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The Effect of Science Games on Classification and Critical Thinking Skills in Young Children

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Abstract: This study aims to determine the effect of science games on the classification and critical thinking abilities of early childhood. The type of research used is a quasi-experimental design with a one-group pre-test post-test design. The research subjects included 15 children in group B at one of the schools in Pujut subdistrict, Central Lombok Regency. Data were collected through observation using observation sheets as research instruments, while data analysis was performed using Paired Sample t-test and Repeated Measures Repeated Measures MANOVA tests. The results showed that science games can improve children's classification and critical thinking skills. This was evident from the increase in the average scores between the pre-test and post-test results. Based on the Paired Sample t-test and Repeated Measures MANOVA tests, the significance values obtained were 0.000 for classification skills, 0.001 for critical thinking skills, and 0.000 for both simultaneously. All significance values were < 0.05, so the alternative hypothesis (Ha) was accepted. Thus, it can be concluded that science games have a significant effect on improving the classification and critical thinking in young children.

Keywords: Classification; Critical thinking; Early childhood education; Science games

Introduction

The introduction of science to early childhood should be done through fun activities. Triharsono (2013) states that science for early childhood should encourage children to play and explore their environment, thereby enabling them to gain scientific understanding, skills, and concepts. One of the effects of introducing science games to children is related to classification. Tekerci et al. (2017) adds that one of the basic scientific abilities that 5-year-olds can understand and perform is classification. The concept of classification is important to introduce to children because it can help them understand several things around them. A simple classification activity that young children can do is grouping objects based on their characteristics.

In addition to classification skills in early childhood, critical thinking skills are very important to develop during early childhood. According to Slavin (2023), critical thinking is the ability to make rational decisions about what to do or what to believe. Furthermore, Susanto (2016) writes that critical thinking skills will make children more sensitive to everyday problems and, by applying these skills, children will be able to solve simple problems. Children need these skills as a life skill so that they can process the information they receive and help them grow into individuals full of ideas. The ability to think critically can be taught implicitly through activities designed in accordance with the child's stage of development (Leggett, 2022). This is important because classification and critical thinking skills are needed during the learning process as children develop ideas about the issues covered in their studies. Yunitasari et al. (2023) explain that children experience good growth and development when teachers or educators are able to provide educational stimuli that are appropriate for the child's age level.

There are various efforts that educators can make to develop classification and critical thinking skills in early childhood, including using learning through play activities that motivate children to solve simple problems they encounter, appear confident, and have

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good language skills when communicating the results of their play activities. The results of research conducted by Hotimah et al. (2024) explain that teachers play a role in achieving critical thinking skills in early childhood, including acting as (1) learning planners who plan all activities to stimulate children's problem-solving skills in everyday life, (2) Learning implementers, who provide guidance, supervision, and help children solve problems in various ways, and (3) Learning evaluators, who assess children's abilities and provide follow-up for children who have not yet developed. The varying abilities of children between individuals become a task for teachers in providing stimuli using different methods or strategies so that children can achieve optimal development. Supporting this, the results of research by Rahayu et al. (2024) explain that one of the stimuli or learning that can be provided is through fun play activities, which must still be able to stimulate children's development.

Based on preliminary observations and interviews with homeroom teachers conducted at a public kindergarten in Pujut Subdistrict, data shows that 66.7% students still have low levels of classification and critical thinking skills. This can be seen when children experience difficulties in classification, including difficulty distinguishing between objects that sink and objects that float, assuming that all small objects will float when placed in water, such as children assuming that pebbles will float when placed in water. In addition, children assume that all large objects will sink when placed in water, for example, children assume that a large jar lid will sink when placed in water. Not only do they have difficulties in classification, but children also have limitations in critical thinking skills. This can be seen during question and answer sessions, where only a few children respond to the teacher's questions. In addition, some children are not enthusiastic about speaking or expressing their ideas.

