

FROM INTUITIVE PRACTICE TO INTENTIONAL PEDAGOGY: SUBITIZATION IN WETLAND-BASED EARLY CHILDHOOD EDUCATION

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Abstract: Subitization is an important aspect of early numeracy that enables children to recognize small quantities without counting and serves as a foundation for number sense development. Although wetland environments provide rich opportunities for contextualized numeracy learning, their potential remains underutilized in many early childhood education settings. This study investigated teachers' understanding and implementation of subitization-related activities and explored the extent to which wetland contexts are incorporated into early numeracy learning. Using a qualitative case study design, data were collected through interviews and classroom observations involving teachers from Pembina Inti Kindergarten in Banjarmasin, Indonesia. Data were analyzed through condensation, display, and conclusion drawing. The findings reveal that teachers regularly engage children in activities that support subitization, such as dice, domino, and object-recognition games. However, they do not explicitly identify these practices as subitization. This indicates a gap between intuitive classroom practice and intentional pedagogical understanding. In addition, wetland resources and experiences are rarely integrated into numeracy activities despite their relevance to children's local environment. The study highlights the need for professional development and curriculum support to

bridge intuitive practice and intentional pedagogy in subitization learning and to promote the meaningful integration of wetland contexts into early childhood numeracy education.

Keywords: *Early Childhood Education, Early Numeracy, Subitization Wetland-Based Learning*

A. Introduction

Early childhood education, or PAUD, as the initial level of education, provides children with rich stimulation while building their brain networks. Good stimulation in every aspect is an important part of learning readiness in the next level of education, one of which is the cognitive aspect, namely, numeracy skills (Katzin et al., 2019). This is in line with the government's expectations, as expressed by President Prabowo, to teach mathematics from the PAUD level in a fun way so that children can think, solve problems, and think critically (Aranditio, 2024). Numeracy learning, which covers a lot of content, including subitization, and the ability of teachers to process numeracy and subitization content in various and fun ways, will improve children's overall numeracy skills, such as their number sense and cardinality (Nur Asri & Fitri, 2024; Nurida, 2024). According to Macdonald and Shumway (Can, 2021; MacDonald & Shumway, 2016), subitization is the rapid focus of attention on the number when looking at a small set of identical objects. Numeracy learning by teachers that includes subitization content will enrich children's stimulation experiences and serve as the foundation for important skills such as cardinality, estimation skills, understanding number operations, and problem solving (Fahlevi, 2024; Hartika et al., 2022).

Numeracy learning in early childhood education by teachers needs to be provided as part of the process of enriching children's cognitive brain stimulation. Teachers, as the spearhead of learning, need to enrich the variety of numeracy learning, especially subitization, as part of the process of developing number sense, cardinality, and number operations (Rice, 2024; Wästerlid et al., 2024). Teachers need to have an understanding of mathematical content first and then create a rich learning design in terms of both the type and form of games. Subitization learning by teachers needs to improve children's ability to concentrate or focus (Cui et

al., 2024; Hartika et al., 2022; MacDonald, 2024). Early childhood teachers can deliver numeracy learning through fun games such as subitization cards, playing subitization dot games, and using loose parts (MacDonald, 2024; MacDonald & Shumway, 2016; Nur Asri & Fitri, 2024; Nurida, 2024).

Preliminary observations conducted across four PAUD institutions in Banjarmasin involving seven teachers revealed a significant disconnect between the theoretical importance of subitization and its actual implementation in wetland-based early childhood education settings. While 90% of the observed teachers regularly incorporated numeration content into their lessons, only 30% extended their numeracy teaching beyond basic addition and subtraction in the context of elementary readiness preparation. More critically, none of the seven teachers had ever encountered the term subitization or could identify it as a distinct mathematical concept. Yet despite this complete absence of conceptual awareness, approximately 50% of the teachers were already intuitively applying subitization-like practices in their classrooms — presenting small sets of objects for children to recognize without counting — without understanding the pedagogical significance of what they were doing. These findings point to a pressing gap not only in teachers' content knowledge but also in the professional development ecosystem surrounding early numeracy instruction in wetland-based PAUD institutions.

