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The Effect of Block Play on the Fine Motor Skills of Children Aged 4–5 Years in Kindergarten

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Abstrak

Kemampuan motorik halus merupakan prasyarat penting bagi kesiapan menulis dan kemandirian anak usia dini, namun di lapangan masih banyak anak yang capaiannya belum optimal. Penelitian ini bertujuan menguji pengaruh permainan balok terhadap kemampuan motorik halus anak usia 4–5 tahun di TK Dharma Wanita Koto Payang. Penelitian menggunakan pendekatan kuantitatif dengan desain pra-eksperimen tipe one-group pretest–posttest design. Subjek penelitian berjumlah tujuh anak Kelompok A yang ditetapkan melalui teknik sampling jenuh. Data dikumpulkan menggunakan lembar observasi terstruktur berisi sepuluh butir yang mengukur empat dimensi motorik halus dengan skala empat tingkat (BB, MB, BSH, BSB). Data dianalisis secara deskriptif dan inferensial melalui uji normalitas, uji-t sampel berpasangan, perhitungan N-gain, serta ukuran efek (Cohen's d). Hasil penelitian menunjukkan rata-rata skor meningkat dari 20,86 (52,14%) pada pretest menjadi 24,57 (61,43%) pada posttest. Uji-t berpasangan menghasilkan t-hitung sebesar 2,184 yang lebih besar daripada t-tabel 1,943 (df = 6; p = 0,036) pada hipotesis terarah, sehingga hipotesis nol ditolak. Ukuran efek tergolong besar (d = 0,83). Dengan demikian, permainan balok berpengaruh positif terhadap peningkatan kemampuan motorik halus anak, meskipun derajat peningkatannya bervariasi antarindividu. Temuan ini menegaskan bahwa permainan balok dapat dijadikan strategi stimulasi motorik halus yang kontekstual di lembaga PAUD.

Kata Kunci: Permainan Balok; Motorik Halus; Anak Usia Dini

Abstract

Fine motor skill is an essential prerequisite for writing readiness and the independence of early childhood, yet many children still show suboptimal attainment in practice. This study aims to examine the effect of block play on the fine motor skills of children aged 4–5 years at TK Dharma Wanita Koto Payang. A quantitative approach was employed using a pre-experimental one-group pretest–posttest design. The subjects were seven Group A children selected through total (saturated) sampling. Data were collected using a structured observation sheet containing ten items measuring four dimensions of fine motor skill on a

four-level scale (BB, MB, BSH, BSB). Data were analysed descriptively and inferentially through a normality test, a paired-samples t-test, the calculation of N-gain, and an effect-size measure (Cohen's d). The results show that the mean score increased from 20.86 (52.14%) at pretest to 24.57 (61.43%) at posttest. The paired-samples t-test yielded a t-value of 2.184, greater than the t-table value of 1.943 (df = 6; p = 0.036) under the directional hypothesis, so the null hypothesis was rejected. The effect size was large (d = 0.83). Accordingly, block play has a positive effect on improving children's fine motor skills, although the magnitude of improvement varied among individuals. These findings affirm that block play can serve as a contextual fine-motor stimulation strategy in early childhood education institutions.

Keywords: *Block Play; Fine Motor Skills; Early Childhood*

Introduction

Early childhood is a golden age that determines the quality of a child's growth and development in the subsequent stages of life. Within this age range, all aspects of development—religious and moral values, physical-motor, cognitive, language, social-emotional, and artistic—develop very rapidly and are mutually interrelated [1]. One aspect that forms an important foundation for formal learning readiness is physical-motor development, particularly fine motor skills. Fine motor skills involve the coordination of the small muscles of the fingers and hands working in harmony with visual acuity, enabling children to perform precise movements such as pinching, grasping, stacking, and drawing [2].

Fine motor skills do not develop on their own; rather, they require appropriate, well-planned, and enjoyable stimulation. The Child Development Achievement Standards (STPPA) mandate that children aged 4–5 years should already be able to coordinate the eyes and hands to perform complex movements, control hand movements that use the fine muscles, and express themselves through activities involving the fingers [3]. Fine motor maturity serves as a readiness prerequisite for academic skills at the next level, especially the skills of writing, cutting, and using writing implements [4]. Children whose fine motor skills are not yet mature tend to have difficulty holding a pencil, tire quickly when writing, and lack confidence in activities that demand movement precision.

