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Improving Kindergarten Children's Exploratory Ability through Project-Based Learning, Experimental Activities, and Loose Parts Media: A Classroom Action Research Study

Nor Anisa*, Ahmad Suriansyah, and Ratna Purwanti
Universitas Lambung Mangkurat,/banajrmasin, Indonesia
*aanniissaa1262@gmail.com

ABSTRACT

Exploratory ability is a central indicator of cognitive development in early childhood because it enables children to observe, question, manipulate objects, test ideas, and construct explanations from direct experience. The preliminary condition in a kindergarten class in Banjarmasin showed that only 4 of 12 children (33%) demonstrated developing exploratory ability, while 8 children (67%) remained in the not-yet-developed category. This classroom action research aimed to improve teacher activity, children's learning activity, and children's exploratory ability by integrating Project-Based Learning, experimental activities, and loose parts media. The participants were 12 kindergarten children aged 5-6 years (5 boys and 7 girls). The intervention was implemented in four meetings through planning, action, observation, and reflection. Data were collected through observation sheets, documentation, interviews, and an exploratory ability assessment rubric. The data were analyzed descriptively using percentages, cross-tabulation, and trend interpretation. The results showed consistent improvement across meetings. Teacher activity increased from a score of 25 (61%, fairly good) in Meeting 1 to 38 (93%, very good) in Meeting 4. Children's classical activity increased from 25% to 100%, and the proportion of children who achieved successful exploratory development increased from 16.7% to 100%. The findings indicate that the integration of project work, simple experiments, and open-ended loose parts materials can create a concrete, playful, and inquiry-oriented learning environment that supports children's exploratory behavior. The study contributes practical evidence for early childhood teachers who seek to transform monotonous worksheet-based instruction into active, child-centered, and developmentally appropriate learning.

Keywords: Cognitive Development; Experimental Method; Exploratory Ability; Loose Parts; Project-Based Learning

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INTRODUCTION

Early childhood education provides foundational stimulation for children's physical, social, emotional, language, artistic, moral, and cognitive development. In the Indonesian context, early childhood education is designed to help children aged 0-6 years receive developmentally appropriate experiences before they enter the next level of education. The national early childhood curriculum also emphasizes that cognitive development includes learning and problem solving, logical thinking, and symbolic thinking, all of which are closely related to children's ability to observe phenomena, ask questions, compare objects, explore causal relations, and communicate findings (Ministry of Education and Culture of the Republic of Indonesia, 2014; Susanto, 2017).

Exploratory ability is particularly important for children aged 5-6 years because this period is characterized by active curiosity, sensory engagement, symbolic thought, and rapid growth in reasoning. Piaget (1952) described young children as active constructors of knowledge, while

Vygotsky (1978) emphasized that children's higher mental functions develop through social interaction and mediated experiences. In classroom practice, these perspectives imply that children should not only listen to teacher explanations or complete worksheets; they should be given time, space, tools, and adult scaffolding to manipulate objects, test simple hypotheses, and discuss what they discover. Play and learning are therefore not separate domains in early childhood. Rather, playful experiences can become meaningful learning contexts when children are actively engaged, socially interactive, and invited to iterate their ideas (Pramling Samuelsson & Asplund Carlsson, 2008; Zosh et al., 2018).

Exploration in early childhood can be defined as children's active efforts to investigate objects, events, and environmental phenomena in order to gain new information. Exploratory activity is visible when children ask what, why, and how questions; use their senses to observe details; compare changes before and after an action; try alternative ways to solve a problem; and communicate what they find. Previous studies in Indonesian early childhood settings have argued that exploration helps children elaborate knowledge, strengthen simple analytical skills, and build meaningful connections between classroom activities and everyday life (Mariana & Yuliantina, 2023; Roziana & Khasanah, 2022; Sujiono, 2013). International literature similarly suggests that play-based and inquiry-oriented experiences are productive when the teacher's role moves along a continuum from observing children's free play to intentionally guiding learning without removing children's agency (Pyle & Danniels, 2017; Pyle et al., 2017).

