Simple Science Experiment Learning Design to Improve Children's Critical Thinking Ability

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Abstract: This study aims to develop a science learning design using experimental methods in improving children's critical thinking skills. The critical thinking indicator applied in this research is the child's ability to express questions and statements based on their analysis of the experimental activities carried out. The research subjects were group B in two different kindergartens using the Design-Based Research (DBR) method through 4 stages, namely 1) problem identification and analysis, 2) developing a prototype solution based on theory 3) conducting an iterative process to test and improve 4) reflecting on product design principles. The conclusions and results of this study are the design of science learning through experimental methods in the form of a structure that includes science themes, competency formulations and developmental achievement indicators, descriptions of science material for teachers, scenarios, and learning evaluations.

Keywords: Learning Design, Science, Experiment Method, DBR

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INTRODUCTION

Learning science for early childhood can provide positive experiences for children that help them to develop an understanding of a scientific concept, develop thinking skills, curiosity, instill a positive attitude, and provide a strong foundation for the development of scientific concepts at the next level of education (Eshach & Fried, 2005). This is confirmed by the number of research results which state that children are considered capable of learning science, because of the nature of children who have high curiosity, actively ask questions and explore new things around them (Conezio & French, 2002).

Science-based learning is learning that directs children to always think critically and logically (Zurqoni, 2018), because with the science children don't just accept or reject something. They observe, analyze, and evaluate the information available before making a decision. Currently, the ability to think critically is a strategic competency that is being demanded along with the development of science and technology. The National Education Association (n.d.) has identified 21st-century skills as "The 4Cs." "The 4Cs" covers critical thinking, creativity, communication, and collaboration. Critical thinking skills are skills for conducting various analyzes, assessments, evaluations, reconstruction, decision making that lead to rational and logical actions (King, et al., 2010). In line with 21st-century learning which can be simply interpreted as learning that provides 21st-century skills to children, including 1) Communication; 2) Critical Thinking; 3) Creative and 4) Collaborative. This is important because someone's critical thinking ability is an “essential core life skill” (Dunn & Smith, 2009; Wallace & Jefferson, 2015) and is owned by every individual that must be continuously honed.

Recent research has shown that critical thinking skills are not only for student success in the classroom but also as a lifelong skill (Han & Brown, 2013). Various approaches are needed to teach critical thinking to various groups of individuals (Lombard & Grosser, 2008; Lyutykh, 2009).

There are still many teachers who find it difficult to understand and implement science learning in early childhood education and recent research has identified preschool teachers as having low self-efficacy related to science education (Greenfild et al. 2009). Besides, preschool

teachers reported feeling uncomfortable teaching science to young children (Conezio & French, 2002). As a result, teachers provide inadequate or inaccurate explanations for scientific phenomena, sometimes describing events as things that happened by themselves, rather than providing factual information about how or why something happened.

Besides, it seems that science learning in Indonesia is still not optimally helping children understand science in everyday life. This is evidenced by the results of the 2018 Program for International Student Assessment (OECD, 2019) test which shows that Indonesia is ranked 62 out of 71 countries for the science category. The tests presented in the program instruments generally explore higher-order thinking skills, more specifically critical thinking. Therefore, thinking skills need to be trained from an early age through a proper learning process to obtain more optimal results.

Andriyansyah (2018) in his research stated that when 25% of 17 children who took part in science activities were happy and able to participate in science learning, 75%, namely 13 children were just silent, talking with friends, playing alone, not interested, and not paying attention experimental activities that are being carried out. Factors causing the problem of low critical thinking skills include science activities that are still carried out using a teacher center approach, which is too teacher-centered without actively involving students in learning. The children just sat there listening to what was explained about the science activities that day, so it did not motivate them to think critically. Weak teachers in designing lessons that are too fixated on mastering the Calistung concept, using inappropriate learning models and strategies. (Andrisyah, 2018).

Therefore, to help teachers equip themselves in understanding the concept and implementation of science learning to improve critical thinking skills in early childhood education, a learning resource is needed that functions to improve teacher performance and motivation in implementing learning (Prastowo, 2018). One of the efforts that can be made to develop critical thinking skills is by using experimental designs and learning methods prepared by researchers in collaboration with teachers. Based on this, the researcher developed a learning design regarding the concept of science through an experimental method that would guide and provide an overview for teachers in carrying out science learning with a complete concept through the science process skills presented.