Based on the many benefits of children's classification and critical thinking skills described above, researchers conducted experiments using science play media to stimulate children's classification and critical thinking skills. Research related to providing stimuli to cognitive aspects conducted by Arifah et al. (2024) found that the critical thinking skills of children aged 5-6 years improved positively using the play method. This was evident from the second observation, which showed improved results in critical thinking skills using science play activities. Widyakto (2014) expressed a similar finding, stating that science games are effective in improving children's mathematical logic abilities, based on a comparison of post-test averages that showed an increase.

Previous studies that used science games as treatment were generally limited to several types of games, such as in previous studies conducted by Amaliah et al. (2024), which only used two games, namely floating and sinking games and magnet games. These two types of science games have been proven to improve classification and critical thinking skills in early childhood, but previous studies are still limited in the variety of science games used, so that the stimulation of children's scientific thinking has not touched on a wide range of phenomena. In this study, the researchers introduced a new feature in the form of four types of science games, namely floating and sinking, magnetism, static electricity, and mirrors. These four games were chosen because each presents a different scientific concept that can stimulate various aspects of children's scientific thinking. Thus, this study not only measures children's classification and critical thinking skills but also provides a richer exploratory experience for early childhood. Therefore, this study aims to examine the effect of science play on classification and critical thinking skills in early childhood.

Method

The approach used in this study is a quantitative approach. The type of research used is quasi-experimental design. Sugiyono (2019) explains that quasi-experimental design research is a type of research that has an experimental group that is not selected randomly. The type of research used is a one-group pre-test post-test design. This design begins by administering a pretest to the experimental group, then after the results come out, it is followed by the administration of treatment (science games), after which a posttest is conducted again to see if there is an effect from the treatment. Below is the design of the one-group pre-test post-test design experiment:

Table 1. Skema Desain One Group Pre-test Post-test Design

Group	Pretest	Treatment	Posttest
Eksperiment	O1	X	O2

Description, O1: pretest score before treatment; O2: posttest score after treatment; and X: treatment to be applied to children.

The location of this study was at State Kindergarten 06 Pujut. This research was conducted in the even semester of the 2024/2025 academic year. The population in this study was all 15 students in group B at State Kindergarten 06 Pujut. The sample used in this study was the entire population, commonly referred to as saturating sampling. In this study, the researcher collected data through observation and documentation.

The prerequisite tests used in this study were validity and reliability tests. The validity test used was the product moment test, while the reliability test used was the Cronbach's alpha test. Hypothesis testing in this study used two types of hypothesis tests, namely Paired Sample t-test and Repeated Measures MANOVA (Multivariate Analysis of Variance) testing.

Result and Discussion

Result

Description of Pre-test and Post-test Data on Classification and Critical Thinking Skills

The results of observations on classification and critical thinking skills through the application of science games can be seen in the following table.

Table 2. Pre-test and Post-test Results on the Effect of Science Games on Classification and Critical Thinking Skills in Early Childhood

Indicator	Pretest					Posttest				
	N	Min	Max	Sum	Mean	N	Min	Max	Sum	Mean
Classification	15	17	22	288	19.20	15	20	29	355	23.66
Critical Thinking	15	25	34	433	28.86	15	26	39	468	31.22

Based on Table 2, which describes the classification ability data, the pretest results showed a a total score is 288, and an average score of 19.2. Meanwhile, the posttest results showed a total score is 355, and an average score of 23.66. Furthermore, based on the description of critical thinking ability data, the pretest results obtained a total score of 433, and an average score is 28.86. Meanwhile, the posttest results obtained a total score is 468, and an average score of 31.22.

Based on the results of the pretest and posttest above, it can be concluded that before the treatment was given, the initial scores for classification and critical thinking skills in group B at TKN 06 Pujut were low. After the treatment, which was a science game, there was a significant increase in the classification scores in the experimental group.

Description of Science Game Treatment

The treatment was carried out from July 15 to July 18, 2025. The treatment consisted of four science games, namely sinking and floating games, magnet games, static electricity games, and mirror games. All science game activities are divided into several game categories, namely science games based on one category, science games based on two categories, and science games based on three categories. The treatment using science games is given in the form of two games per day, and the children are divided into two groups.

