



## The Influence of the STEAM Method on the Cognitive Ability of Logical Critical Creative Thinking in Children Aged 5-6 Years

Devi Maulanasari<sup>1</sup>, Ratnasari Dwi Ade Chandra<sup>1,\*</sup>, Hendrik Siswono<sup>1</sup>

<sup>1</sup>Universitas PGRI Argopuro Jember, Jawa Timur, Indonesia

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### ABSTRACT

**Purpose of the study:** This study aims to compare the effect of the STEAM method with conventional methods in supporting the development of logical, critical, and creative thinking in children aged 5-6 years. The background of this study is based on the need for a learning approach that can develop high-level thinking skills from an early age, considering that conventional methods are deemed inadequate to support this development.

**Methodology:** The method used is quantitative research with a quasi-experimental approach. The research sample consisted of children aged 5-6 years in kindergarten, divided into two groups: the group using the STEAM method and the group using conventional learning methods. Data collection was conducted through tests assessing logical, critical, and creative thinking abilities before and after treatment.

**Main Findings:** The study's results showed that the application of the STEAM method significantly improved the logical, critical, and creative thinking skills in children aged 5-6 years compared to conventional learning methods. The group using the STEAM method experienced a higher increase in scores on the three aspects of thinking.

**Novelty/Originality of this study:** The discussion in this study confirms that integrating the STEAM method into kindergarten learning can be a practical innovation for developing high-level thinking skills in early childhood. This study implies that educators and policymakers should consider the broader application of the STEAM method in early childhood education as a means to prepare a generation that can think logically, critically, and creatively from an early age.

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#### Corresponding Author:

Ratnasari Dwi Ade Chandra,

Universitas PGRI Argopuro Jember,

Jl. Jawa No 10, Tegal Boto Lor, Sumbersari, Jember, Jawa Timur, Indonesia

Email: [ratnachandraut@gmail.com](mailto:ratnachandraut@gmail.com)

## 1. INTRODUCTION

Based on Law No. 20 of 2003 concerning the National Education System, Early Childhood Education (PAUD) is a coaching process given to children from birth to the age of six. The goal is to provide educational stimulation to support the physical and mental growth of children, so that they are ready to continue to the next level of education [1]. PAUD is the main foundation for child development, because during this period there is rapid growth in cognitive, social, and emotional aspects [2]. In terms of cognitive development, children are expected to be able to think logically, critically, provide reasons, solve problems, and understand cause and effect relationships in everyday life [3]. Cognitive is related to thinking skills which include skills in remembering, understanding, applying, analyzing, synthesizing and evaluating [4].

Ability think logical on child age 5-6 years related to the ability to understand the process and consequences of an event [4]. According to Harun Rasyid, the cognitive-logical aspects of children include the ability to group, name, differentiate, and count objects, colors, distance, time, size, weight, and shape [5]. John Dewey emphasized that critical thinking is a process of reflective and evaluative thinking about a belief or knowledge [6]. In early childhood, this ability is related to the ability to analyze new information from the environment. Children who are able to think critically will find it easier to fulfill cognitive development tasks [7]. Meanwhile, Desmita stated that creative thinking is a skill in creating something new, which in children can be seen from the ability to observe, ask questions, and create new things, as well as evaluate [8].

In Curriculum Independence, based on Regulation Minister Education, Culture, Research, and Technology (Minister of Education, Culture, Research and Technology Regulation) Number 12 of 2024 concerning Curriculum on Education Child Age Early, Level Education Basic, and Level Education Intermediate, ability think logical, critical, and creative child age early integrated to in achievement learning phase foundation [9], [10]. The indicators include: children are able to differentiate information, know what is real and what is not, and understand cause and effect. For the creative aspect, children are expected to be able to produce new ideas, show curiosity, and explore through play activities [11]. The flexible and play-based learning approach in the Independent Curriculum allows children to develop thinking skills from an early age [12].

On 5-6 year old child is at on phase development very cognitive rapid, where ability think child start develop And need proper stimulation [13]. PAUD plays an important role in building the foundation of logical, critical and creative thinking skills which are part of the high-level thinking skills (HOTS) needed in the modern era [14]. Therefore, innovative and interactive learning methods are needed to develop these thinking skills [15]. Stimulation think logical, critical creative from an early age helps children become more self-confident, careful, persistent, and responsible [16]. In early childhood learning, the form of learning activities provided must also be adjusted to the child's learning characteristics, such as learning through play activities that are appropriate to the child's developmental achievement level [17].

