ThufuLA: Jurnal Inovasi Pendidikan Guru Raudhatul Athfal
Volume 13 issue 2, 2025
http://dx.doi.org/10.21043/thufula.v13i2.34151
https://journal.iainkudus.ac.id/index.php/thufula
p-ISSN 2355-0163 | e-ISSN 2502-3845

STIMULATING SCIENCE PROCESS SKILLS through THE 'PUFFER FISH' GAME FOR CHILDREN AGED 5–6 YEARS

Anissa Choirum Maulida[1]✉, Rista Sundari[2]
[1]UIN Walisongo Semarang, Semarang, Indonesia
[2]UIN Walisongo Semarang, Semarang, Indonesia
✉*Correspondence: 2103106070@student.walisongo.ac.id*

Abstract: *This study aims to describe how the "puffer fish" game stimulates science skills in children aged 5–6 years through a simple experimental activity. The research was conducted with 12 kindergarten children in Group B at TK Dharma Wanita Ngabean using a descriptive qualitative approach. The activity involved a chemical reaction between vinegar and baking soda that produces gas, causing a balloon to inflate like a puffer fish. Data were collected through observation, interviews, and documentation, and were analyzed through data reduction, data display, and conclusion drawing. The findings show that this activity effectively enhances children's science process skills, as demonstrated by their ability to observe changes in the balloon, ask questions about the reaction, independently mix the materials, and draw simple conclusions about why the balloon inflates. Some technical challenges—such as children's difficulty pouring baking soda — were manageable with teacher guidance. Overall, the "puffer fish" game provides an enjoyable and meaningful learning experience and is appropriate for the early childhood developmental stage, making it a suitable alternative to science activities in the classroom.*

Keywords: *Child, Experiment, Games, Science*

A. Introduction

Childhood is a crucial period in a person's life because, at this stage, children possess great potential to grow and develop holistically across physical, motor, social, cognitive, and emotional domains. UNICEF (2020) emphasizes that early childhood development occurs most optimally when children are in environments rich in stimulation, positive interactions, and responsive caregiving. Therefore, early childhood education needs to be designed to align with children's developmental stages, fostering scientific thinking and problem-solving skills from an early age.

One effective approach to supporting children's development is through play-based activities. Play not only provides enjoyment but also serves as a meaningful learning medium. Through play, children can develop social, emotional, motor, and cognitive skills. Piaget emphasizes that play helps children construct cognitive schemas based on real experiences. This idea is reinforced by Mauluddia and Solehuddin (2023), who state in their literature review that learning through play enables children to build understanding gradually through active interaction and cognitive reflection, rather than merely following direct instruction. Early stimulation provided through play also offers opportunities for children to explore their environment, solve problems, and develop imagination.

Stimulation is defined as a series of activities aimed at stimulating the basic abilities of children aged 0–6 years so they can grow and develop optimally (Ministry of Health of the Republic of Indonesia, 2016). Montessori, as cited in Syabily (2024), emphasizes the importance of using concrete learning materials that align with children's developmental stages to support experiential learning. This view is consistent with Vygotsky, as cited in Hikmah, Syaripudin, and Jannah (2021), who assert that social interaction under adult guidance, particularly within the zone of proximal development, is a crucial factor in promoting children's cognitive development. Therefore, teacher guidance in simple experimental play activities is essential to help children understand scientific concepts.

Early childhood science abilities include process skills such as observing, classifying, measuring, predicting, and communicating. These skills need to be introduced from an early age so that children become accustomed to thinking logically and systematically (Azizah, 2021). Strengthening these abilities aligns with the principles of

the *Merdeka Curriculum*, which encourages the application of the STEAM approach in ECE, where children learn through exploration and problem-solving within integrated, multidisciplinary play activities. Thus, the development of science skills becomes part of the effort to fulfill the holistic and contextual learning orientation promoted by the Merdeka Curriculum. The Montessori approach likewise emphasizes the importance of exploration through concrete materials, as classrooms are prepared with Montessori tools designed to allow children to interact directly with the physical environment and construct understanding through their senses (Tsurayya & Zahrah, 2024). Several previous studies show that simple experiments can stimulate children's thinking abilities. Fitriyani (2020) found that experiments using household materials such as vinegar and baking soda encouraged children to think critically and understand cause-and-effect relationships. Lestari and Suryana (2018) demonstrated that developmentally appropriate play activities can enhance problem-solving skills. Another study by Yuliana (2019) showed that simple experiments can improve science process skills, particularly observing and communicating results.