Description of Floating and Sinking Games

The details of the treatment given to sinking and floating games in each category are as follows:

Floating and Sinking Games Based on One Category

This game encourages children to recognize and categorize objects based on categories such as sinking, floating, large, small, plastic, and non-plastic. Children are also trained to express their opinions, ask questions, and explain the steps of the game in simple terms. Before playing, the teacher gives an introduction, explains the rules, and introduces the tools and objects used, then the children take turns playing. The flow of the sinking and floating object category game is as follows: children put objects in water, observe the results, and then group them in trays according to instructions. For the big and small category, children observe, differentiate, and then group objects in trays. As for the plastic and non-plastic category, children observe the materials of the objects and group them according to instructions. After the game, a discussion session is held with the children to assess their critical thinking skills.

Based on observations in the field, initially some children did not understand which objects sank and their characteristics, which objects floated and their characteristics, and which objects were made of plastic and which were not. However, many children understood the difference between large and small objects.

Floating and Sinking Game Based on Two Categories

This game encourages children to recognize and categorize objects based on two categories, namely large and small sinking objects, large and small floating objects, non-plastic sinking objects, and plastic floating objects. Children are also trained to express their opinions, ask questions, and explain the steps of the game in simple terms. Before playing, children are gathered for an introduction, to discuss the rules, and to familiarize themselves with the tools and objects used. Game flow: children put objects in water, observe the results, then group the objects on a tray according to the predetermined category instructions.

After the game was over, a discussion session was held between the children and the teacher, assisted by the assistant teacher, to assess the children's critical thinking skills. Based on observations in the field, initially many children still confused the classification of large sinking objects, large floating objects, small sinking

objects, and small floating objects. However, many children already understood the classification of non-plastic sinking objects and plastic floating objects.

Floating and Sinking Game Based on Three Categories

This game encourages children to recognize and categorize objects based on three categories: large and small non-plastic objects that sink, and large and small plastic objects that float. Children are trained to actively talk, ask questions, and explain the steps of the game. Before playing, children are gathered for an introduction, to discuss the rules, and to familiarize themselves with the tools used. Game flow: children put objects in water, observe the results, then categorize them according to instructions. After playing, there is a discussion session with the teacher to assess the children's speaking skills.

Based on observations in the field, some children were still confused about classifying objects into many categories, so the teacher spontaneously tried to help them complete the game. However, some children performed well and wanted to repeat the game.

Magnet Game

The magnetic game treatment was conducted on July 15-16, 2025, with a playing time of 45 minutes. The equipment and materials used in this game were U-shaped magnets and bar magnets, marbles, plastic balls, welding wire, small pieces of concrete iron, styrofoam, metal spoons, and plastic spoons. The details of the magnetic game treatment for each category are as follows:

Single Category Magnet Game

This game encourages children to recognize magnets and group objects based on categories: attracted to magnets, not attracted to magnets, large, small, metal, and non-metal. Children are trained to name objects, explain the steps of the game, and ask questions after the activity. Before playing, children are gathered for an introduction and explanation of the rules. Game flow: children bring objects close to the magnet, observe the results, and then group them according to category. For metals and non-metals, children observe that objects attracted to magnets are classified as metals, while those that are not attracted are classified as non-metals. After playing, a question and answer session is held with the teacher to assess children's critical thinking skills.

Magnet Game Based on Two Categories

This game invites children to recognize magnets and group objects based on two categories: size, namely objects that are attracted and not attracted to large or small magnets, and material, namely objects made of metal that are attracted to magnets and objects made of non-metal that are not attracted to magnets. Children are also trained to express their opinions, explain the steps of the game, and ask questions. Before playing, children are gathered for an introduction and explanation of the rules. Game flow: children bring objects close to the magnet, observe the reaction and size, then group them according to category. After finishing, there is a discussion session between children and teachers to assess critical thinking skills.