Field realities show that the fine motor attainment of some young children is still suboptimal. Preliminary observations at TK Dharma Wanita Koto Payang showed that most Group A children were still in the beginning-to-develop (MB) category, particularly on the indicators of eye–hand coordination and finger strength. Several children were not yet able to stack blocks into a tower without it collapsing, had difficulty pinching small objects with the thumb and forefinger (pincer grasp), and were not yet skilled at dismantling and tidying constructions in a controlled way. This condition is thought to be related to learning activities that emphasise worksheets more and provide less of a rich manipulative-play experience.

Theoretically, the importance of play for child development has long been studied by developmental psychologists. Piaget viewed the preoperational child as an active learner who builds understanding through direct action on objects, so that the manipulation of concrete objects becomes a fundamental means of learning [5]. Vygotsky added that a child's development proceeds optimally within the zone of proximal development, that is, when the child receives scaffolding from an adult or a more capable peer [5], [6]. Meanwhile, Montessori emphasised the importance of a prepared environment with play materials that train practical life and fine-muscle coordination independently [7]. These three perspectives position manipulative play, including block play, as a legitimate and effective vehicle for stimulating fine motor skills.

A body of empirical evidence in Indonesia reinforces the urgency of strengthening fine motor skills from an early age. Fine motor maturity correlates with a child's writing readiness upon entering primary school, so that a delay in this aspect may hamper early academic skills [8]. Various manipulative activities—such as beading, clipping, and constructive play—have been shown to stimulate the visual-motor coordination of preschool children [9], [10]. However, the availability and use of structured manipulative-play media are still uneven, particularly in early childhood education (ECE) institutions with limited facilities. This condition strengthens the relevance of testing simple media such as blocks, which are inexpensive, easy to obtain, and can be used flexibly by teachers.

From a developmental perspective, fine motor skills develop alongside the maturation of the nervous and muscular systems, yet the pace of their development is strongly influenced by the richness of the experience and stimulation a child receives. Children given many opportunities to manipulate objects tend to master precise movements more quickly than children who are less stimulated [2], [11]. Therefore, providing play activities that actively involve the hands and fingers is an important responsibility of ECE institutions. Block play, with its concrete, open-ended, and repeatable nature, offers rich stimulation opportunities while being consistent with the learning characteristics of young children, which rest on direct experience.

A range of prior studies has affirmed the importance of a play-based approach in stimulating fine motor skills. Play is the most natural way of learning for young children and at the same time an effective means of training motor skills without burdening the child [12]. Among the various types of play, constructive play with blocks is regarded as having high stimulative value because it requires children to manipulate objects repeatedly, position them precisely, and complete a building design [13]. Blocks are an open-ended play medium with no single correct way of being used, thereby giving children room to explore, experiment, and refine their own movements. Several studies report that block-stacking activities can improve eye–hand coordination, finger-muscle strength, and children's concentration [14], [15]. Other studies in the Indonesian ECE context have also found positive contributions of block media to children's cognitive and creative aspects [16], [17].

Although the evidence on the benefits of block play is substantial, most prior studies have still focused on cognitive, creativity, or gross motor aspects, and were conducted in urban institutions with relatively complete facilities. Studies that specifically examine the effect of block play on fine motor skills in ECE institutions in rural areas with a limited number of children remain relatively rare. In addition, many similar studies merely present a description of improvement without including adequate inferential testing, such as a difference test, an effect size, or a normalised gain (N-gain) analysis. It is this gap that constitutes the research gap this study seeks to address.

Based on this background and gap, this study aims to empirically examine the effect of block play on the fine motor skills of children aged 4–5 years at TK Dharma Wanita Koto Payang. The urgency of the study lies in the need to provide quantitative evidence that can serve as a basis for teachers and ECE managers in selecting fine-motor stimulation strategies that are simple, inexpensive, contextual, and enjoyable. The proposed hypothesis is that there is a positive and significant effect of block play on improving children's fine motor skills (Ha), as opposed to the null

hypothesis stating that there is no effect (H0).

Research Method

This study used a quantitative approach with a pre-experimental design [18]. The design employed was a one-group pretest–posttest design, namely a design involving a single group of subjects without a comparison group, with measurement carried out twice: before the treatment (pretest/O_1) and after the treatment (posttest/O_2). This design pattern can be depicted as $O_1 – X – O_2$, where X is the treatment in the form of block play activities. This design was chosen because it suits the field conditions, which had only a single learning group with a limited number of children, making it impossible to form an equivalent control group.

