International Journal of Islamic Studies Higher Education
https://insight.ppj.unp.ac.id/index.php/insight

# Science Learning Model Based on Multisensory-Ecologi of Cognitive and Social Development in Early Chilhood

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**Article Information:**
Received May 8, 2024
Revised June 20, 2024
Accepted July 18, 2024

**Keywords:** *Early childhood, science learning model based on multisensory-ecology, quality education*

**Abstract**

Science learning is important for early childhood so that they are able to understand the world and the environment around them, through various processes that are then recognized as scientific investigations. Children are expected to be able to solve the problems they face through science learning. This study aims to analyze the effectiveness of multisensory-ecology-based science learning models in improving cognitive and social development of early childhood. Social development in early childhood must also get a balanced portion. This research uses a 2x2 factorial experimental method. The sample consisted of early childhood divided into control and experimental groups. Data were collected through observation, cognitive tests, and social development scales. The results showed that children who learned using the multisensory-ecological learning model had significant improvements in cognitive and social aspects compared to the control group. Diverse sensory stimulation and active engagement in the learning environment contributed to better understanding of science concepts and more active social interaction. This learning model can be used as a reference for educators in designing more effective learning strategies for early childhood. It also supports inclusive education policies by considering the needs of diverse learners.

## INTRODUCTION

Education is a right that every child must obtain (Rahmiati et al., 2021; Wuryandani et al., 2018). Through education, superior human resources can be produced and have adequate competence. Early childhood education has an important role because in this age range there is a basic laying for child development (Ariyanti, 2016; Hairiyah & Mukhlis, 2019; Nurachadijat & Selvia, 2023; Sulastri & Tarmizi, 2017). Humans are monodualist creatures, namely individual creatures as

**How to cite:** Helena, H., Yaswinda, Y., Tulum, L. M., Rahmi, A., Rahmalia, D., & Intan, N., Zeky, S. (2024). Science Learning Model Based on Multisensory-Ecologi of Cognitive and Social Development in Early Chilhood. *International Journal of Islamic Studies Higher Education*, *3*(2), 111–122. https://doi.org/10.24036/insight.v3i2.202

**E-ISSN:** 2964-1861
**Published by:** Islamic Studies and Development Center Universitas Negeri Padang

well as social creatures (Anisa & Fitri, 2017; Cunaya & Apriyansyah, 2022; Nurjannah, 2017). As individuals, humans have personal needs, but as social beings, humans also need interactions withothers to fulfill their daily needs (Iffah & Yasni, 2022; Mailani et al., 2022; Mundiasari, 2022; Riani, 2017; Septiani et al., 2019; Syahyudin, 2020; Xiao, 2018). Socialization skills play an important role in helping humans solve various problems and meet their needs. In science learning, early childhood should get meaningful experiences, such as exploration activities, exploitation and playing with objects around them. These activities can encourage children to actively ask questions and understand the surrounding environment. However, in fact, science learning is often done by watching, only by presenting theories from school magazines or student worksheets, thus providing less direct experience for children.

The science learning media used by teachers in learning activities is still less diverse. Children often only play the role of spectators in the demonstration conducted by the teacher this is influenced by the limited media provided by the school or by the teacher himself. This condition is quite worrying because it can inhibit the natural instincts of children who are at a developmental stage, where they always have the desire to try, express, explore, and exploit the objects around them. As a result, children's cognitive development can be inhibited and not develop optimally. Early childhood social development that is not optimal is characterized by children's low desire to share and socialize with their peers (Aulia et al., 2021; Daulay & Ritonga, 2023). Established friendships are often fragile and often quarrel over small things. In addition, children's attachment to technology, such as gadgets, also causes low social interaction between them (Marpaung, 2018; Sulyandari, 2019; Yulsyofriend et al., 2019). These various problems are the background that encourages the author to further examine the effect of multisensory - ecology-based science learning on improving cognitive and social development in early childhood.

## LITERATURE REVIEW

Early childhood is an individual who experiences rapid development in various aspects, including physical, cognitive, social, and emotional (Amelia & Wahyuni, 2017; Saripudin, 2017). The National Association for the Education of Young Children defines early childhood as individuals aged 0 to 8 years, while in the context of education in Indonesia, Law No. 20 of 2003 specifies an age range of 0 to 6 years. At this stage, children have distinctive characteristics such as high curiosity, egocentric nature, and a tendency to learn through direct experience and social interaction (Handayani & Irawan, 2022).

