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The Effect of Application of Science Experiment Methods in Improving Cognitive Early Childhood Age: Literature Review

Derry Heryandini[1], Dyan Evita Santi[2], Husni Abdillah[3*]
[1,2]Universitas 17 Agustus 1945 Surabaya, Indonesia
*derry_s2@untag-sby.ac.id, dyanevita@untag-sby.ac.id
[3]UIN Sunan Ampel Surabaya, Indonesia
*husniabdillah@uinsby.ac.id

Abstrak

Cognitive development in early childhood is one aspect that needs to be optimized for development because children grow rapidly at an early age. Therefore, the cognitive aspects of early childhood need to get a stimulus so that their development can be optimal. The science experiment is one of the learning methods that can be applied to early childhood. This study aims to discover what science experiments are used in early childhood learning and how they affect cognitive development. The research approach used is qualitative with the type of systematic literature review method PRISMA. The data collection technique is collecting journal articles from previous research per the exclusion and inclusion criteria. The data analysis used is meta-analysis. The results of data analysis show that science experiments applied to early childhood learning include mixing colours and identifying sounds. The results showed that there was an effect of science experiments in improving the cognitive abilities of early childhood.

Keyword: Experiment Science, Cognitive , Early childhood.

INTRODUCTION

Each stage of human development has distinctive developmental characteristics that are different at each stage. The early childhood stages of development are always the centre of attention for both parents and those around them. Early childhood is even referred to as the golden age, where its growth and development are unique (Yamin & Sanan, 2012). According to The National Association for Education of Young Children (NAEYC), the range of early childhood is from when a child is born to the age of eight. This early age range is based on the results of neurological research on growth in the child's brain (Suryana, 2012).

Therefore, early childhood development must be optimized as well as possible so that the potential possessed by children can be optimal for further growth. Education at an early age is essential for children's growth and development to optimize their potential. Children aged 0-8 years are in the golden age, where children are ready to be stimulated (Feez, 2009). During the golden age, children's brain development reaches 80%, *so* it is necessary to get the right stimulus through education (Suyadi, 2010). The golden age period will not be repeated where the development and growth of the middle child are in an optimal period.

Early childhood education is vital to optimizing the provision of their stimulus. According to Law Number 146 of 2014 article 1, Early Childhood Education (PAUD) is an effort to foster children aged 0-6. The coaching effort is carried out by providing a stimulus to help children grow and develop, which includes physical and spiritual, religious, and moral values, social, emotional, cognitive, language and art so that children are ready to follow the next level of education. Therefore, early childhood education is often said to be a significant investment for both parents and the State. Various early childhood education development

aspects include physical and psychological (Mustika & Nurwidaningsih, 2018). Therefore, early childhood needs a scientific learning process (Suryana, 2017).

As explained above, all aspects of child development need stimulus, including the cognitive aspects of children, which also require stimulus in the development process. Cognitive development in early childhood is a thinking process in the form of the ability to connect, assess, and also consider (Khadijah, 2016). According to (Sujiono et al., 2014), cognitive development is a change in children's thinking, intelligence, and language to provide reasons so they can remember, strategize creatively, think about how to solve problems, and connect sentences into meaningful conversations.

According to Piaget, the stages of human cognitive development are divided into four phases: the sensorimotor stage, the preoperational stage, the concrete-operational stage, and the formal operational stage. The sensory-motor stage occurs in the age range of 0-2 years. Children's cognitive development cannot be separated from their environment, and their thinking involves sight, hearing, shifting, and touch at this stage. The preoperational stage occurs in the age range of 2-6 years when their way of thinking is not systematic, inconsistent, and illogical. The concrete-operational stage occurs in the age range of 7-11 years. They can think logically about concrete events. The last is the formal-operational stage occurs in the age range of 11 years to adulthood, when they can think more abstractly, more logically, and more ideally ((Marinda, 2020), (Hurlock, 1980), (Hayati et al., 2017)).