Magnet Game Based on Three Categories

This game invites children to recognize magnets and group objects based on three categories: large and small magnetic objects made of metal, and large and small non-magnetic objects made of non-metal. Children are also trained to name objects, explain the steps of the game, and ask questions. Before playing, children are given an explanation and rules of the game, then take turns playing while observing whether objects are attracted to magnets, their size, and their material. After the game, a discussion session is held with the teacher to assess the children's critical thinking skills.

Static Electricity Game

This static electricity game treatment was conducted on July 17-18, 2025, with a playing time of 45 minutes. The equipment and materials used in this game were HVS paper, origami paper, tissue, styrofoam, wool thread, and rulers. The details of the static electricity game treatment for each category are as follows:

One Category Static Electricity Game

This game encourages children to recognize static electricity and group objects based on one category: objects that are attracted or not attracted to a ruler, large or small, and light or heavy. Children are also encouraged to actively talk by naming objects, explaining the steps of the game, and asking questions. Before playing, children are given an introduction and rules, then take turns rubbing the ruler on their hair and bringing it close to objects to observe whether the objects are attracted or not. After the game, a question and answer session with the teacher is conducted to assess children's critical thinking skills.

Static Electricity Game Based on Two Categories

This game invites children to recognize static electricity and group objects based on two categories: objects that are attracted or not attracted to large and small rulers, as well as objects made of light materials that are attracted and objects made of heavy materials that are not attracted. Children are encouraged to actively talk by naming objects, explaining the steps of the game, and asking questions after the activity. Before playing, children are given an explanation, apersepsi,

and rules of the game. During the game, children rub the ruler on their hair, bring it close to objects, then observe whether the objects are attracted or not, as well as their size and material. After the game, a question and answer session with the teacher is conducted to assess the children's critical thinking skills.

Static Electricity Game Based on Three Categories

This game invites children to recognize static electricity and group objects based on three categories: attracted or not attracted to the ruler, large or small size, and light or heavy material. Children are encouraged to actively talk by naming objects, explaining the steps of the game, and asking questions after the activity. Before playing, children are given an explanation and rules, then take turns rubbing the ruler on their hair and bringing it close to objects to observe the results. After the game, a question and answer session with the teacher is conducted to assess the children's critical thinking skills.

Mirror game

The details of the mirror game treatment for each category are as follows:

One-category Mirror Game

This game encourages children to recognize light reflections from mirrors and group objects based on one category: whether they reflect light or not, whether they are large or small, and whether they are glossy or dull. Children are encouraged to actively talk by naming objects, explaining the steps of the game, and asking questions. Before playing, children are given an explanation and rules, then take turns shining a flashlight on various objects to observe their reflections. After the game, a question and answer session with the teacher is conducted to assess children's critical thinking skills.

Two-Category Mirror Game

This game invites children to recognize mirrors and group objects based on two categories: objects that reflect light and objects that do not reflect light, as well as objects that are large and small, and objects that are glossy or opaque. Children are encouraged to actively talk by naming objects, explaining the steps of the game, and asking questions after the activity. Before playing, children are given an explanation and rules of the game, then take turns shining a flashlight on objects to observe the reflections and group them. After the game, a question and answer session with the teacher is conducted to assess the children's critical thinking skills.

Mirror Game Based on Three Categories

This game encourages children to recognize light reflections through mirrors and group objects based on three categories: whether they reflect light or not, large or small size, and glossy or matte material. Children are encouraged to actively talk by naming objects, explaining the steps of the game, and asking questions. Before playing, children are given an explanation and rules of the game, then take turns shining flashlights on various objects to observe light reflections and categorize them. After the game, a question and answer session with the teacher is conducted to assess the children's critical thinking skills.

Data Analysis

Validity and Reliability Test

After conducting a validity test using the product moment test, it was found that all items in the classification and critical thinking ability instruments were valid. Furthermore, after conducting a reliability test, it was found that the Cronbach's alpha reliability was 0.792, which means that the science game instrument was reliable. Furthermore, it was found that the Cronbach's alpha reliability was 0.758, which means that the classification ability instrument was reliable. Furthermore, a Cronbach's alpha reliability result of 0.789 was found, which means that the critical thinking ability instrument is reliable.