The initial problem identified in the kindergarten class that became the research site was the low level of children's exploratory ability. Based on classroom observation and teacher interviews, children rarely had opportunities to investigate concrete phenomena, make predictions, manipulate diverse materials, or express ideas through self-created products. Learning was dominated by teacher explanation, worksheets, and textbook activities. As a result, children were often passive, easily bored, dependent on the teacher, and less willing to initiate exploration. Preliminary assessment showed that only 4 of 12 children (33%) had begun to show adequate exploratory ability, while 8 children (67%) were still in the not-yet-developed category. If this condition remains unaddressed, children may lose opportunities to develop curiosity, persistence, problem-solving, creativity, and confidence in learning.

A pedagogical strategy that can respond to this problem is the integration of Project-Based Learning (PjBL), experimental activities, and loose parts media. PjBL encourages children to investigate a meaningful question or challenge and produce a concrete product through collaborative activity. A systematic review involving kindergarten and elementary students found that PjBL has promising effects, although implementation quality, fidelity, and assessment design remain crucial factors (Ferrero et al., 2021). In preschool science contexts, project approach-based science programs have also been reported to improve problem-solving skills when children participate in sustained, hands-on, and meaningful activities (Guley & Keskinkilic, 2024). These findings support the use of project work not as a decorative activity, but as a structure that helps children connect curiosity, planning, experimentation, and product creation.

The experimental method strengthens the inquiry dimension of PjBL by allowing children to observe changes directly. In early childhood classrooms, simple experiments help children compare conditions, predict outcomes, test ideas, and draw age-appropriate conclusions. Inquiry-based science education has been recognized as an effective approach for developing children's reasoning, curiosity, and scientific process skills when it is adapted to preschool children's developmental characteristics (Fleer, 2019; Hmelo-Silver et al., 2007; Ma'viyah, 2021). In the present study, experimentation was not framed as formal laboratory work; it was implemented through child-friendly activities involving observation, manipulation, discussion, and reflection.

Loose parts media complement PjBL and experimental activities because they offer open-ended materials that can be moved, combined, redesigned, separated, and used in multiple ways. Nicholson's theory of loose parts states that the richness of variables in an environment increases opportunities for creativity and discovery (Nicholson, 1971). More recent research has

shown that loose parts can support STEM-related behaviors, construction, goal setting, explanation, and exploration, although children's cognitive capacity and home play experiences may influence the extent of benefit (Cankaya et al., 2025; Gibson et al., 2017). In Indonesian early childhood classrooms, loose parts made from natural materials, recycled objects, wood, fabric, plastic, or household items are practical because they are affordable and familiar to children (Dewi et al., 2023; Hijriati, 2024; Rahma & Anggreani, 2024).

Based on this background, the present classroom action research aimed to improve teacher activity, children's activity, and children's exploratory ability through the integrated use of Project-Based Learning, experimental activities, and loose parts media in a kindergarten class in Banjarmasin, Indonesia. The research questions were: (1) How does teacher activity improve during the implementation of the integrated learning strategy? (2) How does children's learning activity improve across meetings? and (3) How does children's exploratory ability develop after the intervention?

METHOD

This study employed classroom action research because the main purpose was to solve an immediate learning problem in a specific classroom while simultaneously improving teaching practice. Classroom action research is suitable when teachers and researchers need to plan an action, implement it, observe the process, and reflect on the results in order to refine the next action (Arikunto et al., 2014; Kemmis et al., 2014; Kunandar, 2016). The study was carried out in four meetings. Each meeting involved the same general action-reflection logic: planning the learning scenario, implementing the integrated PjBL-experiment-loose parts activity, observing teacher and child behaviors, assessing children's exploratory ability, and reflecting on improvements needed for the next meeting.

The research was conducted in a kindergarten located in the Sungai Miai area of Banjarmasin, South Kalimantan, Indonesia. The participants were 12 children in Group B, consisting of 5 boys and 7 girls. The class was selected because the preliminary observation showed that children's exploratory ability had not developed optimally, and the teacher reported that classroom learning was still dominated by explanation, worksheets, and limited use of concrete open-ended media. The school name and children's identities were anonymized in order to protect participants' confidentiality.