Children who enter early childhood education are usually 3-6 years old. According to Piaget, the middle child is at the stage of preoperational cognitive development. The stages of preoperational cognitive development include: 1) Using symbols. This development is where the child does not have to make sensory-motor contact with objects, and they can imagine that the object or person has different properties from what it is. 2) Understanding identity. The child understands the changes that occur to scientific characters. 3) Understanding cause and effect. They understand that an event is what it is. 4) The Child can classify. They can classify objects, people, and events into meaningful categories. 5) The child can understand numbers and can count numbers ((Sujiono et al., 2014), (Marinda, 2020)).

The characteristics of the preoperational cognitive development stage include grouping differences that have similarities, counting from 1-20, recognizing simple shapes, understanding concepts of opposite meaning, distinguishing circle or square shapes from natural objects or pictures, pairing and mentioning objects, and matching shapes. - simple shapes, classifying numbers, writing, fruits and vegetables, recognizing small and large letters, and recognizing colours (Sujiono et al., 2014).

Experimental learning methods can stimulate growth and cognitive development in early childhood (Khaeriyah et al., 2018). The experimental learning method is where students conduct experiments to prove themselves to a studied hypothesis. The experimental method is a series of experiments carried out in a laboratory or room (Sutikno, 2014).

The science experiment learning method allows children to interact directly with activities. Thus, children are expected to understand the process of the activities provided, as well as to understand and understand scientific concepts (Mustika & Nurwidaningsih, 2018). In most practices, the improvement of early childhood cognitive abilities through science is often carried out less by the objectives and does not touch the essence. The application of science experiments in early childhood learning is needed because the only teacher-centred

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lecture method makes children less trained to develop cognitive abilities (Fardiah et al., 2019).

Science learning at the early childhood education level needs to be adapted to abilities and a stimulus for its development, including the development of cognitive aspects. The early childhood science learning stages include colour recognition, plant recognition, colour mixing, animal recognition, and recognizing natural phenomena in the surrounding environment. Science experiments as a science learning method to improve the cognitive abilities of early childhood also need to pay attention to the stages of science learning so that the experimental method applied gets optimal results.

Based on the description above, this study aims to discover what science experiments are used in early childhood education learning and how they affect cognitive development.

METHODS

The research approach used in this research is the systematic literature review. The systematic literature review research method is a research method which uses a review, analysis, and categorization method from previous research conducted with structured research methods in the field. *The systematic literature review* is a research method using reviews, studies, structured evaluations, classifications, and categorizations of field research that has been done previously in a structured way (Davies & K, 2009). *systematic literature review* used in this study is the *preferred reporting item for systematic reviews and meta-analysis* or the PRISMA method, namely, research conducted systematically by following the correct research stages.

The *systematic literature review* with the PRISMA method used in this study was based on the research objective: to analyze the influence of science experiment learning methods in PAUD in improving early childhood cognitive development.

The stages of *a systematic literature review* using the PRISMA method. The first stage is formulating the background and research objectives. Then formulate the problem in the research, search for literature from various sources, conducts literature selection last, and the next is to assess the quality of the literature following predetermined criteria. The sixth stage is extracting the data, and the last is data synthesizing.

A systematic literature review using the PRISMA method was carried out by collecting articles related to this research with various publications in the last ten years or from 2012-2022. Below is a table of literature search strategies based on data sources, publication time, inclusion and exclusion criteria, and *keywords* or search keywords from data sources.

Tabel 1 Literature Criteria

Data sources	Time of publication	Criteria		Keyword
		inclusion	Exclusion	
Google Scholar Garuda (Digital Reference	2012-2022	1. Research articles published in the 2012-2022 timeframe. 2. The dependent variable in the	Journal of experimental method research results with	Science experiments, early childhood cognitive stimulus

Garba)	research article is cognitive. 3. The independent variable in the research is science experiments.	full text.

The articles were obtained from google scholar and Garuda journal based on several national journal publications, including Jurnal Obsesi, Jurnal Aulad: early childhood, Jurnal Buah Hati, Jurnal Anak Usia Dini, and Jurnal Pendidikan Anak Usia Dini.