The study was conducted at TK Dharma Wanita Koto Payang. The population, which also served as the sample, was all Group A children (aged 4–5 years), totalling seven children. Given the limited number of subjects, the sampling technique used was total (saturated) sampling, that is, all members of the population were made research subjects. The treatment was delivered over six scheduled sessions, with the core activity being block play designed in stages, ranging from stacking a simple tower, aligning horizontal patterns, and building shapes from a model, to dismantling and tidying constructions in a controlled way. The teacher acted as a facilitator who provided examples, guidance, and reinforcement without taking over the children's motor activity.

The independent variable (X) in this study is block play, while the dependent variable (Y) is fine motor skills. The conceptual framework underlying the relationship between the two variables is presented in Figure 1.

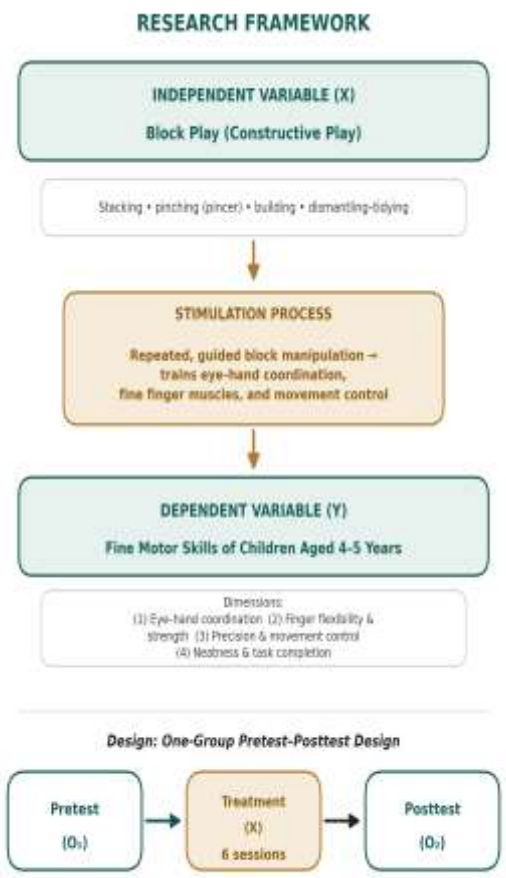

Figure 1. Conceptual Framework of the Effect of Block Play on Fine Motor Skills
Source: Developed by the authors (2026)

Data were collected through structured observation using an observation sheet (rating scale) developed from STPPA indicators and the literature on fine motor theory. The instrument consists of ten items elaborating four dimensions of fine motor skill, namely: (1) eye–hand coordination; (2) finger flexibility and strength; (3) precision and movement control; and (4) neatness and task completion.

The treatment procedure was designed in stages over six sessions so that the level of difficulty increased gradually in line with the principle of moving from simple to complex. The first two sessions focused on introducing blocks and basic practice in the form of picking up, moving, and stacking blocks into a simple tower. The next two sessions emphasised aligning horizontal

patterns and stacking blocks in tiers by size. The last two sessions were directed at building shapes from a model or from the child's imagination—such as a bridge and a house—as well as dismantling and tidying constructions in a controlled way. In each session, the teacher opened the activity with apperception, demonstrated the movements, accompanied the children during play, and closed with a brief reflection. Guidance was provided gradually and reduced as the children's independence increased, in line with the scaffolding principle. The full stages of the activities are summarised in Table 1.

Table 1. Stages of the Block Play Activities

Session	Activity Focus
1–2	Introducing blocks; picking up, moving, and stacking a simple tower
3–4	Aligning horizontal patterns; stacking by size in tiers
5–6	Building shapes from a model/imagination; dismantling and tidying in a controlled way

Source: Designed by the authors (2026)

The development of the instrument began by elaborating the fine motor skills construct into four dimensions and ten operational indicators, as shown in Table 2. Each indicator was accompanied by a scoring rubric describing the observable behavioural criteria for each category (BB, MB, BSH, BSB), so that observers had a clear and consistent reference. The content validity of the instrument was reviewed by an ECE expert lecturer to assess the alignment of the indicators, items, and rubrics with the construct being measured. To maintain the consistency of the observation results, observers' perceptions were aligned before the observation was carried out, and observations were conducted in the same play situation for all children.

