

# The Influence of IoT (Internet of Things) Based Kinetic Sand Media on the Beginning Writing Skills of 4-5 Year-old Children at Annur Bastari Islamic Kindergarten, Pekanbaru

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## ABSTRACT

The childhood phase is a critical stage for early literacy development, particularly in fostering beginning writing skills. This study aims to determine the effect of Internet of Things (IoT)-based kinetic sand media on the early writing skills of children aged 4-5 years at Annur Bastari Pekanbaru Islamic Kindergarten. The media used is a transparent container filled with kinetic sand, equipped with a pressure sensor and a small speaker. When a child writes letters in the sand, the sensor responds to hand movements and provides automatic feedback in the form of lights and sounds corresponding to the letters touched, creating an engaging and enjoyable learning environment. A quantitative approach with an experimental method was employed using a One Group Pretest-Posttest Design, in which one group of 21 children in Group A received a pretest, treatment, and posttest. Data were analyzed using a t-test and normalized gain to measure the effectiveness of the media in improving early writing skills. The results showed a significant improvement, with the average achievement increasing from 33.13% in the pretest to 81.56% in the posttest. The t-test results indicated a significance value of  $0.000 < 0.05$  and a t-count of  $18.166 > t$ -table value of 2.086, confirming a significant influence. Prior to treatment, most children were in the Early Developing and Not Yet Developing categories. After using the IoT-based kinetic sand media, their skills improved drastically, with most reaching the Very Well Developing and Developing as Expected categories. This media effectively stimulates early writing skills in a fun and interactive manner, aligning with the technological advancements in early childhood education.

**Keywords:** *Kinetic Sand, IoT (Internet of Things), Early Childhood, Beginning Writing, Learning Media*

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## INTRODUCTION

The early age period is the most important and fundamental phase in the process of child growth and development. This period is known as the golden age, namely the age of 0 to 6 years, where there is a high level of brain plasticity and sensitivity to various learning stimuli (Hiadayati & Utami, 2022). One crucial aspect of development at this stage is early literacy skills, including early writing. According to (Kurnia & Solfiah, 2020) early writing involves the process of crossing out, imitating letters, writing one's own name, and distinguishing similar letters, all of which require integration between focus skills, eye-hand coordination, and fine motor skills.

Good writing skills will help children express their ideas and feelings through graphic symbols. However, early childhood writing learning is often faced with obstacles because the media and methods used are still conventional, such as the use of Children's Worksheets (LKA), which are less interesting and do not match the characteristics of children's learning (Sholeha, 2022). This condition has an impact on children's low interest and ability in writing, because the activities carried out are passive and boring. Early childhood should be given learning media that are concrete, fun, and able to stimulate various aspects of development at once. Early writing includes the activity of crossing out, imitating letters, writing one's own name, and distinguishing similar letters, all of which require fine motor skills and visual

concentration (Kartika, 2019) . However, the results of initial observations at Annur Bastari Islamic Kindergarten, Pekanbaru showed that the majority of 4-5 year olds were not yet able to write optimally, due to the lack of interesting educational materials that meet their development needs.

Kinetic sand is a good alternative media to develop early writing skills. This object is soft, flexible, and easy to shape, so that children can practice writing letters using their fingers directly on the media. This activity not only improves fine motor coordination but also provides a multisensory experience that children really need in the learning process (Putri & Widyaningsih, 2022; Bahari & Hamidah, 2022). In addition, previous studies have shown the efficacy of kinetic sand in improving early writing skills. As technology advances, learning techniques can now be developed to be more interactive and adaptive. One of them is by integrating *Internet of Things* (IoT) technology into sensory media such as kinetic sand. IoT-based media allows children to get automatic feedback through digital pressure, sound, light, or visual sensors that respond to every child's activity in real time (Perera et al., 2023). In addition to increasing children's involvement in learning, the use of IoT also makes it easier for teachers to monitor children's learning development digitally (Priyadarshini & Banerjee, 2022; Muthiah et al., 2020).

The results of initial observations that have been carried out at Annur Bastari Islamic Kindergarten, Pekanbaru, show that some children aged 4-5 years are not yet able to write their own names, imitate letters consistently, or distinguish certain letter shapes. This shows the need for a creative approach to early writing instruction that is appropriate to the child's developmental stage. To ensure the impact of IoT-based kinetic sand media. It is hoped that this study will help in the creation of interesting and interactive educational materials that effectively improve early literacy in early childhood.

