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Integrating Ethnomathematics into Teaching Strategies to Enhance Preschoolers' Problem-Solving Skills: A Qualitative Case Study

Felisitas Ndeot*, Sofia Hartati[2], Hapidin[3]

[1,2,3]Jakarta State University, Jakarta, Indonesia
*Corresponding Email: icandeot@gmail.com

Abstract

This qualitative case study investigates how ethnomathematics is integrated into teaching strategies to improve problem-solving skills among preschoolers aged 5-6 years. Observational data were collected from two early childhood classes during a structured learning session themed "Tanah Airku", and analyzed through qualitative content analysis. Teachers use a culture-based approach, leveraging the introduction of regional clothing into game-based and inquiry-based learning. The findings show that teachers use culture-based approaches such as the introduction of regional clothing in play activities and inquiry, which creates a variety of problem-solving opportunities, from comparing patterns to making context-based decisions. This strategy not only fosters mathematical thinking and creativity but also strengthens children's connection to their cultural identity. Both teachers apply a child-centered approach but differ in the way they utilize cultural elements and scaffolding techniques to stimulate problem-solving. The implications of this study on professional development, educators utilize culturally responsive pedagogy and early childhood curriculum to incorporate local cultural contexts in learning activities to support effective problem-solving skills.

Keywords: teacher strategies; problem-solving skills; early childhood education; culturally responsive

INTRODUCTION

Problem-solving skills are crucial for early childhood development as they lay the foundation for critical thinking, cognitive growth, and emotional intelligence. Introducing these skills at a young age fosters children's ability to analyze situations, propose solutions, and persist in overcoming challenges. This early training not only enhances academic performance but also promotes social and emotional well-being, making it essential for holistic development. Problem-solving skills are linked to cognitive abilities, enabling children to engage in critical thinking and systematic reasoning (Nadila, 2021). Early proficiency in problem-solving predicts future academic success and interpersonal relationships (Greenwood et al., 2006). Developing problem-solving skills reduces aggression and depression while enhancing prosocial behaviors (Suarez et al., 2024). Problem-solving skills are crucial at an early age as they enable children to adapt to life, enhance self-regulation, empathy, and theory of mind, and are learnable and improvable, significantly impacting their social adaptation and overall development (Cesur & Yarali, 2020). Developing problem-solving skills at a young age equips children with the ability to navigate challenges, make decisions, and enhance their overall cognitive and social development (Diamond, 2018). Problem-solving skills are crucial for early development as they foster engagement, focus, and persistence in task completion, which are essential for school success. Tracking these skills helps assess children's readiness for school and the effectiveness of early interventions (Walker et al., 2023).

Research on problem-solving skills in preschoolers has identified several underexplored areas, particularly concerning the roles of teachers, cultural influences, and

the integration of ethnomathematics. These aspects are crucial for understanding how problem-solving can be effectively nurtured in diverse educational contexts. The ProSkiND framework emphasizes structured teacher preparations and active engagement, highlighting the need for clear instructional guidance in problem-solving activities (Anis et al., 2024). Young children's problem-posing and problem-solving are rarely the focus of research, particularly regarding teachers' roles and insights into their professional knowledge, as well as cultural approaches and ethnomathematical integration in preschool settings (Fosse et al., 2020). The paper highlights that much research on preschool problem-solving skills has focused on domain-specific tasks and memory skills, neglecting broader aspects such as the role of teachers, cultural approaches, and ethnomathematical integration in fostering metacognitive strategies (Lambert, 2001).

The research gap identified in the research revolves around the limited exploration of ethnomathematics specifically within preschool education. While existing literature highlights the effectiveness of ethnomathematics in enhancing mathematical understanding and cultural relevance in older students, there is a scarcity of qualitative studies focusing on preschoolers' problem-solving skills through this lens. Most studies concentrate on higher educational levels, such as elementary and middle school, leaving a gap in understanding how ethnomathematics can be effectively integrated into preschool curricula (Meneghetti et al., 2021). There is a need for more ethnographic approaches that capture the cultural contexts of preschoolers, which can inform teaching strategies. Research on educators' strategies for stimulating problem-solving skills in early childhood education is crucial as it lays the foundation for children's

cognitive and creative development. Effective problem-solving abilities are essential for navigating challenges throughout life, and early childhood is a pivotal period for cultivating these skills. Educators play a vital role in this process by integrating structured activities and engaging methods that promote critical thinking and creativity. Research on educators' strategies is crucial as it highlights effective methods for fostering young children's self-regulation and problem-solving skills, which are key predictors of school success. Understanding these strategies helps cultivate intentional pedagogies that promote autonomy and efficacy in students (Kelley, 2018).