Early childhood cognitive development is closely related to how they understand the world through interactions with the surrounding environment. Cognitive development consists of several main concepts, such as schema, assimilation, accommodation, and equilibration, which allow children to process new information and adjust it to the experiences they already have. Proper stimulation from the environment, especially from parents and educators, can help children develop critical thinking skills, memory, and problem-solving abilities (Nasution, 2016; Retnaningrum, 2016).

In addition to cognitive development, the social aspects of early childhood also play an important role in shaping their character. Children begin to learn to understand social norms, cooperate, and interact with peers and adults (Melinda & Izzati, 2021). Factors such as parenting, family environment, and interaction with peers influence children's ability to build good social skills (Fuadia, 2022; Izza,

2020). With proper guidance, children can learn to conform to social rules, develop empathy and build positive relationships with others.

In the world of education, experiential learning is one of the appropriate approaches for early childhood. children tend to understand concepts more easily through direct exploration than abstract learning methods. One method that can be applied is multisensory-ecology-based learning, which allows children to use various senses in understanding the phenomena around them (Astuti & Nurhafizah, 2023). This approach can help children connect the knowledge gained with their daily lives.

One important aspect of early childhood education is the introduction of simple science concepts. Early science learning can stimulate children's curiosity about the surrounding environment and help them develop observation skills and logical thinking (Marliza & Eliza, 2019). In its application, science learning for early childhood should be done through simple explorations and experiments that involve play activities and hands-on practice.

In addition to science, play-based learning approaches are also an effective strategy in developing children's skills. Role-playing, environmental exploration and project-based learning can help children understand concepts better, while simultaneously developing social and cognitive skills. This experiential learning also supports children in building problem-solving and creativity skills that will be useful in their future lives.

Considering the various aspects of early childhood development, effective education requires methods that are appropriate to their stage of development. A supportive learning environment, positive interactions, and fun learning approaches can provide more meaningful experiences for children. Therefore, educators and parents need to work together in creating conditions conducive to children's optimal growth and development.

## METHODS

This study uses a quantitative method with a 2x2 factorial experimental approach applied in this study with the aim of examining the effect of early childhood cognitive and social development through the use of a Multisensory-Ecology-based science learning model (Fitriani et al., 2022; Zafirah et al., 2018). The groups sampled in this study consisted of an experimental group and a control group. The experimental group followed the learning process using the Multisensory-Ecology-based science learning model, while the control group used the Inquiry method. The instrument used in this study is an observation sheet that assesses behavior, actions, and early childhood development. Observations were made by class teachers who observed children's behavior and development based on predetermined developmental indicators. This study was conducted over three months with a sample size of 60 children. The research sample came from two kindergarten education institutions that had similar characteristics and were selected to be used as experimental and control classes (Asril et al .,2023; Engkizar et al., 2022).

The data collection technique was carried out through the observation method using a child development observation instrument. This observation sheet covers aspects of cognitive development, such as logical thinking and problem solving, as well as aspects of social development, such as interaction with peers and independence in completing tasks. The instruments used have been validated by experts through expert judgment and revised based on the feedback obtained

(Engkizar et al., 2023); Kasmar et al., 2019).

Furthermore, because this study was conducted on a sample, descriptive statistics and inferential statistics were applied to analyze the data obtained. Descriptive statistics were used to describe children's cognitive and social development before and after treatment. Meanwhile, inferential statistics were applied to test the developmental differences between the experimental and control groups. Inferential statistical analysis was carried out with the following steps:

**Normality Test**

The data normality test was carried out using the Shapiro-Wilk test with the help of SPSS. The hypothesis used is that the population from which the data is taken is normally distributed. The decision criteria in this normality test are if the significance value is more than 0.05, then the data is considered normally distributed.

**Hypothesis Test**

In this study, the Multisensory-Ecology-based science learning model is said to have an influence on cognitive and social development of early childhood if there is a significant difference between the average post-test scores of the experimental group and the control group. Statistically, hypothesis testing is done with the Two-Way ANOVA test if the data is normally distributed. If the data was not normally distributed, the Kruskal-Wallis non-parametric test was used.