## METHOD

This research method is experimental research, which is part of the quantitative approach. which shows how the independent variable and the dependent variable are causally related. Experiments are conducted on a variable for which data is not yet available, so that researchers can manipulate research subjects by providing certain therapies, then observing and measuring their impact in the future (Sugiyono, 2024) .

The approach used in this study is quantitative, as the data collection and analysis processes rely on numerical data to obtain objective and measurable information about the phenomena under investigation. This method enables researchers to systematically assess the relationship between variables using statistical tools. The variables in this study consist of an independent variable (X), which is the IoT (Internet of Things)-based kinetic sand media, and a dependent variable (Y), which is the beginning writing ability. The purpose is to determine the effectiveness of the IoT-based kinetic sand media in enhancing students' early writing skills.

The One-Group Pre-Test-Post-Test design used involves conducting experiments on one group without a comparison group. Two observations were made in this study: one before treatment (O<sub>1</sub>) and one after treatment (O<sub>2</sub>) ( Sugiyono, 2024) the design is in this table:

Table 1 Research Design

<i>Sample</i>	<i>Pretest</i>	<i>Treatment</i>	<i>Posttest</i>
Experimental Class	O <sub>1</sub>	X	O <sub>2</sub>

### Information:

KE: Experimental Class

O1: Writing Ability Score (Pretest) before being given treatment

X: Treatment of Kinetic Sand Media Use

O2: Writing Ability Score (*Posttest*) after being given treatment

## FINDINGS AND DISCUSSION

### Place Overview

The location of the event was Annur Bastari Pekanbaru Islamic Kindergarten, located in Gg. Bangau Jaya, Simpang Baru, Panam, Pekanbaru City, which is an Islamic-based educational institution which is currently led by Mrs. Idas Mur, the Principal. with a total of four teachers. Twenty-one young children, aged four to five years old, consisting of ten boys and eleven girls, became the subjects of the study. The learning process at Annur Islamic Kindergarten Pekanbaru uses the Merdeka curriculum.

### Research Implementation

6 meetings were held to collect data for this experimental study, consisting of one meeting for the pretest, four meetings for the treatment, and one meeting for the posttest. Observation activities were conducted on children aged 4-5 years as research subjects. The schedule for implementing the experimental activities is as follows:

Table 2 Research Design

	Activity	Place
Monday, April 28, 2025	<i>Pretest</i>	School
Tuesday, April 29, 2025	<i>Treatment 1. Researchers introduced IoT (Internet of Things) -based kinetic sand media and demonstrated how to use it.</i>	School
Monday, May 5, 2025	<i>Treatment 2. The researcher conducted IoT (Internet of Things) -based kinetic sand media with the activity of writing the letters of the alphabet mentioned by the teacher, then the child wrote the letters on the sand, then the IoT (Internet of Things) -based media would display the letters on the laptop screen and a sound would come out.</i>	School
Tuesday, May 6, 2025	<i>Treatment 3. Researchers use IoT (Internet of Things) based kinetic sand media by writing letters that have the same shape as letters. b and d, p and q. then IoT (Internet of Things) based media will display letters on the laptop screen and sound will come out.</i>	School
Wednesday, May 7, 2025	<i>Treatment 4. The researcher conducted IoT (Internet of Things) based kinetic sand media with children's complete writing activities gradually letter by letter. then IoT (Internet of Things) based media will display letters on the laptop screen and sound will come out.</i>	School
Thursday, May 8, 2025	<i>Posttest</i>	School

### Description of Research Result Data

IBM SPSS version 23 program was used to analyze the data of this study using the t-test statistical approach. The difference between the results before and after therapy was confirmed using the t-test statistical test.

This study seeks to determine how the use of Internet of Things (IoT)-based Kinetic Sand media affects the early writing skills of Annur Bastari Pekanbaru Islamic Kindergarten students, aged four to five years. Twenty-one children aged between four and five years were given a pretest and posttest, with two levels of measurement. The following data description table, which displays fundamental statistical data from the measurement findings, provides a summary of the research data.