However, there remains a gap in the implementation of simple experiments in early childhood education settings. Experimental activities are often not fully child-centered and are not yet integrated with clearly defined science learning objectives. This is consistent with Destiyanti's (2024) findings, which indicate that many experimental activities in early childhood institutions still rely on demonstration-based practices, resulting in limited opportunities for children to explore and engage in scientific processes independently. This condition highlights the need for more participatory, enjoyable, and developmentally appropriate learning strategies for young children.

Based on the above description, this study focuses on the process and impact of the "puffer fish" game in stimulating children aged 5–6 years' science skills. This activity utilizes a reaction between vinegar and baking soda that produces gas, causing the balloon to inflate like a puffer fish. The activity provides children with direct learning experiences that allow them to observe, try, predict, and engage in scientific discussions.

This research was conducted at TK Dharma Wanita Ngabean

because the institution consistently implements exploration-based learning, but has not extensively developed simple science experiments to stimulate science skills. Academically, this institution was selected because it has class characteristics that align with the study's focus: a group of children aged 5–6 years who are actively engaged in project-based play activities. In addition, the teachers at the institution have expressed a need to enrich innovative and contextual science learning strategies, making it a relevant and appropriate research site.

The purpose of this study is to examine the learning process and the impact of the "puffer fish" game in stimulating the science skills of children aged 5–6 years. This research is expected to provide theoretical benefits by strengthening the body of knowledge on experiment-based learning in early childhood education, and practical benefits by offering an innovative, contextual, and meaningful alternative science-learning strategy for both teachers and children.

B. Method

According to Sugiyono (2010), a descriptive qualitative approach is used to investigate objects in their natural settings with the researcher serving as the primary instrument. This approach enables the researcher to understand the processes and interactions that occur during science learning through simple experiments, in line with Creswell's (2018) view that qualitative research focuses on interpreting participants' experiences. This study was conducted at TK Dharma Wanita Ngabean, Boja District, Kendal Regency, during the even semester of the 2024/2025 academic year, involving 18 children in Group B aged 5–6 years who were selected using purposive sampling. This age range was chosen because children at this stage are optimally positioned for scientific exploration and the development of science process skills (Papalia & Martorell, 2021). The classroom teacher was also involved as an additional informant to enhance data depth.

Data were collected through observation, interviews, and documentation. Non-structured participatory observation was used to record children's engagement during the experiment, in line with Merriam and Tisdell's (2016) view that flexible observation helps capture the natural behavior of learners. Interviews with

the classroom teacher were conducted to obtain more detailed information about the children's science skill development. In contrast, documentation in the form of photos and children's work served as supplementary data to strengthen the findings.

Data analysis was carried out in three stages, namely data reduction, data display, and conclusion drawing according to Miles, Huberman, and Saldaña (2014). In the data reduction stage, the researcher selected and sorted data from observations, interviews, and documentation, retaining only the most relevant parts to the study's focus. In the data display stage, the researcher organized the selected data into narratives, tables, or summaries to make the information easier to read and understand. In the conclusion-drawing stage, the researcher looked for patterns in the data, checked their accuracy by comparing information from different sources, and then concluded how the 'puffer fish' experiment influenced the children's science skills.

C. Result and Discussion

In implementing the experiment, the success of the activity greatly depended on the teacher's active involvement in providing explanations and directly demonstrating each step. This enabled the children to follow the activity enthusiastically while also understanding the intended learning goals. The experiment conducted was the "puffer fish" activity, a simple procedure in which baking soda is placed inside a balloon, and vinegar is poured into a plastic bottle. The two materials are combined to produce a chemical reaction. The reaction releases carbon dioxide gas, causing the balloon to inflate and resemble a puffer fish. Through this experiment, the children were guided to observe each change that occurred, ask questions about the phenomena they observed, try to perform the steps with assistance, and conclude from their observations. The teacher's role was crucial in ensuring that each stage was carried out properly, thereby enabling the children to gain a more meaningful learning experience.