In addition, descriptive analysis was also conducted to interpret the results of observations of children's development during the learning process. This analysis aims to describe children's cognitive and social development from the beginning to the end of the study based on the applied learning methods.

## RESULT AND DISCUSSION

**Pre-test Data**

Data on cognitive and social development of early childhood as a whole is obtained from a sample (respondent) of 30 children. The following is a description of the overall cognitive and social development data of early childhood based on the categories set can be seen in Table 1.

**Table 1. Early Childhood Cognitive and Social Development before Applying the Multisensory-Ecology-based science learning model and Inquiry**

| Learning model | Aspect | Mean | Stdv | N |
|---|---|---|---|---|
| Multisensory-Ecology-based science learning model | Cognitive | 48,47 | 4,18 | 30 |
| | Social | 34,10 | 3,89 | 30 |
| Inquiry | Cognitive | 47,07 | 3,22 | 30 |
| | Social | 51,56 | 7,99 | 30 |

**Post Test**

Data on cognitive and social development of early childhood as a whole is obtained from a sample (respondent) of 30 children. The following is a description of the overall early childhood cognitive and social development data based on the categories set can be seen in Table 2.

**Table 2. Early Childhood Cognitive and Social Development after Applying the Multisensory-Ecology-based science learning model and Inquiry**

| Learning model | Aspect | Mean | Std. Deviation | N |
|---|---|---|---|---|
| Multisensory-Ecology-based science learning model | Cognitive | 69,87 | 5,853 | 30 |
| | Social | 67,23 | 2,873 | 30 |
| Inquiry | Cognitive | 68,37 | 6,060 | 30 |
| | Social | 62,20 | 4,715 | 30 |

To describe the condition of early childhood cognitive development of the pretest and posttest groups, see Figure 1.

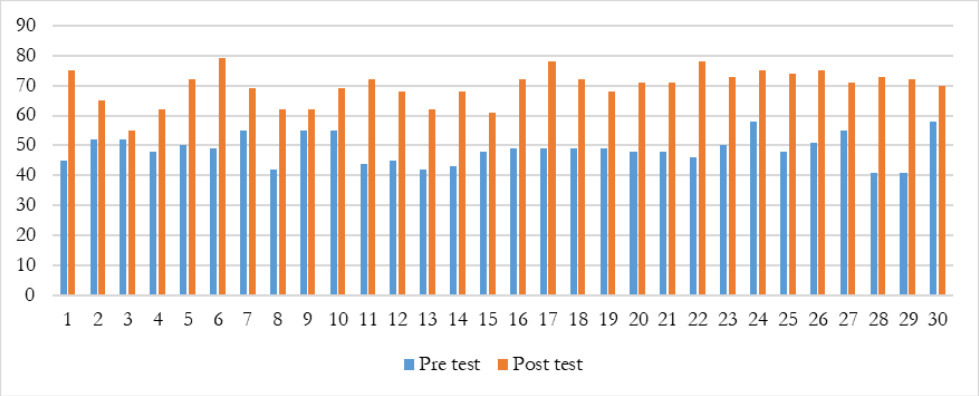


**Fig 1. Histogram of post test results of early childhood social development based on multisensory-ecology-based science learning and inquiry model**

Based on Figure 1 it can be seen that there is an increase in changes in early childhood cognitive development before and after being treated with the Multisensory-Ecology-based science learning model, from 30 early childhood children who received treatment. To see the condition of early childhood social development from the pre-test and post-test groups based on the Multisensory-Ecology-based science learning model, it can be explained in Figure 2.

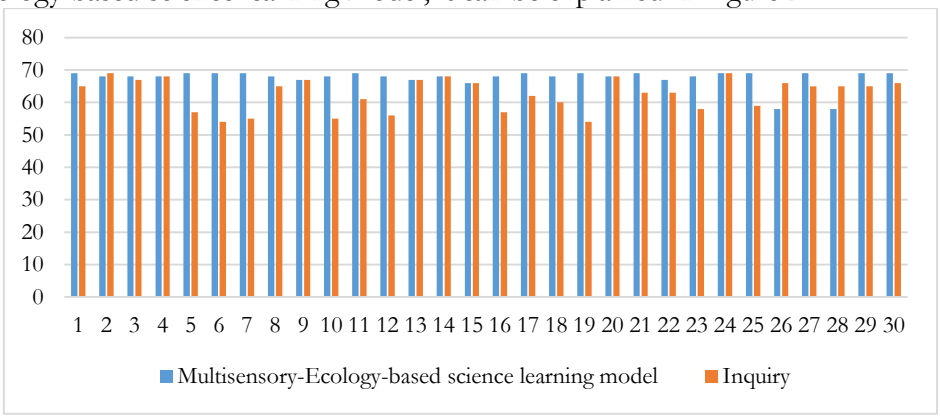


**Fig 2. Histogram of Post Test Results of Early Childhood Social Development Based on Multisensory-Ecology-based science learning and Inquiry model**