Table 3. Research Data Description Table

Variables	Score X Possible (Hypothetical)				X Score Obtained (Empirical)			
	Xmin	Xmax	Mean	SD	Xmin	Mmax	Mean	SD
<i>Pretest</i>	3	12	12.5	1.5	3.0	6.0	4.57	1.16
<i>Posttest</i>	3	12	12.5	1.5	70	11	9.28	1.38

### General Picture of Children's Initial Writing Skills At Annur Bastari Islamic Kindergarten Before Treatment Using IOT -Based Kinetic Sand Media (Pretest)

Through observation with three indicators of beginning writing. This instrument was given to 21 children. The results of the pretest data are presented as follows:

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No	Indicator	Ideal Score	Factual Score	%	Category
1	Writing your own first name	84	30	36.71 %	Starting to Grow
2	Copying letters	84	34	40.48 %	Starting to Grow
3	Distinguish between similar letters (eg: <i>bd, pq</i> )	84	32	38.10%	Starting to Grow
<b>Amount</b>		<b>25.2</b>	<b>96</b>		
<b>Average</b>			<b>4.57</b>		
<b>Percentage</b>				<b>38.1 %</b>	
<b>Category</b>					<b>Starting to Grow</b>

Based on the table above, children aged four to five years have early writing skills that are included in the group starting to develop (MB), namely obtaining 96 or 38.1% of the required level. In addition, it is known that the indicator that shows children can imitate letters has the highest score, namely 34 or 40.48% of the expected score.

The indicator that obtained the lowest score, which was 30 or 36.71 % of the expected score, was writing one's own first name. However, because it is included in the same category, which is starting to develop, the difference between the highest and lowest scores is not statistically significant. The table below illustrates the basic writing skills of children before receiving treatment using IoT-Based Kinetic Sand Media (*Internet of Things*):

No	Category	Range	F	%
1	BSB	76-100	0	0.00%
2	BSH	51-75	0	0.00%
3	MB	26-50	16	76.19%
4	BB	0-25	5	23.81%
<b>Amount</b>			<b>21</b>	
<b>%</b>				<b>100.00%</b>

The average early writing stage, which is starting to develop, according to the table above, with 16 children reaching 76.19% of the required level. The other five children, or 23.81 % of the total, are in the category of not developing.

The following graph presents the results of the pretest of children's writing ability:

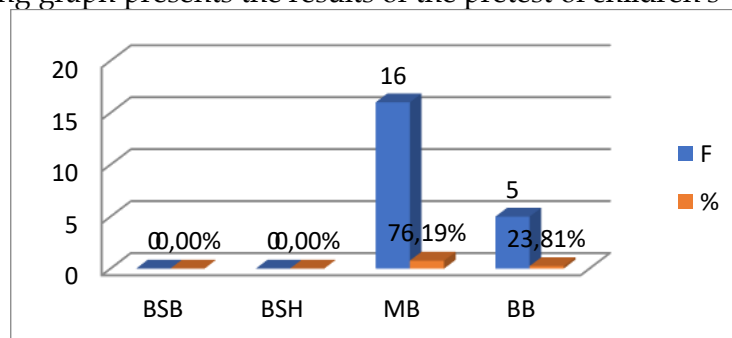


Figure 1. Pretest Graph I T Beginning Reading Ability

*General Picture of Children's Initial Writing Skills at Annur Bastari Islamic Kindergarten After Treatment Using IOT-Based Kinetic and Media (Posttest)*

The study was continued with the provision of treatment using IoT (Internet of Things) based media. for four days. During the treatment, the researcher created a learning activity scenario using four varied activities. At the first meeting, the researcher introduced IoT (Internet of Things) based kinetic sand media and demonstrated how to use it. At the second meeting, the children used IoT (Internet of Things) based kinetic sand media with the activity of writing the letters of the alphabet mentioned by the teacher, then the children wrote the letters on the sand, then the IoT (Internet of Things) based media would display the letters on the laptop screen and a sound would come out. At the third meeting, the children used IoT (Internet of Things) based media with the activity of writing letters that had the same shape.

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then the IoT (Internet of Things) based media would display the letters on the laptop screen and a sound would come out. At the fourth meeting, the children used IoT (Internet of Things) based kinetic sand media with the activity of writing complete children gradually letter by letter. then the IoT (Internet of Things) based media would display the letters on the laptop screen and a sound would come out. After the treatment was given, a posttest was carried out to determine the development of the writing ability. Description of children's initial writing abilities is:

Table 4. Table of *Posttest* Scores for Initial Reading Ability After Treatment.