One of methods that can used For increase ability think logical, critical, and creative child is STEAM method (Science, Technology, Engineering, Arts, and Mathematics)[18]. The STEAM method combines various disciplines and encourages children to explore, experiment and find solutions through direct experience[19]. STEAM learning can be done by creating a safe and fun learning environment, giving children the opportunity to explore, build, try, predict, and relate knowledge to everyday life [20]. STEAM is believed to be able to shape children into creative, innovative, and responsible agents of change [21]. Previous research has shown that STEAM is able to significantly improve children's critical and creative thinking abilities [7]. STEAM-based learning encourages children to ask questions, solve simple problems, and develop critical, creative, and innovative thinking skills. This approach is designed to make learning fun and meaningful, inspiring children by integrating science, technology, engineering, art, and mathematics concepts into everyday life [22]. Other research by pitaloka dan sinaga show existence influence significant learning STEAM based on ability think creative child, with improvement average value from 47.6 to 83.9 after implementation STEAM method [23].

However, in reality, many institution Early Childhood Education Still use method learning conventional, such as lectures, which are lacking effective in develop ability think logical critical creative For child age early [24]. Field lessons observed show that lecture-based teaching does not enable children to work together in solving problems, think creatively, so it is considered that lecture-based teaching is limited because it does not promote high-level thinking and advanced reasoning skills [25]. At TK Al Asyari for example in implementation his learning Still use method conventional. Based on results observation early, children class B1 and B2 in this kindergarten, the implementation his learning Still tend conventional, where the learning process more centered to the teacher and not enough give chance for child For explore in a way independent. Children No Lots involved in experience real live in life everyday, so that learning become not enough contextual And interactive. Besides that, in giving class assignments, methods used Still nature conventional, with a more approach emphasize on Instructions direct from on learning based on experience. Besides That also at school This Still very focus on ability reading, writing and arithmetic as priority main, because existence demands from environment around like when will enter school base must Can control reading, writing and arithmetic, so that aspect development skills think logical, critical, creative child, less get optimal attention.

The urgency of this research lies in the urgent need to change the learning paradigm in PAUD, from conventional to more innovative and oriented towards the development of 21st century skills. Therefore, this study offers a solution through the application of the STEAM method which has been empirically proven to be able to improve children's thinking skills, but has not been widely implemented as in TK Al Asyari. The purpose of this study is to compare the effect of the STEAM method and conventional methods on the logical, critical, and creative thinking skills of children aged 5-6 years at TK Al Asyari. Also provide recommendations based on empirical evidence for PAUD institutions in choosing effective learning methods for children's cognitive development.

This study aiming For compare influence STEAM method and method conventional in support development think logical, critical, and creative child. Through study this, it is expected can obtained a better

picture clear about influence STEAM method in increase ability think child as well as give recommendation for institution education child age early in choose method proper learning use optimize development cognitive child. Results study This expected can give outlook for educator And taker policy in increase quality learning at the level education child age early. With existence proof empirical about influence STEAM method, it is expected approach This can more developed And applied optimally in the education process child age early.

## 2. RESEARCH METHOD

This research uses a quantitative approach with a quasi-experimental design, which is a type of experimental design that involves two groups, namely the experimental group and the control group [26]. This study was conducted at TK Al Asyari, Bondowoso Regency. The sample in this study was selected using purposive sampling technique. Purposive sampling is the selection of samples based on certain criteria that are relevant to the study. The sample criteria in this study are: 1). Children aged 5-6 years who are registered at TK Al Asyari Wonosari; 2). Classes selected with the same number of students in each class; 3). Have readiness to participate in the STEAM learning program; 4). Parents or guardians are willing to give permission to participate in the study.

The number of samples to be used in this study consists of 2 classes from TK Al Asyari, namely classes B1 and B2 with children aged 5-6 years. The classes selected both number 20 children, with class B1 as the experimental group and class B2 as the control group. The research design used was Nonequivalent Control Group Design, where the two groups (experimental and control) were not selected randomly[27]. Both groups were given a pretest, then the experimental group received treatment (STEAM method), and finally both groups were given a posttest. With this design, the changes that occur can be observed by comparing the results of the pretest and posttest in each group [28].