The "puffer fish" activity, as a simple experiment, is designed to stimulate children aged 5–6 years' science skills, particularly in observing, questioning, and trying. This activity directly introduces children to basic scientific thinking, starting from making observations, exploring the causes of events, experimenting, and

drawing conclusions from what they observe. Such stimulation is essential because, at an early age, scientific understanding must be built through real, enjoyable, and easily comprehensible experiences. Children learn that every event has a cause, for example, a balloon inflates because gas is produced from the reaction between vinegar and baking soda. Thus, this activity is not only recreational but also provides opportunities for children to develop curiosity, foster creative thinking, and understand simple cause-and-effect relationships.

However, during the process, the children often showed signs of confusion because, at that age, they still had limitations in listening to explanations, remembering step sequences, and coordinating actions during practice. Intensive teacher guidance remained necessary to ensure the activity ran smoothly. The children's high enthusiasm when the teacher explained often created a less orderly atmosphere because they tended to respond more to things that sparked their curiosity than to listening to the explanation in full. This condition was natural in early childhood, when their attention span was easily distracted, and their curiosity tended to arise spontaneously.

Through these stages, the "puffer fish" experiment demonstrated that the children began to show basic process skills across various aspects. While observing, the children paid close attention as the balloon inflated and could describe the changes in its shape. In the questioning aspect, they asked questions about the functions of the tools used and why the balloon could expand. In the experimentation aspect, the children enthusiastically followed the steps, although some still required teacher guidance at specific points. In conclusion, some children were able to express their observations in simple terms, such as saying, "because when mixed, it gets bigger," which indicates an initial understanding of the reaction. Meanwhile, in the collaboration aspect, the children appeared to work well together, helping one another when pouring the materials or holding the balloon, demonstrating their ability to interact and cooperate in a group setting.

1. **The Process of the "Puffer Fish" Experiment in Stimulating Science Skills in Children Aged 5–6 Years**

The implementation of the "puffer fish" activity was carried out under the theme *"Simple Science"* with the subtheme *"The Puffer*

Fish Experiment." This subtheme was selected because it aligns with the activity's characteristics: a reaction between vinegar and baking soda that produces changes directly observable by the children. This activity is also relevant to early childhood learning outcomes within the element *"Critical Reasoning – Introducing Early Science,"* which emphasizes children's abilities to observe, ask questions, experiment, and explain simple phenomena.

The learning objective of this activity is: *"Children are able to observe the changes that occur when two materials are combined and express their observations using simple language."* This objective aligns with the development of science process skills, particularly observing, predicting, and communicating.

The learning objective flow in the teaching module includes four main steps: introducing the tools and materials for the experiment, practicing simple steps of mixing the materials, observing the changes that occur after the materials are combined, and verbally describing the results of their observations. These four steps directly develop children's science process skills, including the ability to observe by paying attention to the shape, colour, texture, and changes in the balloon; classify by distinguishing solid materials such as baking soda from liquid materials like vinegar; measure by using a spoon to quantify the materials; predict the changes that will occur before the materials are combined; and communicate the results of the experiment through simple discussions. Thus, the learning objective flow supports the gradual development of science skills and aligns with the characteristics of exploratory learning in early childhood. Consequently, both the learning objectives and the progression of learning objectives in the teaching module are consistent with early childhood science process skills and support exploratory learning in accordance with the principles of the Merdeka curriculum.

During the experiment, several structured stages were conducted to ensure the children could follow the process. In the initial stage, the teacher explained the tools and materials that would be used. At this stage, the teacher displayed the balloon, small plastic cup, vinegar, baking soda, plastic spoon, and funnel in front of the children. The explanation was delivered both verbally and visually, with the teacher not only naming the materials but also explaining their functions. For example, the teacher explained that

the balloon was used as the primary container that would expand, the baking soda was the white powder that would react, and the vinegar was the liquid that played a role in the mixing process. This stage aimed to build the children's initial understanding of the relationship among the tools, materials, and the process to be carried out.