METHOD

This research is intended to develop science learning designs in improving children's critical thinking skills. The research method used is the Design-Based Research (DBR) method. DBR is a methodology designed by and for educators who seek to increase the impact, transfer, and translation of educational research into better practices (Anderson & Shattuck, 2012).

There are several stages in the DBR method according to McKenney & Reeves (2014), which are as follows:

1. Identification and analysis of problems by researchers and practitioners collaboratively. At this stage, the researcher conducts a theoretical study of the learning design that occurs in the field, examines problem analysis by identifying problems through pre-research observations and literature studies.
2. Developing a prototype solution based on the standard theory, design principle, and innovation. The researcher determines the learning design that will be developed based on the results of problem identification and analysis involving 2 teachers, mentors, and researchers.
3. Perform an iterative process to test and improve practical solutions. Implement the learning design draft, make revisions involving the teacher, re-implement, revise.
4. Reflection to generate design principles and improve the practical implementation of solutions. Reflecting on the final learning design involves teachers, mentors, and researchers.

Participants

Participants who were the subject of this study were group B teachers of TKIT Ibnu Abbas Cirebon district. The criteria for respondents are schools that implement science learning and teachers who have at least 2 years of teaching experience and have two classes in the 5-6 years age group.

Data collection

1. Observation
   This observation is divided into two parts, namely initial observation and core observation. Initial observations are pre-research conducted to see the basic skills of children's critical thinking through a questionnaire filled out by the teacher, while core observations are experimental observations that are defined in this study.
2. Interview
   Interviews were conducted with practitioners/teachers who taught. The things that the researchers interviewed for the teacher were things related to the child's thinking ability and the design of science learning itself. Whereas for early childhood teachers, it is more in the direction of the discussion, namely discussing the findings of researchers and discussing questions that arise from the results of the research. The following are the researchers' questions regarding the research subjects asked during the interview. According to mom, what is early childhood science? How important?; Do you stimulate science learning in children? How is it going on?; How are science experiments done?; What difficulties do you have when teaching science to children?
3. Documentation
   In discussing the results of this study, some documentation is needed that can support this research. The documentation used to support this research is documentation in the form of images, videos, and audio.

Data analysis

The data analysis used in this research is descriptive. Researchers analyzed this research descriptively, to describe the development of each child from observations when science learning took place to the implementation of the learning design.

RESULTS AND DISCUSSION

Based on the results of observations that have been made through a questionnaire filled out by the teacher, anecdotal notes, and interviews related to science learning and the development of children's critical thinking, there are several findings. The findings that can be seen are the cognitive development of children, especially critical thinking, there are still many underdeveloped children about expressing questions using interrogative sentences. Besides, to answer questions still need to be guided. Likewise, to express an opinion or point of view of thought based on what he already knows. Of the 19 children, 11 children still need to be guided by the teacher to express their opinions or thoughts. Science learning is carried out periodically every year by the indicators of the level of achievement of children's development in the 2013 curriculum as guidelines for the implementation of current learning.

Based on interviews with teachers related to science learning that has been carried out so far, there are still several obstacles including tools and materials that are deemed too expensive if held end masse so that sometimes these science activities are carried out classically together. The following is the teacher's statement regarding science learning that has been carried out so far in school.

"There is no special day for science learning, but it is integrated with other activities once a week because you have to prepare tools and materials and adapt them to the existing theme" (Mrs. Y, 20 February 2020). As for the scientific method itself, it has been carried out using experimental methods in several activities and carried out in groups. "Experimental methods have been carried out on natural phenomena and the children are very enthusiastic. The children who made the mountains out of the sand in groups poured soap, baking soda, and

coloring. The teacher helps pour vinegar. Besides, there was also about bacteria using a hand-sanitizer, black pepper powder, soap. The children's fingers are smeared with soap and then dipped in water that has been sprinkled with black pepper" (Mrs. M, 20 February 2020). From the results of the interview, it appears that the teacher uses the experimental method and the children do activities in groups so that the children do not explore independently the activities they do.