The choice of wetland environments as the specific setting for this study is not incidental. Banjarmasin and its surrounding areas are situated within an extensive wetland ecosystem that shapes the daily lived experiences of both teachers and children in local PAUD institutions. Wetland environments present a uniquely rich and contextually relevant source of natural materials — including water plants, seeds, river stones, and aquatic fauna — that hold significant potential as culturally grounded loose parts and concrete manipulatives for subitization learning (Çiçek, 2024; Liu et al., 2024; Pelland, 2024). Despite this potential, wetland-based PAUD institutions have received little scholarly attention in the numeracy education literature. Most existing research on subitization and early numeracy has been conducted in Western, urban, or resource-rich classroom settings, leaving the distinctive pedagogical challenges and opportunities of wetland environments

largely unexamined. Studying teacher competencies in this specific ecological and cultural context, therefore, provides insights that are not transferable from studies conducted elsewhere and fills a meaningful gap in the geographic and contextual diversity of subitization research.

Based on this explanation, it is necessary to review teachers' ability to develop subitization skills at the PAUD level, especially in wetland environments. The purpose of this study is to describe the state of teachers' abilities in teaching subitization at the early childhood education level in wetland environments. Therefore, this study uses the Qualitative Case Study method (Sugiyono, 2022). Case studies were chosen as the method to explore the main focus of the research, namely the phenomenon of numeracy learning in the context of subitization in early childhood education, with the theme of wetland environments, because the city of Banjarmasin is located in a wetland environment, and also because not many teachers understand subitization but may have already implemented it in their teaching process. Subitization is also often overlooked as the precursor to cardinality and estimation skills, which will later become number operation skills, and wetland environments can be a source of numeracy learning, such as subitization (Çiçek, 2024; Liu et al., 2024; Pelland, 2024).

The results of this study can be used to describe teachers' understanding of subitization in numeracy learning, inform problem-solving and product development, and test the results of these products. Previous studies have explained the effects of subitization on children's cognitive aspects, attention span, and numeracy skills. However, research shows that the diversity of research locations on subitization and teachers' understanding of subitization itself needs improvement and remains centered in America and Europe. Asia, especially Indonesia, has conducted little research on subitization — particularly on teachers' ability to process and manage subitization learning in culturally and ecologically distinct settings, such as wetland-based PAUD institutions. This constitutes a clear research gap that the present study seeks to address. It can be further developed for children with intellectual disabilities (Gönen & Zentel, 2025; MacDonald, 2024; Wästerlid et al., 2024).

B. Method

This study employed a qualitative case study design to explore the complexity and novelty of subitization learning practices among early childhood teachers in a wetland environment (Creswell & Poth, 2018). A case study approach was selected because the phenomenon — how teachers understand, apply, and vary subitization content in their classrooms — requires in-depth, contextually grounded investigation (Creswell & Creswell, 2023).

Research Design Flow

The research proceeded through seven sequential stages: (1) phenomenon identification; (2) instrument preparation; (3) data collection; (4) data condensation; (5) data display; (6) data validation; and (7) conclusion drawing, following the Miles and Huberman interactive model (Miles et al., 2014).

Site and Participants

The study was conducted at Pembina Inti State Kindergarten in Banjarmasin City, which was purposively selected because the institution had formally received numeracy training materials. Two kindergarten B classrooms were involved. Participants consisted of two teachers, each with more than ten years of teaching experience and a prior record of participating in numeracy-related professional training. These criteria ensured that participants possessed sufficient pedagogical experience to reflect meaningfully on their numeracy practices.

Data Collection

Data were gathered over three weeks per classroom through three techniques. Observations were conducted using structured observation guidelines, focusing on how teachers incorporated numeracy and subitization content into play-based classroom activities. Interviews were conducted using semi-structured guidelines, with the researcher developing follow-up questions organically based on participants' responses. Documentation was collected through photographs and audio recordings to support field and interview notes.

Data Analysis

Data analysis followed the Miles and Huberman model through four stages. First, data condensation, in which raw interviews and field notes were coded and reduced into recurring categories aligned with the study's four sub-foci: (1) teacher awareness of numeracy content in play activities; (2) variety of numeracy learning activities; (3) teachers' understanding of subitization; and (4) wetland themes in play activities. Second, data display, in which condensed data were organized into thematic charts cross-referencing field notes, interview notes, and documentation. Third, conclusion drawing, in which patterns and findings were interpreted to produce a descriptive account of subitization learning practices. Fourth, data validation was achieved through source triangulation across the three data types and member checking with school principals to confirm the accuracy and credibility of the findings.