Table 1 Research Design Source. Modification kholiyah [28]

Group	Pretest	Treatment	Posttest
Experiment (E)	X1	X	X2
Control (K)	Y1	Y	Y2

The instrument used was an observation questionnaire for logical, critical, and creative thinking skills which was compiled based on the indicators of Permendikbud Number 12 of 2024. This instrument was adapted from research by Pitaloka & Sinaga (2023) and has been tested for validity by experts. The reliability value of the instrument was measured using Alpha Cronbach and a value of 0.906 was obtained, which indicates that the instrument is very reliable.

Data collection techniques include observation, documentation, and testing. Observation is expressing direct observations of an object in the surrounding environment, whether it is currently occurring or is still in the development stage [29]. Observation is carried out to observe the cognitive abilities of logical, critical, and creative thinking of children. Documentation is a source of data used to complete research, whether in the form of written sources, films, and monumental works, all of which provide information for the research process [30]. Documentation is used to obtain profile data for TK Al Asyari, while testing is carried out to obtain pretest and posttest data. Data analysis includes: 1) Normality Test, to test whether the data is normally distributed using the Kolmogorov-Smirnov. This test is done by comparing the cumulative distribution of the empirical data distribution with the expected normal distribution. Because it is a difference test, an insignificant p-value ( $p > 0.05$ ) indicates that there is no difference between the two distributions[31]. 2) Homogeneity Test. Testing the equality of variance between groups using the Levene Test. The data is transformed by finding the difference between each score and the group average. Data is homogeneous if  $\text{Sig.} > 0.05$  [32]. Hypothesis Test, if the data is normal and homogeneous, the t-Test (Independent Sample t-Test) is used to compare the experimental and control groups. If not normal, the Mann-Whitney U Test is used. The hypothesis for this case is:  $H_0$ : There is no effect of the STEAM method on the cognitive ability of logical, critical, and creative thinking of children aged 5-6 years;  $H_a$ : There is an effect of the STEAM method on the cognitive ability of logical, critical, and creative thinking of children aged 5-6 years. Decision making based on the level of significance: (a) If the probability/level of significance  $> 0.05$ ; then  $H_0$  is accepted and  $H_a$  is rejected; (b) If the probability/level of significance  $\leq 0.05$ ; then  $H_0$  is rejected and  $H_a$  is accepted [33].

## 3. RESULTS AND DISCUSSION

The following are the research results obtained from the pretest and posttest results of the experimental class and the control class. The pretest and posttest data were processed using SPSS. SPSS is an application program that has quite high statistical analysis capabilities and a data management system in a graphical environment using descriptive menus and simple dialog boxes so that it is easy to understand how to operate

it[34]. In this study, normality and homogeneity tests were carried out. Based on the results of the Kolmogorov-Smirnov normality test, the significance value in the experimental group, the pretest value showed a significant result of 0.058. The posttest significance value of the experimental group showed a significant result of 0.350. In the control group, the pretest value showed a significant result of 0.070 and the posttest value showed a significant result of 0.150. The results of the study showed that the pretest and posttest data in the experimental group and the control group were normally distributed and homogeneous. This is evidenced by the results of the Kolmogorov-Smirnov normality test which showed a significance value of  $>0.05$  for all groups.

After the data is normally distributed, then continued by conducting a homogeneity test. Based on the results of the homogeneity test, the experimental group and the control group obtained a sig value of 0.629, because  $0.629 > 0.05$ , the experimental group and the control group were declared homogeneous. The results of the normality and homogeneity test in this study showed that the data was normally distributed and homogeneous. Therefore, further data analysis used the Independent Sample t-Test.

Based on the results of the t-Test, there was a significant difference in the experimental group using the STEAM method, with a significance value of  $0.001 < 0.05$ . Therefore, it can be decided that  $H_0$  is rejected and  $H_a$  is accepted. This means that the application of the STEAM method has a significant positive effect on the development of logical, critical, and creative thinking skills in children aged 5-6 years. In contrast, the control group using the conventional method did not show a significant difference (sig value  $0.228 > 0.05$ ), so that the decision was made that  $H_0$  was accepted and  $H_a$  was rejected, which means that conventional methods do not have a significant influence on the development of children's thinking abilities in that age range.