Normality and homogeneity test

The results of the normality test for classification ability were 0.067 and for critical thinking ability were 0.199, indicating that the data is normally distributed because $p > 0.05$.

The homogeneity test results for classification ability were 0.178 and for critical thinking were 0.278, indicating that the data was homogeneous because the value (sig.) $p > 0.05$.

Hypothesis Testing

Hypothesis 1

Ha: there is an effect of science games on the classification ability of early childhood children.

Ho: there is no effect of science games on the classification ability of early childhood children.

Data analysis to test hypothesis 1 was conducted using a paired sample test with the help of IBM SPSS 27. The decision is made if the sig. p value is > 0.05, then the alternative hypothesis (Ha) is rejected and the null hypothesis (Ho) is accepted, but if the sig. p value is < 0.05, then the null hypothesis (Ho) is rejected and the alternative hypothesis (Ha) is accepted.

Based on the results of the Paired Sample t-test test above, it can be seen that the significance value obtained is 0.000, which means that the sig. value is $p < 0.05$. It can

therefore be concluded that the alternative hypothesis (Ha) is accepted and the null hypothesis (Ho) is rejected.

Table 3. Hypothesis Test 1

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Pre classification-post classification	4.467	1.8	467	5.46	3.4	9.5	4	0

Hypothesis 2

Ha: science games have an effect on critical thinking skills in early childhood.

Ho: science games have no effect on critical thinking skills in early childhood.

Data analysis to test hypothesis 2 was conducted using a paired sample test with the help of IBM SPSS 27. The decision is made if the sig. p value is > 0.05, then the alternative hypothesis (Ha) is rejected and the null hypothesis (Ho) is accepted, but if the sig. p value is < 0.05, then the null hypothesis (Ho) is rejected and the alternative hypothesis (Ha) is accepted.

Table 4. Hypothesis Test 2

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	pre_B- post_BK	-2.267	2.05	0.53	-3.4	-1.13	-4.27	4	0.001

Based on the results of a Paired Sample t-test test, it can be seen that the significance value obtained is 0.001, which means that the sig. p value is < 0.05. It can therefore be concluded that the alternative hypothesis (Ha) is accepted and the null hypothesis (Ho) is rejected.

Hypothesis 3

Ha: there is an effect of science games on critical thinking classification skills in early childhood

Ho: there is no effect of science games on critical thinking classification skills in early childhood.

Data analysis to test hypothesis 3 was conducted using the Repeated Measures MANOVA test with the help of IBM SPSS 27. The decision is made if the sig. p value is > 0.05, then the alternative hypothesis (Ha) is rejected and the null hypothesis (Ho) is accepted, but if the sig. p value is < 0.05, then the null hypothesis (Ho) is rejected and the alternative hypothesis (Ha) is accepted.

Table 5. Hypothesis Test 3

Effect		Value	F	Hypothesis df	Error df	Sig.
Pretest-Posttest	Pillai's Trace	0.981	2.052E2[a]	3	12	0
	Wilks' Lambda	0.019	2.052E2[a]	3	12	0
	Hotelling's Trace	51.295	2.052E2[a]	3	12	0
	Roy's Largest Root	51.295	2.052E2[a]	3	12	0

Based on the results of the Repeated Measures MANOVA test, it can be seen that the significance value obtained is 0.036, which means that the sig. value is p < 0.05. It can therefore be concluded that the alternative hypothesis (Ha) is accepted and the null hypothesis (Ho) is rejected.

Discussion

Science games can be introduced to children, including young children. Science for children is different from science in general; science for children starts with very simple things. Widnyani et al. (2023) argue that simple science for early childhood involves activities such as observing, classifying, drawing conclusions, communicating, and applying based on the scientific experiences they have gained. Science makes children accustomed to following the stages of experimentation and not hiding failure. This means that science can train children's positive mental attitude and also train them to be careful. It is important to introduce science games to children from an early age, as stated by Kanak et al. (2018), who emphasized the importance of science activities in early childhood education, namely that science games provide memorable experiences from the learning process. In addition, Amaliah et al. (2024) stated that science games influence the development of children's abilities. Specifically, science games can stimulate children's classification and critical thinking

skills. This is supported by the statement from Lylod et al. (2017) that daily science activities can improve children's critical thinking skills, curiosity, and self-confidence. Therefore, introducing science games from an early age is important because of the many benefits they offer children.

