intervention process. Initially, several children needed more time to react to the movement of the ball and often failed to align their hand movements with the visual direction of the object. Over time, however, children became quicker and more accurate in responding to the ball's movement. They began anticipating the ball's direction, adjusting their hand positions more effectively, and directing

the ball toward the target with greater precision. According to Gallahue et al. (2019), activities that combine visual perception with coordinated motor responses contribute significantly to the strengthening of visuomotor integration in children. The Mini Foosball activity provided a concrete learning experience that integrated these sensory and motor processes simultaneously.

Another important finding of this study relates to the development of force control abilities. During the early stages of gameplay, children often applied excessive force when rotating the sticks, causing the ball to move too quickly or leave the playing area entirely. Some children also demonstrated inconsistent movement pressure, alternating between movements that were too weak and movements that were too strong. Through repeated play experiences, children gradually learned to adjust the amount of pressure applied to the sticks according to the movement demands of the game. They became more capable of regulating movement intensity to maintain ball stability and direction. This process reflects the development of motor regulation abilities, particularly in controlling the relationship between movement force and movement outcomes.

From a neuromotor perspective, the activities involved in Mini Foosball provide meaningful proprioceptive and sensorimotor stimulation. When children rotate and slide the sticks, the sensory system continuously receives information related to muscle tension, movement direction, hand position, and visual feedback from the moving ball. The nervous system then processes this information to adjust and refine subsequent movements. Through repeated movement experiences, children gradually develop more stable neuromuscular coordination and improved movement precision. Schmidt and Lee (2019) explain that motor learning develops through sensory feedback mechanisms and repeated movement adjustments, while Shumway-Cook and Woollacott (2017) emphasize that manipulative activities involving coordinated visual and motor responses strengthen motor control regulation. The findings of this study support these theoretical perspectives, as the children demonstrated increasingly controlled and efficient movement patterns throughout the intervention process.

In addition to supporting motor development, the Mini Foosball game also created a more active and engaging learning atmosphere in the classroom. The children appeared enthusiastic during the activities, especially because the game allowed them to interact directly with peers in a playful and competitive environment. The game-based learning process encouraged children to remain focused, actively participate, and repeat manipulative movements naturally without feeling pressured. This condition is important in early childhood education because meaningful learning experiences are more effectively achieved when children are emotionally engaged and motivated through play activities.

Furthermore, the use of recycled cardboard as the primary material for the game provided additional educational value. The learning media used in this study demonstrated that effective educational play tools do not always require expensive commercial products. Teachers can creatively utilize accessible recycled materials to develop meaningful learning experiences that are both economical and environmentally friendly. The use of recycled materials also introduces children to concepts of environmental awareness and resource reuse from an early age. These findings are consistent with the study by Amini (2020), which states that recycled-material learning media can increase creativity while simultaneously enhancing the effectiveness of developmental stimulation in early childhood settings.

Overall, the results of this study demonstrate that the Mini Foosball game made from recycled cardboard is capable of integrating manipulative movement practice, sensorimotor stimulation, and enjoyable learning experiences into a single activity. The game not only improves fine motor skills and force control but also supports children's active participation, movement confidence, and sensory-motor integration. Therefore, the Mini Foosball game can serve as an innovative and contextually relevant alternative learning medium for stimulating fine motor development in early childhood education environments.

Conclusion

The findings of this study demonstrate that the Mini Foosball game made from recycled cardboard has a positive and significant effect on the fine motor development and force control abilities of young children. Through repetitive manipulative activities such as rotating, sliding, grasping, and directing the movement of the ball, children experienced improvements in pincer grasp ability, wrist flexibility, eye-hand coordination, and movement regulation. The game provided meaningful sensorimotor experiences that encouraged children to coordinate visual responses with

controlled hand movements in an active and enjoyable learning environment.

The statistical findings also confirmed that children's fine motor abilities improved significantly after participating in the intervention activities. This indicates that play-based manipulative activities can effectively stimulate neuromuscular coordination and support the development of motor control in early childhood. The Mini Foosball activity not only trained children's movement accuracy and force regulation but also increased their engagement and participation during the learning process.

In addition, the use of recycled materials as the main component of the learning media offers important educational and environmental benefits. Recycled cardboard-based play materials provide an economical, creative, and environmentally friendly alternative that can be easily implemented in early childhood education settings. Teachers can develop simple educational play tools independently using accessible materials without relying on expensive commercial products. Therefore, the Mini Foosball game can serve as an innovative and contextually relevant educational play medium for supporting sensorimotor stimulation and fine motor development in young children.

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