Table 2. Blueprint of the Fine Motor Skills Instrument

Dimension	Indicator	Item
Eye–hand coordination	Placing a block on target	1
	Stacking blocks vertically (tower)	2
	Aligning a horizontal pattern	3
Finger flexibility & strength	Pinching a block (pincer grasp)	4
	Moving a block steadily	5
	Rotating the wrist when fitting pieces	6
Precision & movement control	Stacking in tiers by size	7
	Building a shape from a model	8
Neatness & task completion	Dismantling/tidying in a controlled way	9
	Completing the construction fully	10

Source: Adapted from STPPA indicators (2026)

The research variables were defined operationally as follows. Block play (X) is a constructive play activity using blocks, carried out under guidance over six sessions with progressively advancing activity stages. Fine motor skills (Y) is the total score obtained by the child on the ten-item observation sheet, reflecting eye–hand coordination, finger flexibility and strength, precision and movement control, and neatness and task completion. With this operational definition, changes in fine motor skills can be observed in a measurable way through the difference between the pretest and posttest scores.

Table 3. Attainment Categories of Fine Motor Skills

Percentage	Category
76–100%	BSB – Very Good
51–75%	BSH – Good
26–50%	MB – Fair
0–25%	BB – Poor

Source: Modified from ECE assessment guidelines (2026)

Data analysis was carried out in two stages. First, descriptive analysis to obtain a picture of the mean, standard deviation, minimum value, maximum value, and percentage of attainment at the pretest and posttest. Second, inferential analysis to test the research hypothesis. Before hypothesis testing, a prerequisite test was conducted in the form of a normality test on the distribution of the score differences (gain) using the Shapiro–Wilk test, which is appropriate for small samples. If the data were normally distributed, hypothesis testing was carried out with a paired-samples t-test. The testing criterion used a significance level of $\alpha = 0.05$ with a directional (one-tailed) hypothesis: H0 is rejected if the t-value is greater than the t-table value or the significance value is smaller than 0.05.

To complement the difference test, the authors also computed the normalised gain (N-gain) to determine the effectiveness category of the treatment, as well as the effect size using Cohen's d to assess the practical strength of the treatment effect. Each child's percentage of attainment was calculated using the formula in Equation 1, while the N-gain value was calculated using the formula in Equation 2. All statistical computations were carried out with the aid of statistical data-processing software to ensure the accuracy of the results.

$$P = (f / N) \times 100\% \quad (1)$$

$$\text{N-gain} = (\text{Posttest} - \text{Pretest}) / (\text{Max score} - \text{Pretest}) \quad (2)$$

To aid interpretation, the effect-size categories follow Cohen's criteria, namely a d value of about 0.2 is small, 0.5 is medium, and 0.8 or more is large [19]. The N-gain categories follow Hake's criteria, namely a value below 0.30 is low, between 0.30 and 0.70 is medium, and above 0.70 is high [20]. The use of these two measures—effect size and N-gain—is intended so that the conclusions rest not only on statistical significance but also consider the practical meaningfulness of the treatment. This study also attended to ethical aspects by obtaining permission from the school, maintaining the confidentiality of the children's identities through the use of initials, and ensuring that all play activities were carried out in a safe and enjoyable atmosphere for the children.

Results and Discussion

This section presents the research results in sequence, beginning with the description of the pretest and posttest data, the results of the normality prerequisite test, the results of hypothesis testing, the analysis of normalised gain and effect size, the analysis of attainment per dimension, and finally the distribution of attainment categories. The data presentation is accompanied by tables and figures so that the pattern of change in fine motor skills can be observed clearly. Subsequently, the discussion section interprets these findings with reference to developmental theory, the mechanisms of motor stimulation, and relevant prior research, while also affirming the contribution and limitations of the study.

1. Description of Pretest and Posttest Data

Data on fine motor skills were obtained through observation of seven children before (pretest) and after (posttest) the block play treatment was administered. A recapitulation of each subject's scores is presented in Table 4. Pretest scores ranged from 17 to 25 with a mean of 20.86 and a standard deviation of 3.08, whereas posttest

scores ranged from 18 to 30 with a mean of 24.57 and a standard deviation of 6.19. At the class level, mean attainment increased from 52.14% at pretest to 61.43% at posttest, an increase of 9.29 percentage points. The larger posttest standard deviation indicates that the spread of the children's ability became wider after the treatment, signalling a varied response: some children improved sharply while others remained relatively unchanged.

Table 4. Pretest and Posttest Fine Motor Skill Scores

No	Subject	Pre	Post	Gain
1	AAH	21	30	+9
2	AAA	19	28	+9
3	AAK	20	18	−2
4	RAK	17	18	+1
5	KIS	25	30	+5
6	SB	19	18	−1
7	AZA	25	30	+5
	Mean	20.86	24.57	+3.71

Source: Processed primary data (2026)

The full descriptive statistics are presented in Table 5, while the comparison of pretest and posttest scores for each subject is visualised in Figure 2. Based on these data, five of the seven children (71.4%) showed an increase in score, with the highest increase of nine points experienced by two subjects. Meanwhile, two children showed a slight decrease in score. This variation indicates that the children's response to the treatment was not uniform, which is commonly found in groups with differing developmental characteristics and levels of motor maturity.