C. Result and Discussion

Results

Teachers' Awareness of Numeracy Content

Both teachers demonstrated high awareness of the importance of numeracy for kindergarten B children. Teacher A emphasized that children need to be accustomed to counting activities as preparation for elementary school. At the same time, Teacher B took a broader view, linking numeracy to simple arithmetic operations such as addition and subtraction.

"I think numeracy is very important, especially for kindergarten B children, who will soon enter elementary school. If they are accustomed to counting, it will be easier for them to follow lessons there." (Teacher A)

"Numeracy is not just numbers, but also simple addition and subtraction. It can be practiced from early childhood education." (Teacher B)

These two perspectives reflect different orientations: Teacher A approached numeracy through a school-readiness lens, while Teacher B framed it more conceptually, connecting number recognition to basic operations. Observation data supported this distinction — Teacher A's classroom activities were predominantly

worksheet-based with occasional physical games such as number jumping, whereas Teacher B consistently used concrete, real-life objects, including bottle caps, food ingredients, and counting tools embedded in everyday play activities (RG2A1, RG2A2; RG2B1, RG2B2).

"I usually give worksheets, and the children write down the numbers. Sometimes I also use number jumping games to make it more exciting." (Teacher A)

"I use real objects more often. For example, when children make food, we count the ingredients. Or we use bottle caps, which help children understand more quickly." (Teacher B)

The principal's validation confirmed that numeracy is institutionally valued at this school, while also revealing that no standardized activity guidelines exist — meaning the variety and depth of numeracy learning experienced by children depends significantly on individual teacher creativity and understanding.

Teachers' Understanding of Subitization

Neither teacher was familiar with the term subitization before this study. However, observational data revealed that both teachers had been intuitively practicing subitization in their classroom activities without recognizing it as a distinct mathematical concept.

"I didn't know the term subitization, but when playing snakes and ladders, the children immediately see the dice and know the number of dots. It's the same, right?" (Teacher A)

"I use dominoes; the children see the numbers and then cut the tempeh according to the amount. Or I use bottle caps; before and after closing them, the children can guess whether the amount has changed or not." (Teacher B)

Teacher A's subitization practices took the form of dice recognition during Snakes and Ladders and pattern identification using watermelon seeds, in which children were asked to recall the numbers before and after addition or subtraction. Teacher B demonstrated greater variety, using dominoes for quantity matching, cutting tempeh according to dot patterns, and using a plate covered with a lid to prompt children to guess whether the number of bottle caps had increased or decreased. Observation records confirmed these activities occurred consistently across multiple sessions, indicating that subitization-like practice was

embedded in both teachers' routines, even if unintentionally. The principal validated this finding, acknowledging that while the term subitization was entirely new, the practice had in fact been present in daily classroom activities all along.

Wetland Themes in Play Activities

Both teachers acknowledged that wetland themes are rarely incorporated into classroom play activities. The river theme appeared more frequently due to its proximity to the school and children's direct familiarity with it. The swamp ecosystem, despite being more ecologically dominant in the surrounding area, had not been utilized as a learning context by either teacher.

"We sometimes use the river theme because the children often see it directly, but we rarely use swamps." (Teacher A)

"Yes, even though there are many swamps around the school, they have never been used as a learning theme." (Teacher B)

The principal's validation attributed this pattern to a preference for themes of local cultural wisdom — such as traditional regional foods and sasirangan fabrics — that are perceived as more familiar and accessible to children. Observation data supported this, showing that classroom environments and play materials reflected cultural rather than ecological local context.

Data Validation Results from the Principal

In an effort to maintain the validity of the research data, the researcher conducted member checking with the school principal. The principal emphasized that numeracy must be introduced early through play-based activities rather than rigid or formal instruction, reinforcing both teachers' statements about the importance of numeracy as preparation for elementary school. The principal further confirmed that the variety of numeracy activities is entirely at the discretion of individual teachers, with no written guidelines or institutional standards governing the form these activities should take — a finding that directly explains the strategic differences observed between Teacher A and Teacher B.