The intervention combined the main principles of Project-Based Learning, simple experimentation, and loose parts play. PjBL provided the learning structure, the experimental method provided the investigative process, and loose parts media provided concrete and flexible materials for exploration. The general learning sequence was as follows:

- Project orientation: The teacher introduced a contextual question or problem related to children's daily experience and invited children to predict what might happen.
- Exploration of loose parts: Children observed and selected available materials such as natural objects, recycled items, containers, fabric, plastic, wood, or other safe manipulatives.
- Guided experiment: Children manipulated materials, tried simple actions, compared changes, and observed the results with teacher scaffolding.
- Project/product creation: Children used the loose parts to create a simple product, arrangement, model, or representation related to the project theme.
- Reflection and communication: Children were encouraged to describe what they did, what changed, what they found, and why their product or experiment worked in a particular way.

Across the four meetings, the teacher gradually improved classroom management, questioning techniques, distribution of materials, time allocation, and reflection activities. The reflection process was important because it allowed the teacher to respond to children's difficulties and increase the quality of learning in the next meeting.

Data were collected using observation, documentation, interviews, and performance assessment. The teacher activity observation sheet measured the quality of learning

implementation, including preparation, project orientation, guidance during exploration and experimentation, facilitation of discussion, use of media, classroom management, and reflection. The children's activity observation sheet measured participation, attention, collaboration, engagement with materials, willingness to ask and answer questions, and involvement in project completion. Children's exploratory ability was assessed using a rubric that focused on observing objects or phenomena, asking or responding to questions, trying actions with materials, comparing results, solving simple problems, and communicating findings.

Documentation was used to record learning products and classroom situations, while interviews with the teacher and school principal were used to clarify the initial problem and support interpretation of the classroom context. The combination of observation, assessment, documentation, and interview data strengthened the trustworthiness of the findings by allowing the researcher to compare process evidence with developmental outcomes.

The data were analyzed using descriptive statistics, percentages, cross-tabulation, and trend interpretation. Teacher activity was considered successful when the teacher achieved a score of 34-41, categorized as very good. Children's activity was considered successful when the class reached at least 82% active participation. Children's exploratory ability was considered successful when at least 82% of the children achieved the expected developmental category, equivalent to the category of very well developed. The emphasis of analysis was not only on the final percentage, but also on the progression from Meeting 1 to Meeting 4 and the relationship among teacher activity, children's activity, and children's exploratory outcomes.

RESULT AND DISCUSSION

The classroom action research showed a consistent upward trend in teacher activity, children's activity, and children's exploratory ability. The results are presented in four parts: teacher activity, children's activity, exploratory ability, and the overall trend across meetings.

Teacher Activity

Teacher activity increased in every meeting (see Table 1). By Meeting 4, the teacher achieved a score of 38 or 93%, also categorized as very good. The improvement indicates that repeated reflection helped the teacher implement the integrated strategy more effectively.

Table 1 Trend of Teacher Activity

Meeting	Score	Percentage	Category
1	25	61%	Fairly good
2	31	76%	Good
3	34	82%	Very good
4	38	93%	Very good

Children's Learning Activity

Children's classical activity also improved (see Table 2). This progression suggests that consistent exposure to open-ended materials and project routines can reduce dependence on the teacher and increase children's agency.

Table 2 Trend of Children's Classical Learning Activity

Meeting	Percentage	Category
1	25%	A small proportion of children were active
2	50%	Half of the children were active
3	83%	Almost all children were active
4	100%	All children were active

Children's Exploratory Ability

The development of children's exploratory ability followed a similar pattern (see Table 3). The data indicate that children became increasingly able to observe materials, try actions, compare outcomes, discuss what happened, and complete project products. The final result also suggests

that exploratory ability is strongly influenced by the quality of the learning environment and the degree of active participation provided during classroom activities.