Table 5. Descriptive Statistics of Pretest and Posttest

Statistic	Pretest	Posttest
Number of subjects (N)	7	7
Minimum value	17	18
Maximum value	25	30
Mean	20.86	24.57
Standard deviation (SD)	3.08	6.19
Attainment (%)	52.14	61.43

Source: Processed primary data (2026)

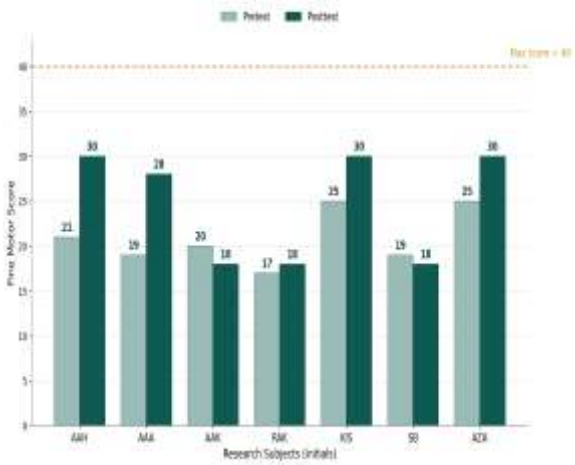

Figure 2. Comparison of Pretest and Posttest Scores for Each Subject

2. Prerequisite Test: Data Normality

Before conducting hypothesis testing, the distribution of the score differences (gain) was tested for normality using the Shapiro–Wilk test, which is appropriate for small samples. The test results showed a significance value of 0.326, which is greater than 0.05 (Table 6). Accordingly, the score-difference data are normally distributed and therefore meet the requirements for analysis using parametric statistics, namely the paired-samples t-test.

Table 6. Results of the Shapiro–Wilk Normality Test

Data	Statistic	Sig.	Remark
Score difference (gain)	0.899	0.326	Normal

Source: Processed primary data (2026)

3. Hypothesis Testing: Paired-Samples t-Test

Hypothesis testing was conducted to determine whether there was a significant difference between the fine motor scores before and after the treatment. The results of the paired-samples t-test are presented in Table 7. The mean difference between posttest and pretest was 3.71 with a standard deviation of 4.50. The t-value obtained was 2.184 with 6 degrees of freedom (df).

Table 7. Results of the Paired-Samples t-Test

Item	Value
Mean difference	3.71
SD of the difference	4.50
t-value	2.184
Degrees of freedom (df)	6
t-table (α = 0.05; one-tailed)	1.943
Significance (p)	0.036
Decision	H0 rejected

Source: Processed primary data (2026)

At a significance level of α = 0.05 with a directional hypothesis, the t-table value is 1.943. Because the t-value (2.184) is greater than the t-table value (1.943) and the significance value (p = 0.036) is smaller than 0.05, the null hypothesis (H0) is rejected and the alternative hypothesis (Ha) is accepted. It can therefore be concluded that there is a positive and significant effect of block play on the fine motor skills of children aged 4–5 years at TK Dharma Wanita Koto Payang.

4. Normalised Gain (N-gain) and Effect Size

To determine the degree and practical strength of the treatment effect, the N-gain value and effect size were computed. The class-level N-gain value obtained was 0.21, which falls in the low-to-medium category. This indicates that, although the treatment had a statistical effect, the magnitude of the mean improvement is still moderate and there remains ample room for development, especially for children whose initial attainment was low.

Conversely, the effect-size computation using Cohen's d yielded a value of 0.83, which is classified as large. This value indicates that, in practical terms, the block play treatment had a meaningful impact on changes in fine motor skills, even with a limited number of subjects. The difference between the moderate N-gain category and the large effect size can be understood because the two measure different aspects: N-gain assesses the proportion of improvement relative to the available room for improvement, whereas Cohen's d assesses the magnitude of change relative to the variability of the scores.

The combination of these two indicators provides a more complete picture: the treatment produced a real and practically meaningful change, yet did not fully raise the children's attainment to the highest level. This finding is important because it underscores that the success of an ECE intervention should be judged not only by the presence or absence of a significant effect, but also by how large and how even the impact is across all children. With this perspective, teachers can make wiser decisions in designing follow-up stimulation.