Data analysis in a systematic literature review with the PRISMA method is carried out by outlining the subject matter with other sections to understand the entire data content of the reviewed literature. Data analysis methods systematic literature review including meta-analysis and meta-synthesis.

According to Peqqry and Hammond, the meta-analysis method is a technique of performing data aggression to obtain statistical power to identify a causal relationship between a risk factor and an effect. The meta-synthesis method is carried out by integrating data to obtain new theories and concepts so that the understanding of the topic being researched is much more in-depth and comprehensive.

RESULTS AND DISCUSSION

Results and discussion of the objectives of this study will be presented at this point. Based on the results of the search for literature data found journal articles that are in accordance with the objectives of this research have been determined. From the number of articles, screening is then performed again based on *eligibility* per the established criteria. After screening the inclusion and exclusion criteria, the number of articles is eight. Then a review will be carried out. The following are the results of a literature search:

The following are the findings of articles related to this research topic. After selecting the data that has been collected, the following are included in the criteria.

Tabel 2 The results of a literature search

Search engine	Google Scholar	GARUDA
Search results	15,800	177
Fulltext, pdf, 2012-2022		150
Suitable titles	23	3
Eligible according to criteria	6	1
Result		**7**

Tabel 3 Articles related to this research topic

Author	Title	Journal name	Link/doi OJS	Findings/Substance Article
Yanti Mustika **Lia Nurwidaningsih** **(Mustika & Nurwidaningsih, 2018)**	The Effect of Early Childhood Science Experiments on Children's Cognitive Development in Kindergarten Kartika Siswi Pusdikpal Cimahi City	Obsession Journal: Journal of Early Childhood Education	10.31004/obsesi.v2i1.12 https://obsesi.or.id/index.php/obsesi/article/view/12	This study aims to determine the experimental learning method or science experiment on the cognitive development of early childhood. The method used in this research is an experimental method, with data collection techniques in the form of *pre-test* and *post-test*. Experimental activities carried out in this study were in the form of colour mixing. The results of this study indicate that science experiments affect children's cognitive development by 4.50.
Yenda Puspita **(Puspita, 2020)**	Application of Science Experiment Learning in Improving Cognitive Ability of Children aged 5-6 years	Aulad: Journal on Early Childhood	https://doi.org/10.31004/aulad.v3i3.80	the research aims to determine the increase in cognitive abilities in applying experimental scientific methods. The science experiment used in the study used colour mixing experiments. The research method used is classroom action research. The results showed that children's cognitive abilities in the initial data were 35%, in cycle one meeting 1 was 39.4%, cycle 1 meeting two obtained data of 45.6%, cycle 2 meeting one obtained data of 49.7%, and in cycle two meetings two obtained data of 68.1%. These data indicate an increase in children's cognitive improvement scores.
Lili Kasmini **Nirwanasari Purba** **(Kasmini & Purba, 2016)**	The effect of science experiments on colour mixing material on the cognitive development of children in	Journal of Buah Hati	https://doi.org/10.46244/buahhati.v3i1.541	This study aims to discover how the application of colour-mixing science experiments to children's cognitive development. This study uses experimental research methods, with pre-test and post-test data collection techniques. The scientific experimental method used is mixing colours.