Table 3 Trend of Children's Exploratory Ability

Meeting	Percentage of successful development	Category
1	16.7%	Developing but not yet successful classically
2	41.7%	Developing but not yet successful classically
3	83.3%	Successful classically
4	100%	Successful classically

Overall Trend

The three observed aspects showed a mutually reinforcing trend. As teacher activity improved, children's activity also increased, and the improvement in children's activity was followed by higher exploratory ability. The trend is illustrated in Figure 1.

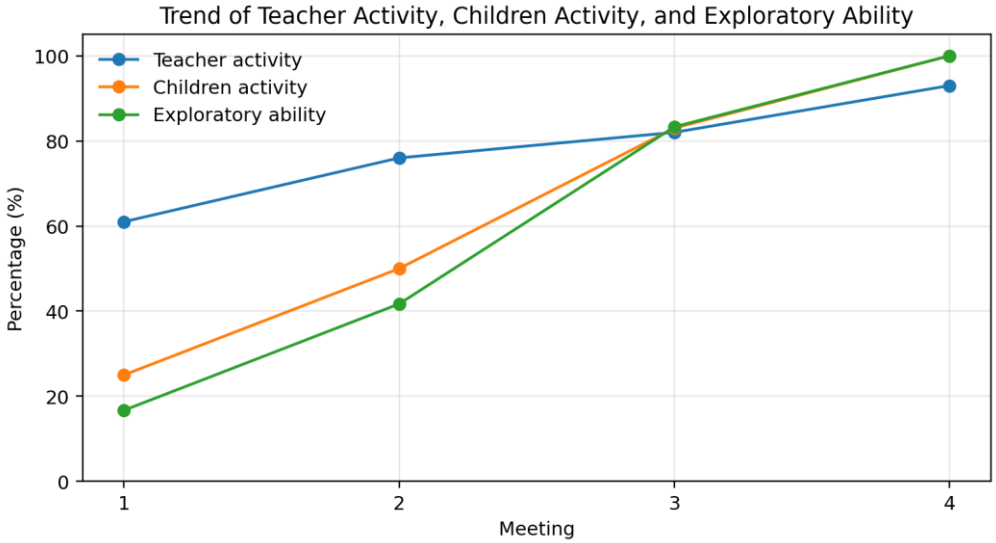

Figure 1 Overall Trend of Teacher Activity, Children's Activity, and Exploratory Ability Across Four Meetings

Figure 1 shows that the most rapid improvement occurred in children's activity and exploratory ability after Meeting 2. This suggests that children needed initial adaptation to the project routine and loose parts materials before they could engage more independently. By Meeting 3, the class had reached the classical success indicator for both activity and exploratory ability, and by Meeting 4, the learning process had become more stable and inclusive for all children.

The findings demonstrate that the integration of Project-Based Learning, experimental activities, and loose parts media can improve the quality of early childhood learning when it is implemented through repeated reflection. The increase in teacher activity from fairly good to very good indicates that the teacher became more capable of organizing a child-centered learning environment. This result is important because the success of inquiry-based activities in early childhood does not depend only on the availability of attractive media. It also depends on the teacher's ability to frame a meaningful problem, provide clear but flexible instructions, ask open-ended questions, manage materials safely, and guide children to reflect on what they have done. This is consistent with the view that teacher professionalism in early childhood education involves the ability to choose suitable learning models, methods, and media based on children's developmental needs (Anggreani et al., 2022; Suriansyah et al., 2014).

The improvement in teacher activity can be interpreted as the product of action research cycles. During the first meeting, the teacher was still adapting to the integrated strategy. The learning activity was no longer a conventional worksheet task; therefore, classroom

management became more complex. Children needed time to understand that they were allowed to choose materials, try different actions, and express ideas. The teacher also needed to balance freedom and guidance. Reflection after each meeting allowed the teacher to adjust the strategy: instructions became more concise, materials were prepared more systematically, children were grouped more effectively, and questioning became more focused on observation, prediction, and explanation. This confirms the function of classroom action research as a practical process for improving teaching quality through repeated planning, action, observation, and reflection (Arikunto et al., 2014; Kemmis et al., 2014).