Based on Figure 2 it can be seen that there is a difference in early childhood social development after being treated between the Multisensory-Ecology-based science learning model and Inquiry from 30 early childhood who received treatment. On average, the Multisensory-Ecology-based science learning model is more effective than Inquiry on social development.

**Table 3. Normality Test of Early Childhood Cognitive and Social Development Data Based on Multisensory-Ecology-based science learning**

**and Inquiry Models**

| Model | Kolmogorov-Smirnov[a] | | | Description |
|---|---|---|---|---|
| | Statistic | Df | Sig. | |
| Multisensory-Ecology-based science learning model | 0,083 | 60 | 0,200* | Normal |
| Inquiry | 0,097 | 60 | 0,200* | Normal |

From table d above, it can be concluded that the normality test of cognitive and social development data based on the learning model is normally distributed.

**Homogeneity Test**

The results of homogeneity testing using the Bartlett test, this test is used for data from several sample groups and as a condition of the hypothesis test to be used in two-way analysis of variance (ANOVA), the results of the homogeneity test can be seen in table 4 following:

**Table 4. Homogeneity Test of Early Childhood Cognitive and Social Development Score**

| Sample Group | Levene Statistic | df1 | df2 | Sig. | Description |
|---|---|---|---|---|---|
| Multisensory-Ecology-based science learning model | 0,417 | 1 | 60 | 0.520 | Homogen |
| Inquiry | 0.164 | 1 | 60 | 0.686 | Homogen |

From Table 4. it can be seen that the number of calculations used in the Bartlett test obtained Sig. of 0.520 for Multisensory-Ecology-based science learning model, and 0.686 for Inquiry, Thus, the value of $f_{hitung} < f_{tabel}$, then in accordance with the testing criteria in the Bartlett test it can be concluded that the data on cognitive and social development of early childhood from all sample groups have the same variance or homogeneous.

**Hypothesis Test**

Hypothesis testing is carried out using a two-way analysis of variance (ANOVA) technique, the main hypotheses put forward in this study are 2, namely:

1. Hypothesis of Multisensory-Ecology-based science learning and Inquiry Model variables

The results of hypothesis testing of the Multisensory-Ecology-based science learning model and Inquiry Model variables through analysis of variance can be seen in the following table:

**Table 5. Two-way Analysis of Variance (ANOVA) of Learning Model Data**

| Source of Variance | SS | Dk | MS | $F_{count}$ | Sig. | Description |
|---|---|---|---|---|---|---|
| Learning Model | 912,220 | 1 | 912,220 | 2<br>20,242 | ,<br>0,000 | Signifikan |

From Table 4.13, it can be understood that in the learning model variable, the Fcount value obtained is 20.242, while Sig. at degree of freedom (dk) 1 and alpha (α) 0.05 is 0.000, then according to the criteria for testing hypotheses through analysis of variance (ANOVA), Sig. is smaller than 0.05, which means that there are significant differences in cognitive and social development of early childhood between the Multisensory-Ecology-based science learning and Inquiry learning models.

2. Hypothesis of Early Childhood Cognitive and Social Development Variables

**Tabel 6. Two-way Analysis of Variance (ANOVA) of Early Childhood**

**Cognitive and Social Development**

| Source of Variance | SS | Dk | MS | $F_{count}$ | Sig. | Description |
|---|---|---|---|---|---|---|
| Progress | 8757,649 | 1 | 8757,649 | 194,330 | 0,000 | Sign. |

From Table 6. it can be understood that in the cognitive and social development variables, the Fcount value obtained is 194.330, while Sig. at degrees of freedom (dk) 1 and alpha (α) 0.05 is 0.000, then in accordance with the criteria for hypothesis testing through analysis of variance (ANOVA), Sig. is smaller than 0.05, which means that there are differences in cognitive and social development of early childhood.

