

Cognitive development analysis of 3-year-old children in the aspect of simple problem-solving

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Abstract

Purpose— This study aims to analyze the cognitive development of 3-year-old children in the aspect of simple problem-solving through recognition of colors and objects.

Design/methods/approach— The study employed a qualitative approach with a case study design, involving two children in the Playgroup class who were directly observed during play activities and interactions with the teacher. Data were collected through direct observation during play activities and learning sessions, using an observation guideline based on three indicators of cognitive development: recognizing problems, attempting solutions, and completing simple tasks. The data were analyzed descriptively through data reduction, data display, and conclusion drawing.

Findings— Based on these indicators, the findings showed two different patterns: one child more often expressed understanding verbally, whereas the other more often demonstrated it by observing others and acting directly on the materials. During block play activities, both children were able to complete tasks using different strategies, either through direct exploration or social observation.

Research implications/limitations— The study highlights that simple problem-solving can develop through different pathways according to each child's character, and concrete media such as colors and objects are effective for cognitive stimulation.

Practical implications— These findings emphasize the importance for teachers to recognize children's characters and apply adaptive, inclusive, and individualized learning approaches.

Originality/value— Simple problem-solving, such as finding a way to complete a task with familiar objects, is an early cognitive skill that supports children's later reasoning and independence in learning.

Keywords: cognitive development, early childhood, simple problem-solving, observation, concrete media

Paper type: Case study.

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Introduction

Cognitive development is one of the aspects of early childhood development that plays a crucial role in supporting children's thinking abilities, understanding of their environment, and capacity to solve simple problems encountered in daily life. In early childhood, particularly at the age of three, cognitive development is in a highly sensitive phase that significantly determines subsequent development (Adatul'aisy et al., 2023). Children begin to demonstrate the ability to recognize problems, attempt to find solutions, and use previous experiences to face new situations. Simple problem-solving, such as working out how to complete a task with available objects, is a specific part of this development. Between the second and fourth year of life, children rapidly develop the ability to solve problems flexibly with objects (Bobrowicz et al., 2020), and more complex object play is associated with better problem-solving performance (Rat-Fischer et al., 2024). Therefore, cognitive development in early childhood cannot be understood solely through learning outcomes; rather, it must be analyzed through the child's thinking processes. This analysis is important so that educators and parents can provide stimulation that is appropriate to the child's developmental stage (Rozana et al., 2020).

Factually, the cognitive development of three-year-old children is characterized by the emergence of early concrete thinking abilities. Children begin to understand simple cause-and-effect relationships, such as realizing that a particular action will lead to a certain outcome. For example, children may attempt to open a locked toy or find a way to reach an object that is out of reach. These behaviors indicate that children are not merely acting reflexively but are already using thinking skills to solve simple problems. However, these abilities are still developing and are highly dependent on direct experiences and guidance from adults. These factual characteristics of cognitive development form an important foundation for this study (Rozana et al., 2020).

According to Jean Piaget's theory of cognitive development, three-year-old children are in the early preoperational stage, a phase in which children begin to use symbols and language but are not yet capable of systematic logical thinking. At this stage, children learn through exploration and concrete experiences. When faced with problems, children tend to try various approaches repeatedly until they find a solution they perceive as successful. This process is known as trial and error and constitutes an essential part of children's cognitive development. Thus, the ability to solve simple problems serves as a key indicator in assessing cognitive development in early childhood. From this perspective, problem-solving is mainly a product of the child's own direct exploration of objects.

In addition to Piaget's theory, children's cognitive development can also be understood from Vygotsky's theoretical perspective, which emphasizes the role of the social environment. According to Vygotsky, cognitive development occurs through interactions with adults or more capable peers. The concept of the Zone of Proximal Development (ZPD) indicates that children can achieve higher levels of development with assistance or scaffolding from adults. In the context of simple problem-solving, teachers and parents play an important role in providing support and guidance without taking over the child's task. Therefore, children's cognitive development is strongly influenced by positive social interactions and a supportive environment (Sun & Rao, 2012; Wood et al., 1976). Previous studies have examined several forms of adult stimulation, including verbal questioning (Torneo et al., 2015), scaffolding during problem-solving tasks (Rizkyanti, 2019), and provision of concrete learning media (Laski et al., 2015). These studies reported that adult simulation supports children's thinking mainly when it is matched to the child. Teachers' questions were often open but made low cognitive demands; scaffolding adjusted to children's understanding helped them complete tasks more independently; and concrete materials helped only under certain conditions, with evidence on their effectiveness remaining mixed.