	group 2B at Pertiwi Kindergarten Banda Aceh			The results showed that science experiments could affect children's cognitive development by 4.25%.
Suryameng **Theodosia yayuk marselia** **(Suryamen g & Marselina, 2019)**	Experimental method in science learning to improve cognitive abilities of early childhood in Santa Yohana Antida 2 Kindergarten Sintang	Dunia Anak: Journal of Early Childhood Education	http://jurnal.stkippersada.ac.id/journal/index.php/PAUD/article/view/388	This study aimed to determine the effect of the application of science experimental methods on improving children's cognitive abilities. This study uses the classroom action method, with two cycles and three meetings in each cycle. The results obtained in the pre-cycle stage obtained a score of 35.7%, cycle one obtained a score of 64.3%, and cycle two obtained a score of 78.6%. It can be concluded that applying the scientific experimental method can improve the cognitive abilities of early childhood.
Ery kheriyah **Aip saripudin** **Riri kartiyawati** **(Khaeriyah et al., 2018)**	Application of experimental methods in science learning to improve early childhood cognitive abilities	AWLADY: Journal of Child Education	10.24235/awlady.v4i2.3155	This study aims to improve early childhood cognitive abilities using science experiments. The research method used is the classroom action method. The results showed that the pre-cycle stage obtained a score of 44.38%, cycle one obtained a score of 61.21%, and cycle two obtained a score of 78.86%.
Rahyana Hasibuan **Dadan Suryana** **(Hasibuan & Suryana, 2021)**	The effect of experimental scientific methods on cognitive development of children aged 5-6 years	Obsesi Journal: Journal of Early Childhood Education	https://doi.org/10.31004/obsesi.v6i3.1735	This study aims to determine and analyze the effect of the scientific experimental method on early childhood cognition. The science experiment used coloured soap bubbles and a ringing bottle. The type of research method used is experimental. The results showed that science experiments with coloured bubbles and bottles affected children's cognitive development.
IGA Agung Ngurah Kartika, I	Application of Science Learning	PAUD Journal	https://doi.org/10.23887/paud	This study aims to improve the cognitive abilities of early childhood through science

wayan wiarta, Made Putra (Kartika et al., 2016)	through Experiments to Improve Cognitive Ability of Kindergarten Children Dwi Rahayu Kumara Denpasar	.v4i1. 7536	experiments. The research method used is classroom action research. The results showed that in the first cycle, a score of 67.26% was obtained, while in the second cycle was 82.66%.

Cognitive development in early childhood aims to enable children to explore the world around them through their five senses (Fajriani & Liana, 2020). Science learning in early childhood connects the brain framework with factual information to have meaning in mastering concepts (Fardiah et al., 2019). Therefore, science learning in early childhood education needs to be maximized to stimulate early childhood cognitive development.

The experimental method is one of the methods used in learning science in early childhood. The application of the experimental method is considered better in science learning compared to the lecture method because it will only focus on the teacher and limit children's interaction with concrete objects ((Puspita, 2020), (Suryameng, 2019), (Hastuti & Hidayati, 2018)). The experimental method is a method that can encourage children to practice a process ((Novie Azizah et al., 2021), (Mayangsari et al., 2014)).

The scientific experiment method used in early childhood learning must be adapted to the child's abilities. Science learning in early childhood is still at the level of colour recognition, mixing colours, introducing plants, introducing animals, and recognizing natural phenomena in the surrounding environment. Based on data that has been collected from various scientific articles that match the criteria, the scientific experimental method applied to early childhood includes experiments to recognize and mix colours (Mustika & Nurwidaningsih, 2018; Puspita, 2020; Kasmini & Purba, 2016; Suryameng & Marselina, 2019; Khaeriyah et al., 2018; Kartika et al., 2016) and the experiment of colour bubbles and bottle sounds (Hasibuan & Suryana, 2021)

Based on research results conducted by Mustika & Nurwidaningsih (2018), a science experiment of mixing colours was conducted to determine children's cognitive development level. The research was conducted at the Kindergarten in Pusdikal Cimahi City. A test was carried out before and after the mixing colours experiment to determine the study's results. The results of this study indicate that science experiments with colour-mixing material affect early childhood cognitive development by 4.50, including in the medium category.

