



The Effect of the Kinetic Sand Play Method on Fine Motor and Cognitive Development in Preschool Children

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Abstract

Background: Fine motor and cognitive skills are essential aspects of preschool children's development, as they are closely related to learning readiness, independence, and self-confidence. **Aims:** To determine the effect of kinetic sand play on the improvement of fine motor and cognitive development in children aged 3–5 years. **Methods:** This research applied a quantitative approach with a quasi-experimental design, specifically the two-group pretest-posttest with control group design. The population consisted of 80 children, and 36 were selected as samples using purposive sampling, with 18 children in both the intervention and control groups. Data were collected using standardized observation sheets and analyzed using the Paired t-test and Independent t-test. **Results:** The results showed a significant difference between pretest and posttest scores in the intervention group $p = 0.000$ (< 0.05), as well as a significant difference between the intervention and control groups after the intervention $p = 0.000$ (< 0.05). **Conclusion:** It can be concluded that kinetic sand play has a positive effect on improving children's fine motor and cognitive development. This activity is recommended to be implemented as an educational stimulus in early childhood education settings, as it is enjoyable, safe, and capable of stimulating children's holistic development.

Keywords: Cognitive intelligence, Early childhood, Fine motor skills, Kinetic sand, Play-based stimulation

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Introduction

Children are a nation's vital asset and represent the future generation. According to the World Health Organization (WHO), a child is defined as an individual from conception until the age of 19. In contrast, the Law of the Republic of Indonesia No. 23 of 2002 defines a child as a person who has not yet reached the age of 18. Therefore, attention to children's growth and development is essential to ensure they grow into healthy, intelligent, and morally upright individuals (Dhiu, 2023).

The preschool period, typically between the ages of 4 and 6, is known as the "golden age," during which children undergo rapid development across multiple domains. At this stage, children begin to learn fundamental skills such as communication, social interaction, and the development of fine motor and cognitive abilities—skills that are crucial as they prepare for formal education (Septiana, 2023).

Data from Indonesia's Central Statistics Agency (BPS) in 2024 indicates that the number of early childhood-aged children in the country is significantly high. Thus, efforts to optimize early childhood development are increasingly vital. Fine motor skills involve the coordination of small muscles, particularly those of the hands and fingers, enabling children to perform precise movements. These skills are fundamental for activities such as writing, drawing, and handling tools. Additionally, cognitive development in preschool-aged children progresses rapidly. Cognition encompasses thinking, memory, and problem-solving abilities. A lack of adequate stimulation during this critical period may lead to developmental delays, including impairments in communication and logical reasoning (Mawaddah & Pohan, 2024; Lubis et al., 2015).

Play is a fun and effective method for stimulating children's development. One type of play suitable for early childhood is kinetic sand play. Kinetic sand is cleaner and safer than regular sand and encourages children's creativity through various shapes and colors. Previous studies have shown that playing with kinetic sand can enhance fine motor development and creativity in children (Mawaddah & Pohan, 2024; Aqidah, 2024). However, most research has focused on only one developmental domain—either fine motor or cognitive skills.

Based on this gap, the present study aims to holistically explore the effect of the kinetic sand play method on both fine motor and cognitive development in preschool children. Preliminary observations conducted at PAUD Miftahul Falaah revealed that several children still exhibited delays in these developmental areas. Therefore, it is necessary to implement targeted interventions through appropriate play-based media to enhance both developmental aspects simultaneously.

Methods

This study employed a quantitative approach using a quasi-experimental design of the *two-group pretest-posttest with control group design* type. This design involved two groups:

an intervention group and a control group. Both groups were given a pretest to assess the initial conditions of fine motor and cognitive development before the treatment. Subsequently, only the intervention group received the treatment in the form of a kinetic sand play method, while the control group did not receive any special treatment. A posttest was then administered to evaluate the differences in outcomes between the two groups.

The subjects in this study were preschool children selected using purposive sampling based on specific inclusion and exclusion criteria. The instrument used to measure fine motor and cognitive development was a standardized observation sheet that had undergone validity and reliability testing. Instrument validity was assessed using the *expert judgement* technique, while reliability was tested using *inter-rater reliability*, which yielded consistent results. The research procedure included administering the intervention over a specific period, collecting data through structured observations, and processing and analyzing the data using statistical tests to determine the effectiveness of the treatment.

Ethical approval for this study was granted by the Health Research Ethics Commission of Poltekkes Kemenkes Tasikmalaya (Approval number: DP.04.03/F.XXVI.20/KEPK/65/2025) dated 3 March 2025. The rights of the respondents were protected by obtaining informed consent from the children's parents or guardians, ensuring data confidentiality, and guaranteeing that participation was voluntary and free from coercion.