5. Analysis of Attainment per Fine Motor Dimension

Further analysis was conducted on the attainment of each fine motor dimension to identify the dimensions most and least affected by the treatment. The comparison of attainment per dimension at pretest and posttest is presented in Figure 3 and Table 8. The largest increase occurred in the neatness and task-completion dimension, which rose from 66.1% to 83.9%, followed by the eye–hand coordination dimension, which rose from 41.7% to 56.0%.

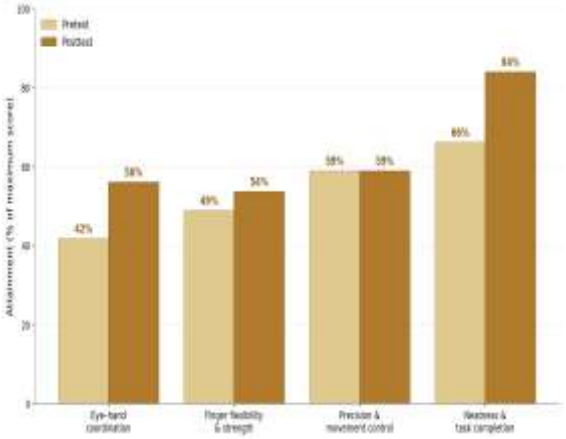

Figure 3. Fine Motor Attainment per Dimension (Pretest vs Posttest)

Table 8. Attainment per Fine Motor Dimension (%)

Dimension	Pre	Post	Difference
Eye–hand coordination	41.7	56.0	+14.3
Finger flexibility & strength	48.8	53.6	+4,8
Precision & movement control	58.9	58.9	0.0
Neatness & task completion	66.1	83.9	+17.9

Source: Processed primary data (2026)

The finger flexibility and strength dimension experienced a smaller increase, namely from 48.8% to 53.6%, while the precision and movement-control dimension remained relatively stable at 58.9%. This pattern shows that block play is most effective at training activities that demand the completion of a design and visual-motor coordination, whereas strengthening the finger muscles and fine-movement precision appears to require a longer training duration and more specific activity variations, such as pinching smaller-sized blocks.

7. Distribution of Attainment Categories

In addition to mean attainment, the distribution of children's categories was also analysed to observe the shift in developmental level. The distribution of the number of children in each attainment category before and after the treatment is presented in Table 9. At pretest, most children were in the Beginning to Develop (MB) category, with four children, and the Developing as Expected (BSH) category, with three children. After the treatment, the number of children in the BSH category rose to four, while the MB category decreased to three.

Table 9. Distribution of Attainment Categories at Pretest and Posttest

Category	Pretest	Posttest
BSB – Very Good	0	0
BSH – Good	3	4
MB – Fair	4	3
BB – Poor	0	0
Total	7	7

Source: Processed primary data (2026)

This shift affirms an improvement in developmental level, even though no child yet reached the Developing Very Well (BSB) category. This is consistent with the low-to-medium N-gain value and reinforces the conclusion that the treatment had a positive impact while still leaving room for improvement, particularly to encourage children to reach the highest category through longer and more varied stimulation.

8. Discussion

The findings of this study reinforce the conjecture that block play is a potential stimulation medium for the fine motor development of young children. The increase in the mean score and the significant t-test result are consistent with the theory that motor skills develop through practice and the repetition of meaningful movements [1], [5]. When stacking, pinching, and tidying blocks, children repeatedly train the coordination between the eyes and hands and strengthen the small muscles of the fingers, so that movements that were initially stiff gradually become more controlled.

The significant result of this study is also consistent with the principle that motor skills are trainable in early childhood, when the plasticity of children's development is at a high level. In the 4–5 year age range, the neural pathways governing hand and finger movement are developing rapidly, so that appropriate stimulation can accelerate the maturation of motor coordination [1], [11]. Scheduled block play activities provide repeated opportunities for children to

practise particular movement patterns until they become increasingly automatic and controlled. This explains why, despite the relatively short treatment duration, measurable changes could still be observed.

Mechanistically, block play stimulates several fine motor components simultaneously. The activity of pinching and grasping blocks trains the intrinsic muscles of the hand and strengthens the pinching movement (pincer grasp) that underlies the skill of holding writing implements. Stacking blocks into a tower or a particular pattern demands visual-motor integration, that is, the ability to align visual information with hand movement so that the block is placed precisely and does not collapse. Meanwhile, building shapes according to a plan involves directed movement control and perseverance in completing the task. Thus, a single block play activity actually trains several fine motor dimensions in an integrated manner, which explains why this treatment was able to produce measurable change.