In the next stage, the teacher prepared a clean transparent plastic bag, then poured in an appropriate amount of vinegar, usually 2–3 tablespoons. After that, the plastic was tightly sealed to prevent the liquid from spilling. This step was essential to keep the vinegar separate from the baking soda before mixing. In this way, the chemical reaction did not occur prematurely but only when instructed during the experiment. This process also showed the children that in science, specific procedures had to be followed to achieve the desired results.

Next, a friend helped insert the plastic bag containing the vinegar into the balloon to make the process easier. This step was carried out in pairs to help the children handle the materials more easily and reduce the risk of spills. The activity not only developed children's fine motor skills but also fostered cooperation, mutual assistance, and communication among peers. In addition, this activity helped strengthen children's social–emotional skills. As shown in the following image:

Figure 1. Putting vinegar into the ballon

Next, the baking soda is added to the balloon. The teacher prepares the deflated balloon that already contains the vinegar, then uses a funnel to insert the baking soda with a spoon. The amount used is usually about ½ to 1 teaspoon. The use of a funnel is intended to ensure the powder enters neatly without spilling, while also teaching children the importance of using tools in scientific activities. At this stage, the children are allowed to try pouring the baking soda themselves with guidance, enabling them to develop fine motor coordination and understand the

concept of measuring materials. As shown in the following image:

Figure 2. Putting baking soda into the ballon using a spoon and a funnel

After combining the two materials by placing the vinegar-filled plastic pouch inside the balloon and adding the baking soda, the teacher ensures that the plastic is entirely inside the balloon without leaking, then ties the mouth of the balloon tightly. This step is essential because if the knot is not secure, the gas produced from the reaction cannot be contained, and the balloon will fail to inflate. The children are also encouraged to observe why the balloon needs to be tied, helping them understand the importance of accuracy and carefulness when experimenting.

The reaction is triggered by hitting or pressing the balloon containing vinegar and baking soda until the plastic pouch bursts. When the pouch breaks, the vinegar flows out and mixes with the baking soda inside the balloon. The teacher instructs the children to take turns performing this step to experience direct involvement in the experiment. This stage provides children with a concrete understanding that in science, specific actions can trigger changes, and those changes can be observed directly.

Observing the results of the experiment occurs when the balloon slowly inflates, resembling a pufferfish. This process occurs through a chemical reaction between vinegar (an acid) and baking soda (a base), producing carbon dioxide gas (CO_2). The gas becomes trapped inside the balloon, causing its volume to increase. At this stage, the teacher not only asks the children to observe the changes in the balloon but also guides them to express their observations in the form of simple questions and conclusions. For example, some children conclude that “the balloon gets big because it was mixed,” indicating an initial understanding of the chemical reaction. The teacher also emphasizes the importance of cooperation, as the children help one another during the process by pouring, holding, and tying the balloon.

The following is the step-by-step process in which the teacher guides each stage of the activity through clear instructions and concrete demonstrations. The children are actively involved in preparing the materials, observing the changes that occur, and discussing the results obtained. With the teacher's guidance, the children can more easily understand the purpose of each stage. At the same time, their active participation allows them to learn through direct experience and develop critical thinking, motor, and social skills simultaneously.

In addition to supporting cognitive, social–emotional, and motor development, each stage of the "Puffer Fish" experiment also contributes significantly to the formation of science process skills in early childhood. Science skills are the foundation of scientific thinking, encompassing the abilities to observe, classify, measure, predict, and communicate findings (Anita, 2011). In the initial stage, when the teacher introduces the tools and materials, children are stimulated to carefully observe the shape, color, texture, and function of each object. This simple activity is important because it teaches children to use their senses purposefully and recognize differences between objects. Furthermore, when children begin to distinguish between liquid vinegar and powdered baking soda, they practice the skill of classification—grouping objects by specific characteristics. This process helps children understand basic scientific concepts, such as the difference between liquids and solids, and the roles each plays in chemical reactions.