No	Indicator	Ideal Score	Factual Score	%	Category
1	Writing your own first name	84	67	79.76%	BSB
2	Copying letters	84	68	80.95 %	BSB
3	Distinguish between similar letters (eg: <i>bd, pq</i> )	84	60	71.43%	BSH
<b>Amount</b>		<b>252</b>	<b>196</b>		
<b>Average</b>			<b>9.29</b>		
<b>Percentage</b>				<b>77.4%</b>	
<b>Category</b>					<b>Developing very well</b>

From the table it can be seen that the BSB criteria has the highest final value for the letter imitation indicator, namely 68 or 80.95 %.

#### *Writing Ability of Early Children in Annur Bastari Islamic Kindergarten (Posttest)*

No	Category	Range	F	%
1	BSB	76-100%	10	47.62%
2	BSH	51-75%	11	52.38%
3	MB	26-50%	0	0%
4	BB	0-25%	0	0%
<b>Amount</b>			<b>21</b>	<b>100%</b>

The table above shows that children at Annur Bastari Pekanbaru Islamic Kindergarten aged 4-5 years, as many as 10 children are in the Very Well Developed (BBI) category with a percentage of 47.62% and as many as 11 children are in the Developing According to Expectations (BH) category with a percentage of 52.38%.

Following Posttest result graph :

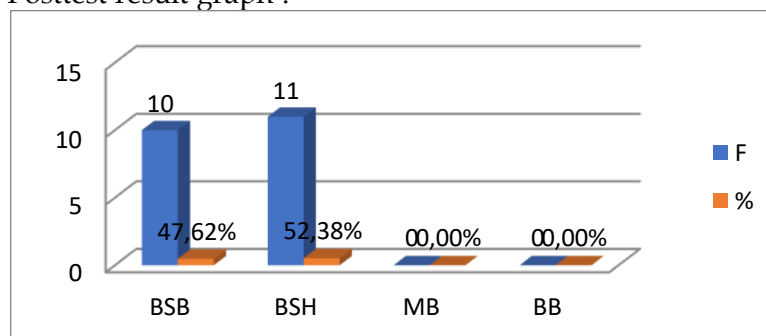


Figure 2. Posttest Graph of Initial Reading Ability

#### *Pretest and Posttest Data*

The comparison is made through the pretest and posttest results which are presented as follows:

Table 5. Recapitulation of Early Writing Skills of 4-5 Year old Children

No	category	Score range	F <i>pretest</i>	%	F <i>posttest</i>	%
1	BSB	76-100	0	0.00%	10	47.62%
2	BSH	51-75	0	0.00%	11	52.38%
3	MB	26-50	16	76.19%	0	0.00%
4	BB	0-25	5	23.81%	0	0.00%

Based on table 4.7, there is a comparison between *pretest* and *posttest*. In the *pretest*, the MB criteria 16 children with 76.19%, and in the BB criteria there were 5 children with 23.81%. In the *posttest* there was an increase in the BSB criteria there were 10 children with 47.62%, in the BSH criteria there are 11 children with a percentage of 52.38%.

### Hypothesis Testing

#### Data Analysis

The statistical technique to find out how much influence the independent variable has on the dependent variable is the t-test. This test is carried out with a significance level of 5% ( $\alpha = 0.05$ ), which means the confidence level reaches 95%, assuming that all other variables remain constant.

#### Normality Test

One-Sample Kolmogorov-Smirnov Test			
		Pretest	Posttest
N		21	21
Normal Parameters <sup>a,b</sup>	Mean	4.5714	9.2857
	Std. Deviation	1.16496	1.38358
Most Extreme Differences	Absolute		
	Positive	.176	.173
	Negative	.164	.109
		-.176	-.123
Test Statistics		.176	.173
Asymp. Sig. (2-tailed)		.090 <sup>c</sup>	.099 <sup>c</sup>

The sig value in the *Kolmogorov-Smirnov* column is greater than 0.05, then the data is considered normal, if less than 0.05, then the data is considered abnormally distributed. The Sig. value is 0.090 in the pretest and 0.099 in the posttest indicating that the data is normally distributed and suitable for use in research.

#### Homogeneity Test

	Test Statistics	
	Pretest	Posttest
Chi-Square	143 <sup>a</sup>	1.143 <sup>a</sup>
Df	3	4
Asymp. Sig.	.986	.887

$H_0$  is accepted because the *Asymp Sig pretest* and *posttest* have Sig values of more than 0.05, with the *Asymp Sig pretest* of 0.986 and the *posttest* of 0.887. Thus, the research data can be said to be homogeneous or have the same variance.