This result is consistent with a number of prior studies that found block play activities to contribute positively to children's eye–hand coordination and fine motor skills [14], [15], [21]. Similar studies reported improved eye–hand coordination after children were given scheduled block-stacking activities [14], as was also found in a study examining fine motor stimulation through block-stacking activities in Group A children [15]. The present study's findings complement this evidence by including inferential testing, an effect size, and a per-dimension analysis that have not often been presented in earlier studies.

Constructive play with blocks positions the child as an active subject who builds knowledge through direct interaction with objects, as emphasised in Piaget's constructivist view [5], [7]. The teacher's role as a facilitator who provides examples and gradual guidance in this study reflects the scaffolding principle within Vygotsky's zone of proximal development, namely the provision of assistance that is gradually reduced as the child's independence increases [5]. This activity is also consistent with the principle of meaningful learning in early childhood, namely learning through concrete and enjoyable play experiences [22]. In other words, the success of block play is determined not solely by the medium, but also by the way the teacher facilitates the play experience.

Another interesting finding is the uneven pattern of improvement across dimensions. The neatness and task-completion dimension and eye–hand coordination increased the most, whereas the finger-strength and movement-precision dimensions were relatively stagnant. This can be explained by the characteristics of the designed activities: the treatment stages emphasised the assembly and completion of constructions involving visual coordination and task completion, so that these dimensions were the most trained. Strengthening the finger muscles, by contrast, requires intensive and repeated practice in pinching small objects over a longer duration. This finding implies that the effectiveness of block play is specific to the type of movement trained, consistent with the principle of training specificity in motor development [2], [23].

Nevertheless, this study also found that the improvement was moderate and varied among individuals, as shown by the low-to-medium N-gain value and the presence of two children who did not improve. Such variation is to be expected in ECE research because fine motor development is influenced by many factors, including biological maturity, health condition, the frequency of stimulation at home, and the level of the child's engagement and concentration during the activity [2], [23]. The relatively short treatment duration—six sessions—is thought to have been insufficient to produce a large and even change across all dimensions, particularly in strengthening the finger muscles, which demands sustained practice. The difference

between the moderate N-gain category and the large effect size also affirms that the treatment effect is statistically real, yet in practical terms still requires enrichment so that all children's attainment is optimal.

The finding regarding the variation in attainment per dimension carries an important practical implication. Because the finger flexibility and strength and the movement-precision dimensions were less boosted, teachers are advised to enrich block play activities with variations that demand higher precision, for example using small-sized blocks, interlocking blocks, or combining blocks with other manipulative activities such as beading and clipping. Within the context of the Merdeka Curriculum, which emphasises play-based and child-centred learning, block play can be integrated into broader play activities so that all fine motor dimensions are stimulated in a balanced way [3], [23]. In addition, involving parents in providing manipulative-play activities at home can strengthen the stimulation effect gained at school.

This study has several limitations that need to be taken into account when interpreting its results. First, the pre-experimental design without a control group means that the increase in scores cannot be attributed purely to the treatment, because maturation and other learning factors during the research period also played a part. Second, the very small number of subjects (seven children) limits the statistical power and the generalisability of the findings. Third, hypothesis testing used a directional approach; had a two-tailed test been used, the significance would lie at the threshold, so the result needs to be interpreted with caution. Fourth, the measurement relied solely on observation and may therefore contain observer bias, despite efforts to use a detailed rubric. Therefore, further research is advised to use a quasi-experimental design with a control group, a larger number of subjects, a longer treatment duration, and an instrument whose reliability has been empirically tested, in order to obtain stronger evidence that can be generalised more broadly.

When viewed from the broader literature, the benefits of constructive play are not limited to fine motor skills alone. The activity of assembling and designing buildings from blocks also trains spatial ability, problem solving, and planning, all of which are related to children's executive functions [16], [17]. Thus, the improvement in the neatness and task-completion dimension in this study may not solely reflect motor skill, but also the maturity of self-control and the child's perseverance in completing an activity. This shows that block play has a holistic stimulative value and is worth making a routine part of play activities in ECE.

The teacher's role as a facilitator proved to be an important factor in the success of the stimulation. In this study, the teacher did not merely provide blocks, but also gave examples, posed open-ended questions, and offered reinforcement when a child successfully completed a construction. This pattern of interaction creates a directed play experience without removing the child's freedom to explore. This finding strengthens the view that the quality of adult mediation—not merely the availability of materials—is the key to the effectiveness of play-based learning [5], [22], [24]. Therefore, improving teachers' competence in facilitating manipulative-play activities should be a focus in the professional development of ECE educators.