At the stage when the materials are poured into the balloon, children learn to measure liquid and powder using a spoon, which not only trains quantitative skills but also introduces the concepts of volume and quantity. This activity aligns with Suyanto's (2017) view that early measurement skills can foster an initial understanding of mathematical concepts closely related to science. When children begin to predict what will happen when vinegar and baking soda meet, they are developing the ability to anticipate, that is, making guesses based on prior knowledge and previous experiences. Predictions such as "the balloon will get bigger" or "there will be bubbles" indicate the emergence of scientific thinking patterns. Finally, when the balloon inflates and resembles a puffer fish, the teacher encourages children to verbally express their observations, for example, through group

discussions or answering questions. This activity fosters the skill of communicating results, which involves conveying scientific information in simple terms, taking into account their language abilities. Thus, this activity not only provides an enjoyable experimental experience but also serves as a comprehensive medium for science learning through the practical application of the five basic science process skills.

The following are photos documenting each stage of the activity in the 'Puffer Fish' experimental game, starting from the preparation of materials to the final result of the experiment:

Figure 3. Preparation of materials

Figure 4. Putting baking soda

Figure 5. Tying the balloon

Figure 6. Hitting the balloon

Figure 7. Showing a photo of the balloon that has inflated to resemble a puffer fish

The implementation of the 'Puffer Fish' experiment requires the application of several principles to ensure that the activity runs effectively and successfully. The teacher must ensure children's safety by using safe materials and maintaining a controlled learning environment. In addition, clearly demonstrating each step is essential to help children understand the experimental procedures. Active involvement, such as holding the tools, mixing the materials, and observing changes, is key to the success of the learning process. The teacher also needs to guide the children's observations of the changes that occur, maintain the correct

sequence of procedures so that the chemical reaction works optimally, and manage time effectively since the reaction happens quickly. After the experiment is completed, brief communication and reflection are necessary so that the children can express the results of their observations. By applying these principles, the experimental activity can run safely and meaningfully, supporting the development of early childhood science process skills.

Several supporting factors influence the success of the "Puffer Fish" experiment. First, the readiness of complete tools and materials in appropriate measurements is essential to ensure the reaction runs optimally. Second, the teacher's role as a facilitator is crucial, especially in providing clear instructions, direct demonstrations, and guidance as children carry out each step. Third, a safe and conducive learning environment—including sufficient space, stable tables, and adequate supervision—also plays an important part. Fourth, the children's enthusiasm and active participation contribute significantly, as hands-on involvement supports both the smoothness of the process and the understanding of the concept. Fifth, cooperation among the children, particularly when inserting materials into the balloon or holding the tools, helps minimize technical errors such as spills or leaks. Additionally, effective time management is important because the chemical reaction occurs quickly and requires immediate readiness. With these factors in place, the experiment can run smoothly and provide meaningful learning experiences for the children.

On the other hand, several inhibiting factors were also identified, such as children's lack of concentration when listening to instructions, inaccurate measurement of materials that prevented the balloon from inflating optimally, and limitations in children's fine motor skills when pouring or inserting materials into the balloon. In addition, the risk of a leaking plastic container or a balloon that is not tightly tied may also hinder the chemical reaction. An unconducive learning environment, such as a narrow space or children crowding too closely, can further disrupt the activity.

To overcome these obstacles, teachers can provide clearer demonstrations that capture children's attention and offer closer assistance during the material-measuring process. Using

supporting tools, such as larger funnels, can also help children pour the materials more easily. Rechecking the tools—especially the plastic and balloons—should be done before the experiment begins to ensure they are not leaking. In addition, arranging the seating and dividing the children into small groups can create a more conducive learning environment, allowing the experiment to run more smoothly and successfully.