Among these forms of stimulation, this study focuses on the recognition of colors and objects. These activities were chosen for three reasons. First, color recognition is treated as a cognitive ability in Indonesia's national early childhood standards, which also list problem-solving as one of the core cognitive domains for Playgroup-age children (Kemendikbud, 2014). Colors and objects therefore fit what teachers are already expected to stimulate. Second, colors and objects are concrete and familiar. Young children's thinking is commonly described as

concrete, and objects that children can touch and move are widely used in early classrooms (Laski et al., 2015; Petersen & McNeil, 2013). Third, object-based tasks make problem-solving visible, because children's attempts to complete a task with objects can be observed directly as they act (Bobrowicz et al., 2020; Rat-Fischer et al., 2024). Colors and objects therefore serve as the task context through which problem-solving is observed, not as a variable whose effect is measured.

However, existing studies show a gap. Most previous research on early problem-solving has used experimental or test-based tasks, such as tool-use set-ups, puzzles, and standardized measures (Bobrowicz et al., 2020; Rat-Fischer et al., 2024; Rizkyanti, 2019). It has also focused on infants, on children older than three, or on mathematical problem-solving, where measures for 3-year-olds have not been reliable enough (Sun & Rao, 2012; Vessonen et al., 2024). Studies of the later outcomes of early cognitive skills have relied mainly on executive function tests (Mulder et al., 2017; Richland & Burchinal, 2012). The few qualitative studies that observed problem-solving in natural play involved toddlers younger than three and used materials set up by the researcher (Alkouri, 2016; Geiken, 2011). Few studies have examined how simple problem-solving appears in the everyday play of children aged 3 within a single classroom, and how children differ in the ways they reach a solution. This matters because the two theories described above point to two possible routes: independent exploration (Piaget) and learning through social observation and adult support (Vygotsky). It is not yet clear how these routes appear side by side in children of the same age and setting.

The urgency of this study is based on the reality that many educators and parents still lack an understanding of specific indicators of children's cognitive development, particularly in the aspect of simple problem-solving. In learning practices, children are often assisted immediately without being given the opportunity to attempt to solve problems independently. This condition can hinder the development of children's thinking abilities and independence. Therefore, this study is important to provide a concrete description of how the cognitive development of three-year-old children unfolds in learning situations and daily activities (Rozana et al., 2020).

This study differs from previous research, which generally discusses children's cognitive development in a broad manner or employs quantitative approaches. This research specifically focuses on the aspect of simple problem-solving using a qualitative case study approach. The study does not aim to measure children's development numerically but seeks to gain an in-depth understanding of children's thinking processes through direct observation and interview (Rozana et al., 2020). Thus, this study offers novelty and contributes to the field of early childhood education.

Based on the above explanation, this study is entitled "An Analysis of Cognitive Development in Three-Year-Old Children in the Aspect of Simple Problem-Solving (A Qualitative Case Study)." The title reflects the research focus, the subjects studied, and the approach employed, while also indicating a research gap related to in-depth studies of early childhood thinking processes (Sari et al., 2024).

Methods

This study employed a qualitative approach using a case study research design to gain an in-depth understanding of the cognitive development of three-year-old children in terms of simple problem-solving. A case study is a type of research that examines a bounded case, either a single subject or a small number of subjects, intensively within its natural context (Yin, 2018). This study used a multiple-case design with two children, each treated as a separate case. The unit of analysis was each child's problem-solving behavior during play and learning episodes, and the two cases were compared to identify similarities and differences. This approach was selected because it allows researchers to comprehensively and deeply understand the child's thinking processes. The study does not aim to make generalizations but rather to explore the phenomenon in a specific and contextual manner. Therefore, the case study approach is considered appropriate for examining cognitive development in early childhood (Sanusi et al., 2020).

The sampling technique used in this study was purposive sampling. The selection of the subject was based on the suitability of the subject's characteristics with the research objectives.

The research subjects were two three-year-old children enrolled in a Playgroup (Kelompok Bermain) class. The children were selected because this age represents an early stage of cognitive development characterized by the ability to solve simple problems. After determining the subject, the study focused directly on data collection techniques (Rawanti et al., 2023)

Data collection in this study was conducted through observation. Observation employed an observation guideline as the primary research instrument. The observation guideline was developed based on indicators of cognitive development in three-year-old children. The observed indicators included the ability to recognize problems, attempt solutions, and complete simple tasks. Observations were carried out directly during play activities and learning sessions in the playgroup classroom.