Regarding subitization, the principal confirmed that the term had only become known through the researcher's explanation during the validation process. Nevertheless, the principal acknowledged that teachers had in practice been applying

subitization in daily activities, even without assigning it a specific name — for instance, when children are asked to quickly identify the number of objects without counting them individually. Regarding the wetland theme, the principal admitted it is rarely foregrounded in learning activities. Although the school is situated in an area rich in swamp ecosystems, the themes most commonly raised in the classroom concern local cultural wisdom, such as traditional regional foods and sasirangan fabrics, which children encounter more readily in their daily lives. Taken together, the principal's validation reinforces all four core findings of this study: that numeracy is valued but practice-dependent, that subitization is practiced intuitively but not conceptually understood, and that wetland themes remain an underutilized pedagogical resource.

Discussion

Teachers' Awareness and Practice of Numeracy

The finding that both teachers hold a strong awareness of the importance aligns with the established view that early numeracy skills form a critical foundation for children's long-term cognitive development (Hartika et al., 2022; Nur Asri & Fitri, 2024). However, the divergence in their pedagogical approaches is analytically significant. Teacher A's reliance on worksheets and symbol-focused tasks reflects a transmission-oriented model of early mathematics instruction, whereas Teacher B's use of concrete objects and real-life situations reflects constructivist principles, wherein children build mathematical understanding through active engagement with meaningful materials (Cui et al., 2024; Wästerlid et al., 2024). From a play-based learning perspective, Teacher B's approach is more developmentally congruent with how young children construct number sense — through physical manipulation and embodied experience rather than abstract symbol recognition (Can, 2021). The absence of institutional guidelines, as confirmed by the principal, leaves this gap in approach unaddressed at the school level, making individual teachers' competency the primary determinant of children's numeracy experiences.

The Role of Teacher Competency in Shaping Numeracy Quality

The divergence between Teacher A and Teacher B also raises a broader question about what constitutes numeracy competency

in early childhood education settings. Competency in this context is not simply a matter of content knowledge — knowing what subitization is, for example — but also encompasses pedagogical content knowledge: the ability to transform mathematical understanding into appropriate learning experiences that are engaging and developmentally meaningful for young children (Rice, 2024). Teacher B's practice, despite the absence of formal subitization knowledge, demonstrates a high level of pedagogical intuition in selecting materials and designing activities that naturally invite mathematical thinking. This intuition, however, is not a reliable substitute for explicit content knowledge. Without understanding the theoretical basis of subitization, teachers cannot intentionally build on children's intuitive recognition abilities to scaffold progressively more complex number thinking. This finding points to the need for professional development programs that bridge the gap between teachers' existing intuitive practices and the theoretical frameworks that would allow them to extend and refine those practices more deliberately (Fahlevi, 2024; Wästerlid et al., 2024).

Teachers' Understanding of Subitization

The most significant finding of this study is the gap between teachers' conceptual knowledge and their intuitive subitization practice. The fact that both teachers were practicing subitization without being able to name or theorize it reflects the distinction MacDonald and Shumway (2016) describe between perceptual and conceptual subitization. Teacher A's dice-and-seed activities engaged children in perceptual subitization — the immediate apprehension of small quantities without counting. Teacher B's bottle cap and domino activities moved further toward conceptual subitization, requiring children to decompose and reason about changes in quantity, which connects directly to foundational number-operation thinking and number conservation (MacDonald & Wilkins, 2019; Özdem & Olkun, 2019). From a constructivist standpoint, these activities are valuable because they position children as active sense-makers rather than passive recipients of numerical information (Can, 2021; Wurm et al., 2021). However, without metacognitive awareness of subitization as a theoretical construct, teachers cannot deliberately sequence, scaffold, or extend these experiences to develop children's number

sense systematically. This represents a critical professional development gap that this study makes visible — and one that is consistent with Çiçek's finding that subitization remains undertheorized and underimplemented in non-Western early childhood education contexts.

Subitization as a Bridge to Broader Mathematical Thinking

Beyond its role as a standalone numeracy skill, subitization serves as a conceptual bridge to broader, more complex mathematical competencies in early childhood. When children rapidly recognize quantities without counting, they are not merely performing a perceptual task — they are developing the cognitive infrastructure for cardinality, number conservation, and eventually arithmetic operations (Fahlevi, 2024; Hartika et al., 2022). The activities observed in this study, particularly Teacher B's bottle cap guessing task and domino-to-tempeh matching, demonstrate how subitization naturally transitions into early number operation thinking when designed with sufficient cognitive challenge. This finding suggests that subitization should not be treated as a preparatory or peripheral skill in early numeracy curricula, but rather as a central and generative one — a point that is still insufficiently recognized in Indonesian PAUD practice (Nur Asri & Fitri, 2024; Nurida, 2024). Framing subitization as a bridge rather than a baseline would encourage teachers to design richer activity sequences that use quantity recognition as a starting point for exploring addition, subtraction, and estimation, rather than treating it as an endpoint in itself.