### Hypothesis Testing

With SPSS version 23 software, paired sample t-test was used to compare the pre-test and post-test results in this study. This test was to determine whether the first writing ability of children in Annur Bastari Islamic Kindergarten, aged 4-5 years, was significantly different before and after treatment with IoT (*Internet of Things*) based kinetic sand media.

If the Sig value less than 0.05, then the data is considered to have increased significantly.  $H_0$  is accepted and  $H_a$  is rejected if Sig. > 0.05; conversely, if Sig. < 0.05, then  $H_0$  is rejected and  $H_a$  is accepted. The statistical hypothesis is stated as follows before the conclusion is made:

$H_0$  : There is no influence of using IoT (Internet of things) based Kinetic Sand media on children's initial writing abilities.

$H_a$  : There is an influence of using IoT-based Kinetic Sand media (Internet of things) on children's beginning writing abilities.

Comparison of pretest and posttest results in the experimental group in this table:

Table 11. Hypothesis Test

Paired Samples Test							
Paired Differences							
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference	t	df	Sig. (2-tailed)

					Lower	Upper			
Pair 1	Pretest - Posttest	- 4.71429	1.18924	.25951	-5.25562	-4.17295	-18,166	20	.000

The t-value of the statistical test is 18.166. because *the volume* sig. 0.000 < 0.05, so the two-tailed test shows the absolute value, therefore the (-) value is not used (Sugiyono, 2024). Thus, it can be said that kinetic sand media based on the Internet of Things (IoT) has an influence on writing skills.

To find out whether the hypothesis is accepted or rejected using SPSS version 23 data. The calculated t result of 18.166 is greater than the t table = 2.086 with dk, this can be proven by comparing it with the table value of the t test calculation results:

$$DK = (n-1)$$

$$DK = (21-1)$$

$$DK = 20$$

With dk 20, ttable = 2.086 is obtained. Thus, H0 = rejected and Ha = accepted, which means that IoT (Internet of Things) -Based Kinetic Sand Media has an effect on children's early writing skills.

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To find out how much influence IoT (Internet of Things) -based kinetic sand media has on children's early writing skills.

Normalized Gain Test

$$G = \frac{\text{Skor Posttest} - \text{skor pretest}}{\text{Skor Ideal} - \text{skor pretest}} \times 100\%$$

$$G = \frac{195 - 96}{252 - 96} \times 100\%$$

$$G = \frac{99}{156} \times 100\%$$

$$G = 63.46\%$$

The information in this study includes several key terms used to measure the effectiveness of the treatment. "G" represents the gain or difference between the pretest and posttest scores, indicating the improvement in students' performance after the intervention. The "Posttest" score refers to the value obtained after the treatment is given, while the "Pretest" score refers to the value measured before the treatment. The figure "100%" is used as a fixed reference number in calculating the percentage of gain or improvement, helping to quantify the effectiveness of the treatment in a standardized manner.

Based on calculations using the Normalized Gain formula, it was obtained that the influence of IoT (Internet of Things) -based kinetic sand media on children's early writing skills was 63.46%. This percentage is included in the moderate category based on the classification, namely:

Table 6. Normalized Gain Categories

Normalized gain	Assessment Category
G < 30	Low
30% < G < 70%	Currently
G > 70%	Tall

The increase category, as determined by the G formula mentioned above, is 63.46%, which is included in the moderate group (30 < G < 70%).

*Discussion of Research Results*

*Research Results Before Being Given Explore Reading Book Media Based on Pretest Results*

Children at Annur Bastari Pekanbaru Islamic Kindergarten, aged 4-5 years, still have relatively poor early writing skills, according to the pretest results. Five children (23.81%) are in the BB criteria, while 16 children (76.19%) are in the MB criteria out of a total of 21 children. Both the BSB and BSH criteria were not achieved by young children. According to these findings, most children are still unable to write their own names, imitate letters, or distinguish