To strengthen data validity, method and data source triangulation was applied (Carter et al., 2014; Denzin, 1978; Patton, 1999). In addition to classroom observation, brief semi-structured interviews were conducted with the class teacher about each child's usual behavior when facing simple problems. Documentation consisted of photographs, video recordings, and the teacher's anecdotal records of the children's activities. The observation findings were then cross-checked against the interview and documentation data. A finding was treated as supported when the sources converged, for example, when a behavior seen in the observation was also described by the teacher and visible in the recordings. Any discrepancies between sources were noted and discussed during the analysis.

The data analysis technique used was descriptive qualitative analysis. The observational data were analyzed through the stages of data reduction, data display, and conclusion drawing. Data reduction involved selecting and organizing data according to cognitive development indicators. Data display was presented in the form of descriptive narratives based on observational findings. Conclusions were drawn to describe the cognitive development of the research subject (Khoiruzzadi et al., 2020)

Result

Based on observations conducted in the playgroup classroom, the teacher introduced various objects placed on the floor and asked the children to identify the color of each object. The observation results indicated differences in children's characteristics in recognizing colors and objects. The first child, who was more active, was able to immediately answer the teacher's questions correctly, demonstrating the ability to identify, remember, and connect visual information with verbal expressions. The second child, who was more passive, did not provide verbal responses but continued to pay attention to the surrounding environment and adjusted to group activities (Hidayana et al., 2024). This child processed information through observation before taking action, indicating that problem-solving can occur through processes of observation, reflection, and concrete action. These findings confirm that the ability to recognize simple problems is not only reflected in verbal responses but also in how children observe, analyze, and respond to stimuli nonverbally. This suggests that colors and objects serve as important media for stimulating children's cognitive abilities according to their individual characteristics, while also facilitating diverse learning processes based on each child's pace and learning style (Kusuma et al., 2023)

During block play activities, the active child demonstrated high creativity by arranging blocks according to shape and color while also following the sequence based on the rules provided by the teacher. This process reflects the development of planning skills, fine motor coordination, and early logical thinking, which emerge through direct exploratory experiences. The passive child, despite not speaking, also showed strong skills in arranging blocks, was able to predict the outcomes of each step, and independently completed the block structure. This strategy indicates that the passive child relied on concrete experiences and social observation as a basis for problem-solving. These results emphasize that children's participation in learning is not always evident through verbal communication but can be assessed through their ability to complete practical tasks and engage directly with learning materials. The findings highlight the importance for teachers to recognize each child's individual characteristics so that instructional approaches can be adapted to provide optimal, creative, and responsive learning opportunities for all children.

Further observations of children's responses to the teacher's questions revealed that the

active child expressed understanding verbally, responded accurately, and demonstrated developing communication skills, while the passive child remained silent but was able to complete practical tasks, such as systematically arranging blocks. The teacher added that the passive child displayed different characteristics at home, tending to be more talkative, but appeared calmer and more observant in the classroom (Afifah & Utami, 2024). This emphasizes that social context influences how children express their understanding. The passive child utilized observation and concrete experiences as learning media, whereas the active child employed a combination of verbal interaction and physical exploration to develop cognitive abilities. These findings suggest that instructional strategies that overly emphasize verbal responses may limit the potential of passive children; therefore, teachers need to adjust teaching methods to optimally stimulate the abilities of all children.

The integration of children's individual characteristics within learning activities demonstrates that although learning strategies differ, both children were able to complete tasks with satisfactory outcomes. The active child learned through verbal interaction and direct exploration of objects and colors, while the passive child learned through observation, concrete experiences, and nonverbal social interaction. Both pathways were effective in developing simple problem-solving skills, indicating that concrete media such as colors and objects serve as significant cognitive stimulation. These activities not only help children understand concepts and develop early logical thinking skills but also enhance social skills, cooperation, and self-confidence. The findings underscore the importance of teachers recognizing children's characteristics and applying adaptive, inclusive, and creative approaches so that each child can develop optimally according to their individual potential through developmentally appropriate learning experiences.

Discussion

The ability to recognize colors and objects in three-year-old children reveals significant differences in individual characteristics in the way they process information. Active children express their understanding through accurate verbal responses, demonstrating visual memory skills, rapid cognitive responses, and the ability to connect objects with verbal symbols. Meanwhile, passive children, although not responding verbally, are still able to observe, process information, and act according to given stimuli (Handoko et al., 2025).