Results

1. Respondent Characteristics

Based on Table 1, the average age of respondents in the intervention group was 2.17 years (SD = 0.70), while in the control group it was 1.94 years (SD = 0.72)

Table 1. Characteristics of Respondents Based on Age (n=36)

Variables	Min	Max	Mean	Median	SD
Intervention	1	3	2.17	2.00	0.70
Control	1	3	1.94	2.00	0.72

Meanwhile, in Table 2, the majority of respondents in both groups were female, with 61.1% in the intervention group and 55.6% in the control group.

Table 2. Characteristics of Respondents Based on Gender (n=36)

Variables	Intervention Group (n=18)		Control Group (n=18)		Total (n=36)		
	n	%	n	%	n	%	
Gender	Male	7	38.9	8	44.4	15	41.67
	Female	11	61.1	10	55.6	21	58.33
Total	18	100	18	100	36	100	

2. Fine Motor and Cognitive Development Before Intervention

Based on Table 3, prior to the intervention, the intervention group had an average fine motor score of 60.83 (SD = 8.78; 95% CI: 56.46–65.20) and a cognitive score of 60.06 (SD = 10.31; 95% CI: 54.94–65.19). Meanwhile, the control group had an average fine motor score of 51.39 (SD = 10.40; 95% CI: 46.21–56.56) and a cognitive score of 37.84 (SD = 10.11; 95% CI: 32.46–43.22).

Table 4. Fine Motor and Cognitive Development Before Intervention (n=36)

Group		Min	Max	Mean	SD	95% CI
Intervention	Fine Motor Skills	45	75	60.83	8.78	56.46–65.20
	Cognitive	37.50	75.00	60.06	10.31	54.94-65.19
Control	Fine Motor Skills	25	70	51.39	10.40	46.21-56.56
	Cognitive	25.00	56.25	37.84	10.11	32.46-43.22

3. Fine Motor and Cognitive Development After Intervention

Based on Table 4, the average fine motor score in the intervention group increased to 88.61 (SD = 7.43; 95% CI: 84.91–92.31), and the cognitive score rose to 87.50 (SD = 7.10; 95% CI: 83.96–91.03). In contrast, the control group obtained an average fine motor score of 67.22 (SD = 7.32; 95% CI: 63.58–70.86), and a cognitive score of 55.20 (SD = 10.11; 95% CI: 50.17–60.23).

Table 4. Fine Motor and Cognitive Development After Intervention

Group		Min	Max	Mean	SD	95% CI
Intervention	Fine Motor Skills	75	100	88.61	7.43	84.91-92.31
	Cognitive	75.00	100.00	87.50	7.10	83.96-91.03
Control	Fine Motor Skills	50	80	67.22	7.32	63.58-70.86
	Cognitive	43.75	75.00	55.20	10.11	50.17-60.23

4. Comparison Before and After Intervention in the Intervention and Control Groups

Based on Table 5, there is a significant difference between the pre-test and post-test scores in the intervention group for both variables. The average fine motor score increased from 60.83 to 88.61 ($p = 0.000$), and the cognitive score increased from 60.06 to 87.50 ($p = 0.000$).

Table 5. Fine Motor and Cognitive Development in the Intervention Group Before and After the Intervention

Intervention Group		Mean	Std. Deviation	Sig. (2-tailed)
Fine Motor Skills	Pre-test	60.83	8.78	0,000

	Post-Test	88.61	7.43	
Cognitive Skills	Pre-test	60.06	10.31	0.000
	Post-Test	87.50	7.10	

Based on Table 6, the control group also showed an increase, albeit smaller, from 51.39 to 67.22 for fine motor skills ($p = 0.000$), and from 37.84 to 55.20 for cognitive abilities ($p = 0.000$).

Table 6. Development of Fine Motor Skills and Cognitive Abilities in the Control Group Before and After Intervention

Control Group		Mean	Std. Deviation	Sig. (2-tailed)
Fine Motor Skills	Pre-test	51.39	10.40	0,000
	Post-Test	67.22	7.32	
Cognitive Skills	Pre-test	37.84	10.81	0.000
	Post-Test	55.20	10.11	

6. Comparative Analysis of the Effects Between the Intervention and Control Groups (Post-Intervention)

Based on Table 7, there is a significant difference between the intervention and control groups after the intervention. For the fine motor skills variable, the intervention group obtained a mean score of 88.61 (SD = 7.437), while the control group scored 67.22 (SD = 7.320), with $p = 0.000$.

Table 7. Fine Motor Skills Development After Intervention

Group	Mean	Std. Deviation	SE	Sig. (2-tailed)
Intervention	88.61	7.437	1.753	0,000
Control	67.22	7.320	1.726	

Berdasarkan tabel 8, terdapat perbedaan yang signifikan antara kelompok intervensi dan kontrol setelah intervensi dilakukan. Pada variabel kognitif, kelompok intervensi memperoleh skor rata-rata 87,50 (SD = 7,110), sementara kelompok kontrol 55,20 (SD= 10,112), dengan $p= 0,000$.