2. **The Impact of the "Puffer Fish" Experiment Process on Stimulating Science Skills in Children Aged 5–6 Years**

The teacher assessed children aged 5–6's science skills using an authentic assessment approach during the "Puffer Fish" experiment. The assessment was conducted through structured observation using a checklist to evaluate the children's abilities to observe, classify, measure, predict, and communicate the results of the experiment. The teacher recorded spontaneous scientific behaviors, such as the children's interest in the balloon's changes, their questions about the causes of differing results, or their ability to explain the steps of the experiment. In addition, the teacher used anecdotal notes to document individual development and conducted oral assessments through reflective questioning after the experiment. This authentic assessment is relevant because it provides a realistic picture of how children apply their knowledge and skills in real-life contexts.

The achievement of these science skills is directly correlated with the development of Higher Order Thinking Skills (HOTS) in children. When children observe an expanding balloon and compare results across groups, they demonstrate early analytical abilities. Asking questions about why one balloon inflates larger or smaller represents a simple form of evaluation of the ongoing process. In addition, when children attempt to find solutions—such as adjusting the funnel position or adding more baking soda—they engage in problem-solving, which is one indicator of HOTS in early childhood. Thus, this experiment not only facilitates basic scientific thinking skills but also encourages the emergence of higher-level thinking patterns through direct interaction with the observed phenomena.

The learning process that emerged during the "Puffer Fish" experiment is also in line with the principles of deep learning in the *Merdeka Curriculum*. Deep learning emphasizes meaningful,

contextual knowledge, encouraging children to understand concepts deeply rather than merely following instructions. In this activity, the children not only mixed vinegar and baking soda but also understood the cause-and-effect relationship of their actions. They connected prior experiences—such as seeing objects expand or react—with the new phenomena they observed in the experiment. The teacher acted as a facilitator by posing guiding questions that encouraged children to reflect, such as "Why did the balloon get bigger?" or "What happens if we add more powder?" This process shapes continuous, meaningful learning, in which children construct new knowledge from concrete experiences and the social interactions that occur throughout the activity.

The results of implementing the simple "Puffer Fish" experiment also revealed several significant positive impacts on the development of science skills in children aged 5–6. One of the most noticeably developed abilities was observation skills. Throughout the activity, the children showed full attention to the changes occurring, such as when the balloon began to inflate due to the reaction between vinegar and baking soda. They were not merely passive observers; instead, they actively compared their group's experiment results with those of other groups. Some children even pointed to another group's balloon, which inflated more quickly, and then discussed why the results differed. This comparing activity represents an early form of analytical thinking, in which children begin to develop basic cognitive abilities through directed observation, distinguishing details, and identifying differences in experimental outcomes.

The ability to ask questions (curiosity) also developed rapidly through this activity. Spontaneous questions such as "Why isn't our balloon big yet?" or "Why is theirs bigger?" indicate that the children were actively exploring their surroundings. This questioning activity is a form of early scientific thinking because, through questions, children learn to identify the cause-and-effect of an event. In the context of early childhood science learning, the ability to ask questions not only reflects curiosity but also supports language development through the use of new vocabulary and strengthens critical thinking skills as children seek logical explanations for phenomena they observe. The teacher plays an important role at this stage by providing responses that

encourage children to think more deeply.

In addition to observation and questioning, the "Puffer Fish" experiment was also highly effective in developing the skill of trying or experimenting. The children were directly involved in every stage of the activity, from pouring baking soda to holding the funnel to pressing the balloon. This activity provided concrete learning experiences, in line with Montessori principles that emphasize hands-on learning. The children learned that to achieve a particular result, they needed to carry out specific steps in sequence. This process not only introduced basic scientific concepts such as chemical reactions and gas formation, but also strengthened problem-solving skills, as the children had to figure out how to make the experiment succeed.

The next stage observed in this activity was the ability to conclude. After the experiment was completed, the children began to express their thoughts about the results, such as "Ours is big because we pressed it together" or "Because when they're mixed, it makes gas." These statements indicate the emergence of cause-and-effect understanding and early deductive thinking. Although still simple, the process of concluding is important because it helps children organize their empirical experiences into more structured knowledge.