These findings are consistent with Piaget's theory of the preoperational stage, in which children begin to understand concrete situations through direct experiences, symbols, and object manipulation. Colors and objects function as concrete media that help children internalize experiences, understand concepts, develop logical thinking, and enhance independent simple problem-solving abilities (Handoko et al., 2025). Concrete media also provide opportunities for children to learn through observation, reflection, and real experimentation, in accordance with the principles of active learning in early childhood (Hidayana et al., 2024).

Differences in play strategies between active and passive children indicate that problem-solving skills can be developed through multiple pathways. Active children utilize direct exploration, try various block arrangements, and spontaneously correct errors, while passive children employ observational strategies, learn from peers, and arrange blocks with careful planning (Jf & Azmi, 2022). Both pathways demonstrate that learning can occur through direct action or observation, in line with Vygotsky's theory of the Zone of Proximal Development (ZPD) and the importance of scaffolding in learning (Jf & Azmi, 2022). Block play activities not only enhance fine motor coordination and early logical reasoning but also foster planning skills, outcome evaluation, and social awareness, all of which support children's overall cognitive development (Khoiruzzadi et al., 2020).

Children's responses to teachers' questions further confirm that cognition is not always expressed verbally. Active children demonstrate their understanding through immediate verbal answers, while passive children show comprehension through concrete actions, such as arranging blocks or observing their surroundings. These findings highlight the importance of social context and individual characteristics in the learning process. Teachers must be able to recognize these differences, adjust instructional strategies, and create learning environments that allow passive children to learn without verbal pressure, while still challenging active

children through verbal interaction and physical exploration (Aminah & Mauliyah, 2025).

The integration of children's characteristics in play-based learning emphasizes that concrete media such as colors and objects are highly effective for stimulating the cognitive development of three-year-old children. Both children were able to complete tasks according to their respective characteristics, demonstrating that simple problem-solving can be achieved through different pathways, whether through verbal interaction, observation, or direct experience. This approach supports Piaget's theory of the preoperational stage and Vygotsky's emphasis on social interaction, while also highlighting the importance of teachers recognizing children's individual characteristics, providing appropriate learning experiences, and ensuring that each child develops optimally through adaptive, creative, and inclusive approaches. Concrete media enable children to internalize experiences, understand cause-and-effect relationships, develop logical thinking, and build social skills, all of which are essential for early cognitive development.

Conclusion

Based on the research findings and discussion, it can be concluded that three-year-old children are able to recognize simple problems through colors and objects, although the ways they express their understanding differ according to individual characteristics. Active children tend to express their understanding verbally, while passive children demonstrate comprehension through observation and concrete actions without verbal responses. Children's participation in play activities, such as block building, confirms that simple problem-solving can be achieved through different strategies: active children rely on direct exploration, whereas passive children utilize concrete experiences and social observation.

Children's responses to teachers' questions highlight the importance of social context in learning. Passive children are able to process information and act effectively without verbal interaction, while active children express their understanding through direct communication. The integration of children's individual characteristics in play-based learning demonstrates that concrete media, such as colors and objects, are effective in stimulating cognitive development. These findings emphasize the importance of teachers recognizing children's characteristics and applying adaptive, creative, and inclusive approaches to ensure that all children can develop optimally according to their individual potential.

Overall, this study confirms that simple problem-solving abilities in three-year-old children develop through different pathways, including verbal interaction, observation, and direct experience. Concrete media serve as essential tools in supporting cognitive development as well as social skills in early childhood.

Declarations

Author contribution statement

Astri contributed to the conceptualization of the study, data collection, and preparation of the initial manuscript. Isma Purnama contributed to the research methodology, data analysis, and interpretation of the findings. Diana H. Bakari contributed to the supervision of the research, critical review of the manuscript, and refinement of the final version. All authors contributed to the development of the manuscript and approved the final version for publication.

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Data availability statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request. The data include observational records and supporting documentation related to the children's problem-solving activities.

Declaration of interests statement

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

Declaration of using AI (Artificial Intelligence)

Artificial intelligence (AI) tools were used to assist in drafting and refining the manuscript's declarations and improving the clarity of academic writing. The AI tool was not used to generate or fabricate research data or findings. The authors reviewed and revised the AI-assisted text and take full responsibility for the accuracy, originality, and integrity of the manuscript.

Additional information

This study employed a qualitative multiple-case study design involving two three-year-old children in a Playgroup classroom. The study focused on children's simple problem-solving abilities through the recognition of colors and objects, with particular attention to individual differences in verbal expression, direct exploration, and social observation.

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