Testing

The trial was carried out in a limited manner and was divided into two, namely small group trials and large group trials. Small group trials were carried out in group B1 with one teacher and 10 children who were stimulated through this science learning design. The science material presented is about static electricity which is carried out through the experimental method of balloons that stick to paper after the balloon has been rubbed against the cloth or hair. Trial data showed that each child experienced an increase in cognitive abilities, especially in critical thinking as seen from the ability to ask, answer questions, and make conclusions in an activity. Each child shows improvement in different indicators. For example, Ananda Al, has increased in indicators a) the child can ask questions using the question sentence, b) the child can answer the teacher's questions appropriately.

Furthermore, a large group trial was conducted in group B2 with one teacher and 19 children. The implementation of science learning design in this trial was carried out after experiencing improvements from previous trials, namely the accuracy of the content or science introduction material and the addition of indicators to each activity. Then the second revision is the attractiveness of the media used in learning. In this second trial, an increase occurred in 15 children. As was the case in the first trial, the improvement of each child was found in different indicators of critical thinking skills. Although there are still 4 children who do not experience improvement in their critical thinking skills. After further study, these four children from the start have become the teacher's notes because there is one factor or another that is a factor for these children who are still being guided a lot to be able to express their opinions.

Permendiknas RI No. 137/2014 on early childhood education standards, which is a renewal of Permendiknas No. 58/2009 explains the level of achievement of children's development, one of which is the development of science which is in the scope of cognitive development. So that in any given learning is the result of planning made by the level of achievement of child development that has been arranged therein. Likewise, with science learning, the scope of cognitive development includes indicators of general knowledge and science. Furthermore, guidelines for the level of achievement of children's development in the scope of cognitive development are used as the goal of achieving early childhood science learning.

Science learning that is carried out certainly refers to these standards, so that the indicators of children's development achievements can be achieved as expected. Meanwhile, the abilities of each child have different thinking powers. Likewise, with the level of critical thinking skills that are influenced by the environment. Several indicators of critical thinking in early childhood, namely: the ability to observe and analyze; the ability to ask and understand questions; the ability to solve (Misyana & Mayasi, 2018).

This critical thinking ability can be developed in early childhood using materials and methods that are by the stages of children's thinking abilities which are still concrete. Through the experimental method, children can explore the things they want to know. The experimental method itself is a way of presenting learning when children conduct experiments by experiencing and proving themselves something they have learned (Djamarah and Zain, 2002: 84). The principle of the method is to provide real and planned to learn activities and experiences for children. In experimental activities,

children do themselves, observe, analyze, and prove themselves and conclude the results of their experiments so that children's thinking skills can develop. Even Nugraha stated that the critical thinking skills of children will develop by doing frequent observation activities (Nugraha, 2008: 39). In this observation activity, the child can recognize objects better and the child gets to know their environment more. Anggraeni (2014) in the results of his research showed that environment-based experimental methods could improve children's critical thinking skills, it was proven that the results of observations made reached a success indicator of 71%. Besides, it is evident from this research that it is quite significant to use science learning designs through simple experimental methods in improving children's critical thinking skills. This experimental method is indeed a suitable method for determining children's critical thinking abilities.

After implementing the science learning design through the experimental method there are several interpretations related to the results of the trials on the teacher, namely 1) this experimental method is easy to implement 2) not many teachers know the steps of the experimental learning method 3) this experimental method can improve children's learning outcomes depending on how teacher creativity in delivering learning materials 4) each child has different developments. According to Nana Sudjana (2006: 84) the steps in carrying out the experimental method (experimental method) are: a. Preparation or planning the teacher needs to prepare several things at the preparation stage or planning of experimental activities, namely: 1) setting experimental objectives, 2) determining experimental steps 3) preparing tools and materials to be used for experiments. b. Conducting experiments (allowing children to try). c. Follow-up experiments (provide evaluation and assessment)

As for the results of the learning design trial, there were two revisions, including the first revision, the accuracy of the content or science introduction material, and the addition of indicators to each activity. Then the second revision is the attractiveness of the media used in learning.

CONCLUSION

Based on the revised learning design results, it can be concluded that this learning design can be used for teachers to achieve learning objectives, especially for learning science and children's critical thinking skills. Through the experimental method, teachers can be more effective in improving children's critical thinking skills because children do their experiments independently, exploring things around them that they find interesting. The researchers themselves realized that this design was still not perfect and was a small part of the development of early childhood science learning which still needed improvement. Researchers recommend that each teacher can develop more broadly and be adapted to the situation of their respective school conditions.

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