Tabel 8. Cognitive Development After Intervention

Kelompok	Mean	Std. Deviation	SE	Sig. (2-tailed)
Intervensi	87.50	7.110	1.676	0,000
Kontrol	55.20	10.112	2.383	

Discussion

This study aims to examine the effect of the kinetic sand play method on the development of fine motor skills and cognitive abilities in preschool children. The results indicate a significant improvement in both aspects following the intervention. The discussion below is structured to address the hypothesis and compare the findings of this study with previous research. The majority of respondents in this study were 4 years old, which is the early stage of children transitioning from associative to cooperative play. At this age, children's abilities to interact and collaborate begin to develop. This supports the implementation of group-based interventions such as kinetic sand play. Consistent with the findings of Awanis et al., it was reported that children's engagement in activities at early childhood education centers positively influences their motor and cognitive development (Awanis et al., 2022).

Gender did not show a significant influence on the outcomes of this study. Both boys and girls were equally active and exhibited high enthusiasm during the intervention. This finding differs from the results of Cinar et al., which indicated that girls outperform boys in motor skills during the preschool period. This discrepancy is likely influenced by environmental context, child characteristics, and the play approaches utilized (Cinar et al., 2023). Prior to the intervention, the development of both fine motor and cognitive skills in the intervention and control groups was classified as low to moderate. This suggests that the stimulation provided through daily activities in early childhood education was not yet optimal. Previous studies by Marpaung & Simatupang and Febrianti & Winda also found that most preschool children had not reached their maximal developmental potential before receiving specific play therapy. These findings underscore the importance of sensory play-based interventions to more effectively stimulate child development (Febrianti & Winda, 2020).

After the intervention, the intervention group demonstrated a higher level of improvement compared to the control group. Children in the intervention group showed significant progress in fine motor skills such as squeezing, molding, and shaping the sand, as well as in cognitive abilities including categorizing shapes, distinguishing colors, and completing simple tasks. These results align with Jean Piaget's cognitive development theory, which posits that preschool children are in the preoperational stage, making them highly responsive to symbolic and manipulative stimulation

Studies by Astuti et al. and Inayah et al. also demonstrated that kinetic sand play supports the development of fine motor skills while fostering creativity and problem-solving abilities. Children actively shape, observe, and explore the texture of the sand, thereby gaining concrete learning experiences that strengthen cognitive connections and fine muscle coordination (Astuti et al., 2023). The comparison between the intervention and control groups post-intervention also revealed a significant difference. The group receiving kinetic sand play stimulation exhibited superior developmental outcomes compared to children who only participated in routine school activities. This reinforces the findings of Sidiq et al., which state

that sensory play not only develops motor and cognitive skills but also social and emotional aspects, as children are trained to cooperate, concentrate, and imagine (Sidiq et al., 2025).

Optimal development of fine motor and cognitive skills is crucial for supporting children's independence in daily activities and readiness for learning. Children with well-developed fine motor skills find activities such as writing, drawing, and dressing themselves easier. Similarly, children with advanced cognitive abilities are better able to understand instructions, think logically, and complete learning tasks effectively. The results of this study suggest that kinetic sand play can be used as a stimulation medium for the development of fine motor and cognitive skills in early childhood. Community and pediatric nurses can utilize this play method in growth promotion activities at early childhood education centers and community health posts. Furthermore, educating teachers and parents about the benefits of kinetic sand can enhance their involvement in supporting child development in an enjoyable and effective manner. This emphasizes that nurses play an important role not only in curative aspects but also in the promotion and prevention of developmental problems in children (Nurfahira et al., 2023).

Conclusion

This study demonstrates that the kinetic sand play method has a significant effect on improving fine motor and cognitive development in preschool children. Children who received intervention through kinetic sand play showed greater improvement in both aspects compared to those who only participated in regular school activities. Prior to the intervention, most children were categorized within low to moderate developmental levels; however, after the intervention, there was an increase to good and very good categories, particularly in the intervention group. The kinetic sand play method proved effective as an enjoyable stimulation medium because it simultaneously enhances hand coordination, concentration, and cognitive abilities. Therefore, kinetic sand can be employed as an alternative learning method beneficial for early childhood development and serves as a relevant approach to support play-based learning processes in accordance with children's developmental stages.

Suggestions for future research include incorporating a variety of designs and approaches to maintain children's interest and expand the impact of this play method on other developmental domains, such as socio-emotional and language skills. Additionally, modifications to the kinetic sand medium—such as adding scents or varying temperatures—could be explored as forms of additional sensory stimulation.

Conflicts of Interest

Generated from the conflict of interest forms by each author.

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