In addition to cognitive aspects, this experiment also played an important role in developing children's social–emotional skills, particularly through cooperative activities. At each stage of the experiment, the children helped one another and shared roles, such as holding the funnel, pouring the materials, or keeping the balloon from falling. This collaboration taught them how to interact positively, negotiate, and appreciate others' opinions. These abilities form an important foundation for children's future social development. Moreover, working in groups also strengthened their communication skills, as they had to express ideas and listen to their peers' instructions.

The "Puffer Fish" experiment also provided benefits for fine motor development. Activities such as scooping baking soda with a small spoon, pressing the balloon, or tying the balloon required intensive hand–eye coordination. These fine motor skills are important for preparing children for future academic activities, such as writing or using writing tools correctly. When children encoun-

tered difficulties, their group members often offered assistance, which indirectly fostered empathy and other social skills.

From a self-regulation perspective, this activity taught children patience and concentration. Because the activity was carried out in turns, the children had to wait for their turn to participate. This waiting process trained their ability to control impulses and follow simple social rules. Children who initially tended to be impatient showed improvement after receiving guidance from the teacher and support from their peers.

Furthermore, this experiment fostered important scientific attitudes, such as accepting failure, thinking reflectively, and seeking solutions. Some groups experienced failure because the amount of baking soda was inaccurate or the balloon was not tied tightly. However, the children did not feel discouraged; they remained interested in observing other groups' results, discussing the causes of their failure, and trying to correct their mistakes. This attitude forms an important foundation for scientific character in the future, as children learn that failure is a natural part of the learning process.

Finally, the entire experimental process fostered children's enthusiasm and motivation toward science. The classroom atmosphere became lively as the balloons began to inflate; the children cheered, laughed, and compared their experiment results. These positive emotions play an important role in developing long-term interest in learning, as science learning is experienced as fun, relevant, and meaningful. Thus, the "Puffer Fish" experiment activity is not only a medium for practicing basic science skills such as observing, questioning, experimenting, concluding, and cooperating, but also contributes to shaping scientific character, enhancing social and motor skills, and building the foundation for critical thinking and children's confidence in facing future learning challenges.

The overall results of this study are consistent with the findings of Fitriyani (2020), Yuliana (2019), Lestari and Suryana (2018), Mauluddia and Solehuddin (2023), and Anita (2011), who all emphasize the effectiveness of simple experiments and play-based activities in stimulating early childhood cognitive and scientific abilities. The uniqueness of this study lies in the systematic implementation of the "Puffer Fish" experiment in an early childhood

classroom, which not only enhances cognitive development but also supports children's social, motor, and scientific attitudes. The limitations of this study include children's dependence on teacher guidance and the small number of participants, which limits the results' generalizability. Nevertheless, the findings indicate that through teacher facilitation and active child participation in each stage of the experiment, this activity successfully provides meaningful learning experiences and simultaneously promotes the development of children's critical thinking, motor, and social skills.

D. Conclusion

The implementation of the "Puffer Fish" experiment demonstrates that simple science activities using safe materials such as vinegar and baking soda can be effectively applied in early childhood classrooms. Children gain concrete experiences of cause-and-effect relationships through the balloon-inflation process, which results from a chemical reaction, with teachers serving as facilitators who provide guidance, demonstrations, and support throughout the activity.

This experiment successfully stimulates science process skills in children aged 5–6, including observing, comparing, questioning, experimenting, and drawing conclusions, while also strengthening social skills, fine motor abilities, and scientific attitudes. The findings align with the principles of HOTS and deep learning within the Merdeka Curriculum. The main limitations of this study involve the small number of participants and the children's reliance on teacher guidance; however, overall, the activity proved enjoyable and effective in supporting early childhood scientific development.

Future research is recommended to involve a more diverse group of participants, use more detailed observational instruments, such as video recordings, and extend the observation period to obtain a more comprehensive picture of children's science skill development. Subsequent studies may also compare various types of simple experiments, explore the perspectives of teachers and parents, and examine more deeply the relationship between science process skills, HOTS, and deep learning practices within the Merdeka Curriculum.