Based on the overall findings, several practical recommendations can be formulated. First, block play should be carried out routinely and continuously, not merely over six sessions, so that the strengthening of the finger muscles and movement precision receives adequate practice. Second, activities should be varied with blocks of various sizes and textures

and combined with other manipulative activities to stimulate all fine motor dimensions in a balanced way. Third, teachers are advised to record each child's development individually so that stimulation can be tailored to each child's needs, especially for children whose attainment has not yet improved. Fourth, collaboration with parents through play activities at home can strengthen and sustain the stimulation results obtained at school.

The findings of this study are relevant to the policy direction of early childhood education in Indonesia, which emphasises meaningful learning through play. Within the framework of the Merdeka Curriculum, block play can be positioned as part of child-centred, simple project-based learning, so that besides training fine motor skills it also fosters independence, creativity, and collaboration [3], [23]. Thus, the results of this study are useful not only theoretically but also practically for everyday learning practice in ECE institutions.

Despite these limitations, this study contributes relatively complete quantitative evidence—covering a difference test, an effect size, N-gain, and a per-dimension analysis—on the effect of block play on fine motor skills in an ECE context with limited resources. The novelty of this study lies in presenting a per-dimension analysis that reveals the effectiveness of block play to be selective towards particular types of skill. This finding can serve as a basis for teachers and ECE managers to design more targeted block play activities according to the fine motor dimension they wish to develop.

Compared with prior studies that generally reported the success of block play in a comprehensive manner, this study provides a more nuanced picture. Some earlier studies concluded a large and even improvement in fine motor skills after the administration of block activities [11], [21], yet rarely examined which dimensions were most and least affected. By including a per-dimension analysis and a category distribution, this study shows that the global conclusion of “having an effect” can conceal important variation at the level of specific skills as well as at the individual level. The methodological implication is that future ECE intervention research is advised not to stop at a difference test of total scores, but also to trace more detailed patterns of change so that the resulting recommendations are better targeted.

Furthermore, the results of this study need to be interpreted within the framework of long-term development. Fine motor skill is not a skill formed instantly, but develops continuously through the accumulation of meaningful movement experiences. Therefore, the moderate improvement found within six sessions is in fact a positive first step which, if continued consistently, has the potential to yield higher and more stable attainment. Teachers and parents hold a key role in ensuring the continuity of this stimulation, both through structured activities at school and everyday play at home. With this understanding, block play should not be regarded as a momentary intervention, but as part of a play culture that nurtures children's skills gradually and holistically.

From a measurement standpoint, the use of an observation sheet with a detailed rubric proved adequate for capturing changes in children's fine motor skills. Even so, observation still contains an element of observer subjectivity, so in larger-scale studies it is advisable to involve more than one observer and to compute an inter-observer agreement index to strengthen reliability. In addition, supplements in the form of photo or video documentation of the play process can help verify the assessment and support qualitative analysis of the children's motor behaviour. Strengthening this measurement aspect would increase confidence in the findings while enriching understanding of

the developmental process occurring during the intervention.

Conclusion

Based on the research results, it can be concluded that block play has a positive and significant effect on the fine motor skills of children aged 4–5 years at TK Dharma Wanita Koto Payang. The mean fine motor skill score increased from 20.86 (52.14%) at pretest to 24.57 (61.43%) at posttest. The results of the paired-samples t-test show a t-value of 2.184, greater than the t-table value of 1.943 (df = 6; p = 0.036), so the null hypothesis was rejected, with an effect size classified as large (d = 0.83). The improvement was most prominent in the neatness–task completion and eye–hand coordination dimensions, while the finger-strength and movement-precision dimensions still require additional stimulation.

This finding implies that block play can serve as a simple, contextual, and enjoyable fine-motor stimulation strategy for ECE institutions, particularly in areas with limited resources. Given the limitations of the design and the number of subjects, it is recommended that future research use a design with a comparison group, more subjects, and a longer treatment duration, so that stronger and more broadly generalisable evidence can be produced.

In practical terms, the results of this study recommend that ECE teachers make block play a planned and continuous fine-motor stimulation activity, with activity variations that reach all dimensions and adequate guidance. For institution managers, these findings provide a basis for providing adequate manipulative-play media and encouraging the development of teachers' competence in facilitating play activities. In this way, the potential of block play as a fine-motor stimulation medium can be optimised to support children's learning readiness at the next level.

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