After conducting observations at TKN 06 Pujut, the researcher found that children's classification and critical thinking skills were still relatively low. This was seen when some children were still quiet, unable to express their opinions, less vocal in asking questions, and unable to distinguish the colors, textures, sizes, and shapes of objects. Arfah (2025) explains that classification skills are important cognitive skills in child development because they enable children to understand the world around them and organize their experiences better. The classification process plays an important role in building concepts, problem solving, and decision making, which are key components of cognitive development. Not only classification skills, but critical thinking skills are also equally important for children (Doyan et al., 2022). Sapia et al. (2025) states that critical thinking is one of the most important things for the future of modern children. Children do not have to mention facts or information, but they must be able to think at a higher level, such as gathering information, analyzing, and thinking about what they see. Based on this explanation, the researchers conducted an experimental study using science games to improve classification and critical thinking skills in early childhood.

The researchers began this study by conducting a pretest on children in group B at TKN 06 Pujut. The pretest results showed that the average score obtained for the classification skills of children in group B at TKN 06 Pujut was 20.86 for classification skills and 29.93 for critical thinking skills. After conducting the pretest, the treatment using science games was administered. The science game treatment was given for 4 days with 2 games given per day. When the games were played, the children were divided into two groups. Group 1 played game 1 (e.g., floating and sinking), while group 2 played game 2 (e.g., magnet game), and so on until the fourth day. On the first and second days, the games played were floating and sinking and the magnet game. Mufiana et al. (2024) explained that the concepts of floating and sinking are relevant and easy for children to understand through direct experimentation. By involving children in activities such as observing objects that float or sink in water, as well as making creative projects using natural materials, they can connect theory with practice. Through magnet play activities, children learn about basic science concepts (attraction and repulsion), patterns, and problem solving. In addition, magnet games also help train hand-eye coordination, increase creativity, and develop exploration skills and curiosity. Playing with magnets also provides opportunities for children to interact with their peers, thereby training communication skills, cooperation, and role sharing. In other words, magnet games are not only entertainment, but also an interactive learning medium that supports children's holistic growth and development.

Next, the games for the third and fourth days are simple static electricity games. Deaton (2017) states that simple static electricity games, such as rubbing a balloon on hair or tissue, have been proven effective in developing scientific curiosity in early childhood. This activity.

Conclusion

Based on the results of the study, it can be concluded that science games can improve classification and critical thinking skills for children in group B at TK 06 Pujut, as seen from the increase in scores and averages in the pre-test and post-test that were conducted. Based on the tests conducted using Paired Sample t-test and Repeated Measures MANOVA tests, it can be seen that science games have an effect on the classification and critical thinking skills of early childhood. A decision is made if the sig. (2-tailed) value is < 0.05, then Ha is accepted, and if the sig. (2-tailed) value is > 0.05, then Ho is accepted. The calculation results for hypothesis 1 show that the sig. value (2-tailed) is 0.016, which means < 0.05 and it can be said that Ha is accepted, which means that there is an effect of science games on the classification abilities of early childhood. Then, for the second hypothesis, the sig. (2-tailed) value is 0.002, which means < 0.05 and it can be said that Ha is accepted, which means that there is an effect of science games on critical thinking skills in early childhood. Finally, for the third hypothesis, the sig. value (2-tailed) was 0.042, which is < 0.05, and it can be said that Ha is accepted, meaning that there is an effect of science games on classification and critical thinking skills in early childhood.

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Author Contributions

Conceptualization, methodology, validation, investigation, observation, analysis, and resources, B.W.P.; data curation, writing original draft preparation, writing review and editing, visualization, G., F.; All authors have agreed to published the version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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