The increase in children's activity from 25% to 100% suggests that the learning environment became progressively more engaging and accessible. At the beginning, some children were passive because they were accustomed to teacher-centered activities. However, the use of loose parts and project tasks gave children a more concrete reason to participate. Children could touch, move, combine, and redesign materials. These opportunities are developmentally appropriate because preschool children learn most effectively when they can coordinate sensory experience, movement, language, and social interaction. The result supports previous arguments that play-based learning is not a reduction of academic learning, but a pedagogical route through which young children actively construct knowledge (Pramling Samuelsson & Asplund Carlsson, 2008; Pyle & Danniels, 2017; Zosh et al., 2018).

Project-Based Learning contributed to children's activity by giving the classroom a shared purpose. Instead of completing isolated tasks, children were involved in a sequence: understanding a problem, exploring materials, conducting a simple experiment, creating a product, and explaining the outcome. This sequence helped children see the connection between action and result. The finding aligns with Ferrero et al. (2021), who reported that PjBL can support learning in kindergarten and elementary contexts when the implementation maintains essential elements such as meaningful questions, active investigation, and product creation. It is also consistent with Guley and Keskinkilic (2024), who found that a project-based science education program improved preschool children's problem-solving skills. In the present study, PjBL worked because it was adapted to young children: the project was concrete, the product was simple, the investigation was short enough for children's attention span, and the teacher provided scaffolding without taking over children's decisions.

The experimental method strengthened children's exploratory ability because it transformed curiosity into observable action. Children did not only hear explanations from the teacher; they were invited to try, observe, compare, and discuss. These activities are central to exploratory cognition because children begin to understand that an action can produce a change and that different materials can produce different effects. In early science education, guided inquiry and experimentation allow children to develop early scientific process skills such as observing, predicting, classifying, and communicating (Fleer, 2019; Hmelo-Silver et al., 2007; Ma'viyah, 2021). The improvement from 16.7% to 100% indicates that exploratory ability can develop quickly when children repeatedly encounter opportunities to investigate concrete phenomena in a supportive classroom climate.

Loose parts media served as the material basis for exploration. The materials were not fixed toys with predetermined functions; they were flexible objects that children could interpret and transform. This feature is central to Nicholson's theory of loose parts, which argues that creativity and discovery increase when the learning environment contains many variables that children can manipulate (Nicholson, 1971). The present findings support this theoretical position. Children became more active when they had access to materials that allowed multiple solutions. For example, a child could use the same object as a container, a building component, a decorative element, a measurement tool, or part of a model. Such open-ended affordances encourage children to make decisions, revise ideas, and solve emerging problems.

Recent empirical research gives additional support to the role of loose parts in exploratory and STEM-related behavior. Cankaya et al. (2025) found that children displayed more STEM behaviors with loose parts than with limited-purpose toys, including constructing structures, communicating goals, explaining how objects work, and exploring mathematical concepts.

Cankaya et al. (2023) also reviewed the relationship between loose parts play and cognitive development and highlighted links with problem solving, creativity, reasoning, and executive function. However, Gibson et al. (2017) cautioned that the quantitative evidence on loose parts and cognitive, social, and emotional outcomes remains limited and methodologically varied. Therefore, the present study should be read as practical classroom evidence rather than definitive causal proof. Its contribution lies in showing how loose parts can be integrated with project and experimental pedagogy in a real kindergarten classroom.

The relationship among teacher activity, children's activity, and exploratory ability is one of the strongest patterns in the findings. When the teacher improved preparation, scaffolding, and reflection, children became more willing to participate. When children became more active, they had more opportunities to observe, try, compare, and communicate. This chain of improvement supports Vygotsky's (1978) view that children develop through mediated social interaction. The teacher's role was not to provide answers but to mediate children's engagement with materials and peers. Questions such as "What do you notice?", "What will happen if...?", "Why did it change?", and "How can we make it work better?" helped children move from simple manipulation to reflective exploration.