A science experiment was carried out by recognizing and mixing colours based on research results (Puspita, 2020) conducted at the Hafizah Kids Kindergarten, Tampan District. The results show an increase in cognitive abilities after the experiment of mixing colours in early childhood at Hafizah Kids Kindergarten. The results of the experiment in this study are as follows:

Tabel 4 The results of the experiment

Indicator	Achievement				
	Data Initial	Cycle I		Cycle II	
		P1	P2	P1	P2
Children recognize primary colours	37.5%	48.4%	53.1%	54.7%	67.2%
Children dare to mix colours	42.2%	46.9%	53.1%	60.9%	76.6%
Children can identify new colours and basic colours	37.5%	42.2%	46.9%	48.4%	68.8%
Children can find new colour variations with different colour mixing compositions	29.7%	29.7%	42.2%	45.3%	76.6%
Children can communicate their findings	28.1%	29.7%	32.8%	39, 1%	51.6%

The scientific experiment method with colour mixing material (Kasmini & Purba, 2016) conducted at TK Pertiwi Banda Aceh showed the effect of science experiments on increasing children's cognitive abilities by 4.25%. The effect of science experiments on indicators achieved by children can mix more than seven colours. They are directly involved in experimental activities, can mix primary and secondary colours, and can communicate the results of experiments.

Suryameng & Marselina (2019) at Santa Yohana Kindergarten also carried out the scientific method with the material mixing colours. Before the science experiment, the child's cognitive ability was 35.7%. In the first cycle, the child's cognitive ability increased to 64.3% using a science experiment mixing colours. Meanwhile, children's cognitive abilities were 78.6% in the second cycle.

Science experiments with colour-mixing materials were also carried out by (Khaeriyah et al., 2018) at RA Baiturrahman with the classroom action research method. Pre-cycle results obtained a score of 44.38%. In the first cycle, a score of 61.21% was obtained and 78.86% in the second cycle. These results show that science experiments with mixing colours affect increasing cognitive abilities of early childhood at RA Baiturrahman.

Other research related to the application of science experiments with the method of mixing colours was also carried out by (Kartika et al., 2016) at Dwi Rahayu Kumara Kindergarten Denpasar. The results of this study indicate an increase in children's cognitive abilities through the application of the scientific experiment method with the material mixing colours. The first cycle got a score of 67.25%, while the second cycle got a score of 82.66%.

It is different in applying science experiments to early childhood research (Hasibuan & Suryana, 2021) at Al-Hikmah Kindergarten. In this study, science experiments in early childhood were not just mixing colours as was done in the six studies previously described. However, science experiments in the form of colour bubbles and bottles sounded.

Each child tried to make colour bubbles with the available equipment, such as food colouring, water, straws, laundry soap, HVS paper and aqua glass. The child will see the colours of the bubbles that fall on the HVS paper. While the bottle sounds, the child distinguishes which bottle makes the loudest sound between empty bottles, bottles containing a little water, and bottles full of water. The cognitive abilities trained in the experiment were the ability to identify colours and distinguish sounds. The results of this study indicate that science experiments have an effect on increasing cognitive abilities.

Based on the data collected from the research results of seven journal articles that match the criteria set in this study, it shows that the application of science experimental learning in early childhood increases children's cognitive abilities. The science experiment material used in the form of mixing colours and recognizing sounds in the study followed the criteria in science learning for early childhood, namely being concrete, having a direct visible causal relationship, and children being able to conduct direct exploration (Mustika & Nurwidaningsih, 2018). In addition, the applied science experiment activities are wrapped in playing under the child's world. It is done because early childhood activities cannot be separated from play activities (Retnaningrum, 2016).

In early childhood cognitive development, the abilities that need to be achieved include being able to think logically, think critically, express reasons, solve problems and find causal relationships (Novitasari, 2018). The application of science experiments can stimulate early childhood cognitive development to achieve more optimal cognitive abilities (Mustika & Nurwidaningsih (2018); Puspita (2020); Kasmini & Purba (2016); Suryameng (2019); Khaeriyah et al. (2018); Hasibuan & Suryana (2021); Kartika et al. (2016)).

CONCLUSION

Based on the results of data analysis from seven journal articles that match the inclusion and exclusion criteria of science experiment methods applied to early childhood education, namely related to colour mixing and sound recognition. It can be concluded from the seven research results that the application of experimental scientific methods affects the increasing cognitive abilities in early childhood.

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