related letters. The observed finding that Children's Worksheets (LKA), which are repetitive and offer less stimulation to children's fine motor skills, continue to dominate the learning methods used, further supports this problem. (Sholeha, 2022) , This is in line with the statement (Utami & Suryanti, 2024) which states that conventional learning media is not effective enough in increasing the involvement and concentration of early childhood. (Kurnia, 2019) states that children's writing skills develop through concrete experiences that stimulate fine muscle coordination and visual perception. Putri & Widyaningsih (2022) state that kinetic sand can be an alternative sensory media that supports the writing process naturally and enjoyably. In the context of modern educational technology, kinetic sand media combined with *the Internet of Things* (IoT) is believed to be able to increase children's learning motivation through automatic feedback based on sound, light, or visual displays (Perera et al., 2023) . According to (Priyadarshini & Banerjee, 2022) IoT-based media provides an adaptive learning experience that can adjust to the child's developmental level. If not handled with an innovative and developmentally appropriate approach, children are at risk of experiencing early literacy delays, which impact their readiness to enter the next level of education (Muthiah et al., 2020) ; (Hernawati & Alam, 2024)

#### *Research Results After Being Given Explore Reading Book Media Based on Posttest Results*

After the child has followed the learning process using IoT (Internet of Things ) Based Kinetic Sand, Children's early writing skills improved significantly. Children appeared more focused, enthusiastic, and active in learning activities. The posttest *results* showed an increase in the average score to 77.4 % with a total score of 196. A total of 10 children (47.62%) were included in the BSB category, while 11 children (52.38%) were included in the BSH group. This media is designed in a fun and interactive way, with a combination of tactile elements (sensory) and digital technology, which successfully stimulates children's motivation to learn to write. Children showed increased abilities, especially in the indicators of writing their own names and distinguishing similar letters, while the indicator that was still challenging was imitating letters with consistent shape. This finding is in line with the research of Putri & Widyaningsih (2022) which states that kinetic sand is effective in training children's fine motor coordination. In addition, Kurnia, (2019) emphasized that initial writing skills are formed through fun and concrete experience-based exercises. riyadarshini & Banerjee (2022) added that IoT can strengthen children's interaction with media through automatic feedback that strengthens concentration and learning engagement. Meanwhile, Muthiah et al. (2020) underlined the importance of digital media that can adapt to children's learning needs.

#### *The Influence of Kinetic Sand Media Based on Iot on The Initial Writing Skills of 4-5 Year old Children at Annur Bastari Islamic Kindergarten, Pekanbaru.*

To measure the effectiveness of using kinetic sand media based on the Internet of Things (IoT) regarding the writing skills of early childhood, statistical analysis was carried out using the SPSS version 23 program. The t-test result of 18.166 was greater than the t-table value of 2.086 (at  $\alpha = 0.05$  and  $df = 20$ ). Based on these results,  $H_0$  is rejected and  $H_a$  is accepted, so there is a significant effect. The contribution of this media to this increase reached 75.44%, which is included in the high category. This finding strengthens the view of Kurnia (2019), who stated that the success of developing writing skills in children is highly dependent on the suitability of learning media with the characteristics and developmental phases of early childhood. Sensory-based media such as kinetic sand provide concrete experiences that stimulate fine motor skills, while IoT integration allows for adaptive interactions and responds directly to children's activities in real-time (Perera et al., 2023; Priyadarshini & Banerjee, 2022). In its implementation, children showed improvements not only in the technical aspects of writing such as imitating letters, distinguishing similar letters, and writing their own names but also in the affective aspects and learning engagement. Children looked more focused, enthusiastic, and active during the learning process. This supports the statement of Muthiah et al. (2020), which states that fun technology-based learning can improve children's motivation and overall learning quality. In line with a previous study by Nurhayati & Widayati (Rojab et al., 2023) which found that kinetic sand media has high effectiveness in

stimulating fine muscle coordination needed in early writing. Thus, IoT-based kinetic sand media has been proven to be able to make a significant contribution to the development of basic literacy in early childhood, as well as being an innovative approach in realizing fun, active, and meaningful learning.

## CONCLUSION

Several conclusions were drawn from the study. First, the pretest results showed that the initial writing ability of children aged 4-5 years at Annur Bastari Pekanbaru Islamic Kindergarten was in the "starting to develop" category. This indicates that before receiving treatment with IoT (Internet of Things)-based kinetic sand media, children experienced difficulties in writing their own names, imitating letter shapes, and distinguishing similar letters such as b-d and p-q. Second, the posttest results demonstrated significant improvement, with most children reaching the "developing as expected" and "very well developed" criteria. This progress reflects that the IoT-based kinetic sand media effectively enhanced their ability to perform early writing tasks. Lastly, the research findings showed that the treatment had a fairly large influence on ability development, with an effectiveness rate of 63.46%, placing it within the moderate range.

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