References

Anita, C.D, (2011). Meningkatkan Kemampuan Sains Anak Usia Dini Melalui Pembelajaran Berbasis Keterampilan Proses. *Malih Peddas: Majalah Ilmiah Pendidikan Dasar*, 1(2), 1-9. https://doi.org/10.26877/malihpeddas.v1i2.301

Azizah, E. N. (2021). Keterampilan Proses Sains Dasar Anak Usia Dini. *Widyawacana: Jurnal Ilmiah Pendidikan*, 8(1), 1-10.

Creswell, J. W. (2018). *Research Design: Qualitative,*

Quantitative and Mixed Methods Approaches (5th ed.). SAGE Publications.

Destiyanti, I. C. (2024). *Desain instruksional eksperimen sains*

sederhana pada anak usia dini. Jurnal Pelita PAUD, **8**(2),412–419. https://doi.org/10.33222/pelitapaud.v8i2.3793

Fitriyani, R. (2020). Penerapan Permainan Sains Sederhana untuk Meningkatkan Kemampuan Kognitif Anak Usia Dini di TK Aisyiyah Bustanul Athfal. *Jurnal Pendidikan Anak Usia Dini,* 7(1), 45-52.

Hikmah, N., Syaripudin, A., & Jannah, M. (2021). Konsep

Perkembangan Sosial Emosional Anak Usia Dini di RA. Raudhah : *Jurnal Pendidikan Islam Anak Usia Dini,* 3(1), 44-52. https://doi.org/10.15642/raudhah.v3i1.1408

Kementerian Kesehatan Republik Indonesia. (2016). *Pedoman*

Stimulasi, Deteksi, dan Intervensi Dini Tumbuh Kembang Anak di Tingkat Pelayanan dasar. Direktorat Jenderal Bina Gizi dan Kesehatan Ibu dan Anak.

Lestari, N. & Suryana, D. (2018). Peran Kegiatan Bermain dalam Menstimulasi Perkembangan Kognitif Anak Usia Dini. *Jurnal Obsesi : Jurnal Pendidikan Anak Usia Dini,* 2(2), 123-130.

Mauluddia, A., & Solehuddin, M. (2023). Bermain sebagai strategi

pembelajaran bermakna pada anak usia dini: Sebuah kajian literatur. *Jurnal Pendidikan Anak Usia Dini*, 7(1), 12–24.

Mauluddia, L., & Solehuddin, M. (2023). Pembelajaran Berbasis

Permainan dalam Mengembangkan Kognisi Anak Usia Dini: Kajian Literatur. *Jurnal PAUD Horizon*, 7(1), 22–31.

Mehta, J., & Fine, S. (2019). *In search of deeper learning: The quest To remake the American high school*. Harvard University Press.

Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative research: A guide To design and implement* (4th ed.). Jossey-Bass.

Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative data Analysis: A methods sourcebook* (3rd ed.). SAGE Publications.

Papalia, D. E., & Martorell, G. (2021). *Experience human development* (14th ed.). McGraw-Hill Education.

Sugiyono. (2010). *Metode penelitian pendidikan: Pendekatan kuantitatif, kualitatif, dan R&D*. Alfabeta.

Suyanto. (2017). *Dasar-dasar pendidikan anak usia dini*. PT Remaja Rosdakarya.

Syabily, A. (2021). Penerapan metode Montessori dalam mendukung kebutuhan psikologi anak usia dini. *Educhild: Jurnal Pendidikan Islam Anak Usia Dini, 5*(1), 1–15.

Tsurayya, B., & Zahrah, W. (2024). *Eksplorasi aspek-aspek perancangan fasilitas pendidikan anak usia dini yang menerapkan metode Montessori*. Tekstur: Jurnal Arsitektur, 5(2),233–244. https://doi.org/10.31284/j.tekstur.2024.v5i2.5365

UNICEF. (2020). *Early childhood stimulation*. UNICEF.https://www.unicef.org/flnhub/resources/early-childhood-stimulation

Yuliana, T. (2019). Pengaruh kegiatan eksperimen terhadap keterampilan proses sains anak usia dini. *Jurnal Pendidikan Anak, 4*(2), 66–74.

This page intentionally left blank