The results of this study confirm that the STEAM method is effective in improving the logical, critical, and creative thinking skills of early childhood. STEAM-based learning is an integrated approach that can be applied at every level of education[35]. STEAM in early childhood education, emphasizing the importance of developmentally appropriate STEAM integration to build children's cognitive, social, and creative skills[36]. This finding is in line with previous research which states that STEAM-based learning can significantly improve the creative and logical thinking skills of early childhood compared to conventional learning methods [23] [37]. The STEAM method creates learning situations that encourage questions, discussions, and challenges, thus providing a solid foundation for the development of children's critical thinking skills [38]. STEAM literacy can be an effective tool for fostering curiosity in children. When children are given the opportunity to explore and experiment, they will feel more challenged to find out more about the world around them [39]. The STEAM method which integrates aspects of science, technology, engineering, art, and mathematics provides a more holistic and interesting learning experience, so that children are more motivated to develop high-level thinking skills such as analysis, evaluation, and creativity [40].

Furthermore, children who learn through the STEAM method show better development in understanding concepts, collaborating, and communicating[41][42]. This shows that STEAM not only improves cognitive aspects, but also social and emotional aspects that are important in early childhood development[43]. The active and contextual learning approach in STEAM facilitates children to explore, experiment, and construct knowledge independently, which ultimately strengthens their critical and creative thinking skills [44]. STEAM is also an effective approach to increasing creativity, problem solving, and early childhood learning initiatives. It also highlights the role of teachers in supporting the success of STEAM [45]. The importance of innovation in learning methods in PAUD does not only lie in the techniques used by teachers but the role of educators is also very important in creating a supportive and comfortable learning environment for children [46]. Through STEAM method learning activities, AUD is taught to "process". The processing mentioned here is carried out through observation activities, game activities, pattern recognition activities, creative thinking skills training activities, collaboration skills activities and communication activities with peers to complete tasks given by the teacher [47]. The use of STEAM-based learning also improves the process of scientific knowledge, which provides opportunities for children to be able to search and find out for themselves or carry out investigations in learning activities[48]. The STEAM framework, like steam that can fill any space and change into many forms, is very flexible and can be applied anywhere. When used properly, this framework can be a very effective and fun tool for teaching and learning a variety of topics at all levels of education [49]. Conscious use of the STEAM framework can make the learning process more interesting and efficient at various levels of education.

The generalization of the results of this study can be applied to PAUD institutions with similar characteristics, especially those that still apply conventional methods. The practical implication is that early childhood education institutions are advised to adopt the STEAM method to optimize children's cognitive development. The novelty of this study lies in the implementation of STEAM in the Al Asyari Kindergarten environment which has never been done before, as well as the use of adaptation instruments that have been proven valid and reliable. The limitations of the study include the scope which is limited to one school and the relatively small number of samples. For further research, it is recommended to expand the scope and conduct longitudinal studies to see the long-term impact of STEAM implementation. The main recommendation is the importance of teacher training related to STEAM implementation and the development of PAUD curriculum that emphasizes the development of high-level thinking skills from an early age.

Thus, the results of this study support the importance of implementing the STEAM method in early childhood education as an effective strategy to develop logical, critical, and creative thinking skills. The use of this method can be a better alternative compared to conventional methods that tend to be passive and less stimulating aspects of creativity and problem solving in children.

#### 4. CONCLUSION

Based on the results of data analysis and discussion that have been carried out, it can be concluded that the STEAM method is significantly able to improve the logical, critical, and creative thinking skills of children aged 5-6 years at TK Al Asyari. The application of the STEAM method in the learning process has a greater positive impact compared to the use of conventional methods that have been applied in the school. Through the integration of science, technology, engineering, art and mathematics, children are given the opportunity to explore, experiment, and find solutions to various problems independently. This child-centered and real-experience-based learning process is able to stimulate high-level thinking skills, such as the ability to identify problems, gather information, develop alternative solutions, and generate creative ideas. Compared to the control group using conventional methods, the experimental group receiving STEAM learning showed a more significant increase in logical, critical, and creative thinking skills. This indicates that the STEAM method is more effective in developing the cognitive potential of early childhood. Thus, this study provides empirical evidence that the STEAM method can be a promising alternative in improving the quality of learning at the early childhood education level. It is hoped that these findings can be a reference for educators and policy makers in designing a curriculum that is more innovative and relevant to the needs of child development in the modern era.

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