The findings also clarify why the combination of three components was more appropriate than using only one component. PjBL alone may become product-oriented if the teacher focuses only on final work. Experimental activities alone may become short demonstrations if children do not have enough agency. Loose parts alone may become free play without intentional learning goals if the teacher does not facilitate reflection. When combined, the three components complement one another. PjBL provides purpose and sequence, the experimental method provides inquiry and evidence, and loose parts provide flexible material affordances. This integration creates a balanced learning environment that is playful, concrete, purposeful, and reflective.

The results support previous local studies that used similar approaches in early childhood classrooms. Salsabila and Novitawati (2021) reported that exploratory activity improved when experimental methods were combined with loose parts media. Norhikmah and Rini (2022) showed that PjBL and experimental methods supported children's science ability. Rahma and Anggreani (2024) found that PjBL supported by loose parts improved children's science learning. Dewi et al. (2023) also found that loose parts influenced cognitive development in early childhood. The present study strengthens these findings by combining all three components and showing parallel improvements in teacher activity, children's activity, and exploratory ability.

From a practical perspective, the study suggests several implications for early childhood teachers. First, teachers should reduce dependence on worksheets and increase concrete inquiry activities. Worksheets can assess certain skills, but they cannot replace direct exploration of real objects and phenomena. Second, loose parts should be intentionally selected based on safety, cleanliness, variety, and relevance to the project theme. Third, teachers need to prepare guiding questions before the activity because children's manipulation of objects becomes more meaningful when it is accompanied by language, prediction, comparison, and reflection. Fourth, assessment should not only focus on the final product; it should also document how children observe, try, collaborate, revise, and explain. These process indicators are essential for evaluating exploratory ability in early childhood.

The study also has implications for school leaders. Professional development for early childhood teachers should include practical training in designing PjBL scenarios, managing loose parts materials, and facilitating inquiry-based dialogue. As shown by the improvement in teacher activity, teachers can become more effective when they have opportunities to reflect on practice. School leaders can support this process by providing collaborative planning time, storage and safety systems for loose parts, and peer observation sessions. In resource-limited schools, loose parts offer an affordable alternative because many materials can be obtained from the local environment, recycled objects, or natural materials. However, affordability should not

lead to random use; materials must still be intentionally curated and linked to developmental goals.

Despite the positive trend, several limitations must be acknowledged. The study involved only 12 children in one kindergarten class, so the findings cannot be generalized statistically to all early childhood settings. The design did not include a comparison group, and the improvement may have been influenced by repeated exposure, teacher attention, or children's increasing familiarity with the classroom routine. The intervention lasted only four meetings, so it cannot show whether the improvement would be maintained over a longer period. The assessment used classroom observation and rubrics, which are appropriate for action research but still require careful inter-rater agreement in future studies. Future research should involve more classrooms, longer intervention periods, comparison groups, and more detailed documentation of children's exploratory talk and problem-solving processes.

Overall, the study provides useful evidence that exploratory ability can be improved when learning is designed as a meaningful, hands-on, and reflective process. The improvement across all three aspects indicates that the learning problem was not caused by children's lack of ability, but by limited opportunities for active exploration. When the classroom environment changed, children's participation and exploratory performance changed as well. This point is important for early childhood pedagogy: children's curiosity needs to be protected and expanded through rich materials, purposeful projects, simple experiments, and teacher scaffolding that respects children's agency.

CONCLUSION

This classroom action research found that the integration of Project-Based Learning, experimental activities, and loose parts media improved teacher activity, children's learning activity, and children's exploratory ability in a kindergarten class in Banjarmasin. Teacher activity increased from 61% in Meeting 1 to 93% in Meeting 4. Children's classical activity increased from 25% to 100%, and children's exploratory ability increased from 16.7% to 100%. The success indicator was achieved by Meeting 3 and strengthened in Meeting 4.

The findings indicate that exploratory ability develops when children are given concrete materials, meaningful project challenges, opportunities to experiment, and teacher scaffolding that encourages observation, prediction, comparison, problem solving, and communication. For classroom practice, teachers are advised to use loose parts not merely as play materials but as media for guided exploration and project creation. For future research, the strategy should be tested with larger samples, longer implementation periods, and more rigorous assessment of exploratory talk, scientific process skills, and long-term retention.

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