**Early Childhood Cognitive Development Viewed from Multisensory-Ecology-based science learning model**

The results of data analysis show that the level of cognitive development of early childhood before the application of the Multisensory-Ecology-based science learning model is in the low category. After the application of the Multisensory-Ecology-based science learning model, children's cognitive development increased to the high and very high categories. In more detail, the results of data analysis show a significant increase in early childhood cognitive development.

The Multisensory-Ecology-based science learning model can be applied as an alternative in improving cognitive development of early childhood. After the treatment, children's cognitive development showed an increase, as indicated by the change in the average score before treatment of 48.47 to 69.87 after treatment. Some of the development indicators that are visible, among others: children show patience in teaching and learning activities and during play, are able to queue in various activities, and maintain the cleanliness of the school environment by throwing garbage in its place and sorting garbage properly. In addition, children began to recognize numbers 1-5 well, and some of them were able to write their own names.

Multisensory-Ecology-based science learning model provides guidance for teachers in designing more effective learning to improve early childhood cognitive development Matura et al (2024); Rahmatullah et al (2021); Zeng et al (2017). This model is also considered suitable for science learning, where teachers can create an interesting and fun learning atmosphere. Through simple experiments, children become more interested and motivated in learning. In addition, the classroom atmosphere can be more easily controlled, and the relationship between teacher and child becomes closer, creating a more comfortable learning environment (Engkizar et al., 2024).

**Early Childhood Social Development Viewed from the Multisensory-Ecology-based science Learning Model**

The results of data analysis show that the level of social development of early childhood before the application of the Multisensory-Ecology-based science learning model is in the low category, with an average score of 34.10. After implementation, children's social development increased with an average score of 67.25. In more detail, data analysis shows a significant increase in early childhood social development. Children began to be able to place themselves in good social situations, especially in completing tasks and when playing together. They also showed an attitude of sharing and queuing in play activities. Fauziddin & Mufarizuddin (2018); Giordano et al (2020); Jeti & Herliyani (2018) state that early childhood social development can be supported through play, which plays a role in developing children's social, emotional and cognitive aspects. In the socialization process, children need interaction with others to help them adapt to the environment.

According to Raihana (2018), children's development should not only be

focused on the individual child himself, but also influenced by his environment, both physical and social. Therefore, meaningful learning can improve children's critical thinking and creativity. Children's intellectual, emotional, social, sensory and physical development is not only the result of biological factors, but also the result of interaction with the environment. In this case, the role of the teacher is very important in choosing the appropriate learning model, so that children can adjust to peers and build better social relationships Engkizar et al (2023).

**Early Childhood Social Development in View of the Inquiry Learning Model**

The results of data analysis show that the level of social development of early childhood before the application of the inquiry learning model is in the low to medium category. After the application of the Inquiry learning model, children's social development increased to the moderate to high category. In more detail, the results of the analysis show a significant increase in early childhood social development. This shows that the Inquiry learning model can be used as an approach in improving early childhood social development Buchanan et al., (2016); Depari & Hasruddin (2020).

The average difference between the two learning models in improving early childhood social development showed significant results. The Multisensory-Ecology-based science learning model has an average score of 67.23, while the Inquiry model has an average score of 62.20. These results show that the Multisensory-Ecology-based science learning model is more effective in improving early childhood social development compared to the Inquiry model.

## CONCLUSION

Science learning provided in kindergarten should pay attention to all aspects of child development, especially children's cognitive and social development. In addition, the treatment and feeling of comfort of children in learning must also always be a concern of teachers. Multi-sensory is the involvement of all sensory tools in learning which includes the senses of sight, smell, taste, touch and hearing. Meanwhile, ecology is an activity that invites children to get closer to nature and the environment around them. Teachers should use the right method in learning. With the multi-sensory-ecology based science learning method the above will be realized and teachers can also easily use it. Because this multi-sensory-ecology based science learning method has five characteristics namely 1), exploration, 2). Multi-sensory, 3). Variety of learning media, 4). Interaction, 5). This paper is expected to be useful and help teachers in developing science learning. So that interesting science learning can be created, and increased cognitive and social development in early childhood will also be realized.

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