Wetland Themes in Numeracy Learning

The finding that wetland themes are rarely used in numeracy learning reveals a gap between the ecological richness of the school's surrounding environment and the learning contexts teachers draw on. While the preference for cultural local wisdom themes, such as traditional foods and sasirangan fabrics, is pedagogically legitimate, the exclusive prioritization of cultural over environmental contexts represents a missed opportunity (Fitria et al., 2021; Novitawati & Anggreani, 2021). Wetland ecosystems in particular offer a contextually rich and authentic source of subitization stimuli — the varied quantities of aquatic plants, seeds, fish, and insects present in swamp environments

provide naturally occurring visual sets that are ideal for perceptual subitization tasks (Çiçek, 2024; Liu et al., 2024; Pelland, 2024). The challenge ahead is therefore not simply thematic variety, but how to deliberately integrate wetland environments as a meaningful context for subitization learning — one that connects children’s daily lived environment with foundational mathematical thinking (Doddyansyah et al., 2025; Ridhaningtyas et al., 2024).

Toward Contextually Grounded Subitization Learning in Wetland Settings

The integration of wetland themes into subitization learning is not merely a matter of curriculum decoration — it carries deeper pedagogical value rooted in the principle of contextually grounded learning. When children encounter mathematical concepts through materials and environments that are genuinely part of their lived experience, the learning becomes not only more meaningful but also more cognitively accessible (Liu et al., 2024; Pelland, 2024). In the context of Banjarmasin’s wetland communities, this might take the form of counting groupings of water hyacinth flowers, floating seeds, or fish in a small container — all of which present naturally bounded visual sets that invite subitization without artificial construction. Such activities would simultaneously develop children’s number sense and deepen their ecological awareness of the environment they inhabit, reflecting an integrated approach to early childhood education that honors both cognitive and environmental dimensions of development (Çiçek, 2024; Fitria et al., 2021). For this integration to occur in practice, however, it cannot rely on individual teacher initiative alone — it requires deliberate curriculum design, teacher training, and institutional support that positions the wetland environment as a legitimate and valuable resource for early mathematical learning.

Institutional Implications

The principal’s validation situates the classroom-level findings within a broader institutional picture. The confirmation that subitization is absent from formal curriculum guidance, that activity design is left wholly to teachers’ discretion, and that wetland themes are institutionally underutilized reveals that subitization learning in this setting occurs incidentally rather than

intentionally. When subitization emerges only as a byproduct of individual teacher intuition rather than as a planned curricular component, children's exposure to this foundational skill becomes inconsistent across classrooms. Addressing this requires not only targeted professional development for individual teachers, but also institutional curriculum frameworks that explicitly recognize subitization as a core early numeracy competency in wetland-based early childhood education contexts.

D. Conclusion

This study reveals that early childhood teachers in wetland-based PAUD institutions in Banjarmasin already intuitively practice subitization — through dice games, dominoes, watermelon seeds, and bottle cap activities — despite lacking conceptual awareness of subitization as a mathematical construct. While both teachers demonstrate strong awareness of the importance of numeracy, their approaches diverge significantly: one remains anchored in symbol-based worksheet tasks, the other grounded in constructivist, play-based engagement with concrete materials. Wetland themes, despite the ecological richness of the surrounding environment, remain largely absent from numeracy learning, with teachers favoring cultural local wisdom themes perceived as more familiar to children.

Taken together, these findings point to a critical gap between intuitive practice and intentional pedagogy. Subitization is already happening in these classrooms — but without theoretical grounding, teachers cannot deliberately scaffold, sequence, or extend it to systematically build children's number sense. Similarly, the wetland environment holds untapped potential as an authentic and contextually meaningful source of subitization stimuli, yet this potential remains unrealized without deliberate integration into the curriculum. Addressing both gaps requires targeted professional development that bridges teachers' existing intuitions with subitization theory, alongside institutional curriculum frameworks that explicitly position wetland ecosystems as a legitimate resource for early numeracy learning. Future research should focus on developing and testing such frameworks in wetland-based early childhood education contexts across Indonesia.

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