This research addresses this gap by exploring how ethnomathematics is integrated into teaching strategies aimed at developing problem-solving skills among preschoolers. Focusing on two early childhood classrooms in Indonesia, this qualitative case study investigates how teachers design and implement culturally rooted activities and how these influence children's problem-solving development. The research focused on addressing two connected questions:

RQ1: How do preschool teachers integrate elements of ethnomathematics into their teaching strategies to develop problem-solving skills in 5 to 6-year-old children?

RQ2: What types of opportunities for problem-solving are created through culturally rooted teaching practices in early childhood classrooms?

METHODS

Research Design

This study adopted a qualitative case study design as outlined in previous literature by Creswell. A case study is a qualitative approach in which the investigator explores a real-life, contemporary bounded system (a case) or

multiple bounded systems (cases) over time through detailed, in-depth data collection involving multiple sources of information (e.g., observations, interviews, documents, and reports), and reports a case description and case-based themes (Creswell, 2012), this study focuses on a bounded system, two preschool classrooms, in which problem-solving skills were fostered through culturally rooted teaching strategies. This approach allowed for an in-depth understanding of how ethnomathematical elements were integrated into real classroom practices and how these influenced children's engagement in problem-solving activities.

Context and Participants

The research was conducted in two preschool classrooms located in Eastern Indonesia, each with a culturally rich learning environment. The participants consisted of two early childhood teachers teaching children aged 5–6 years. Both teachers were selected using purposive sampling based on their experience in implementing culturally-based instruction and their willingness to integrate local cultural elements into mathematics activities. Each classroom had 10–12 students, and both teachers held early childhood teaching certifications.

Data Collection Techniques and Trustworthiness

Data for this qualitative case study were collected using multiple techniques to ensure the richness and triangulation of perspectives. The researcher conducted direct classroom observations during structured learning sessions, capturing video recordings of the interactions between teachers and children. All videos were transcribed verbatim to facilitate detailed analysis. In addition, semi-structured interviews were conducted with each

participating teacher and recorded using a voice recorder. These interviews were also transcribed for analysis. Complementary documentation, including lesson plans, photos of learning materials, and children's work samples, were collected to contextualize the practices observed. These data collection techniques followed the recommendations of Creswell, who emphasized the importance of gathering multiple sources of evidence in qualitative case studies (Creswell, 2012). Furthermore, the approach aligns with Miles, Huberman, and Saldaña, who advocate for triangulating data sources to ensure the validity of findings (Miles et al., 2014). Data were collected over three weeks using three main techniques:

2.3.1 Observation: Each teacher was observed three times during 60-minute structured learning sessions themed "Tanah Airku". Observations focused on teacher-child interactions, problem-solving activities, and the integration of cultural elements.

2.3.2 Semi-structured interviews: Conducted after the observations, these interviews explored the teachers' perspectives on the strategies used, their intentions, and how cultural elements supported children's problem-solving development.

2.3.3 Documentation: Supporting materials such as lesson plans, student work samples, and photos of classroom activities were collected to enrich the contextual understanding and verify observed practices.

To ensure the credibility, transferability, dependability, and confirmability of the study, several strategies were employed throughout the research process, aligned with Lincoln and Guba's criteria (Lincoln & Guba, 1985).

Data Analysis Process

The collected data were analyzed using a thematic content analysis approach following the steps: data condensation, data display, and drawing conclusions (Miles et al., 2014). The analysis process includes data transcription, open coding, categorization, and theme discovery. To increase the validity of the data, the source triangulation technique (observations, interviews, documentation) and the confirmation of results through member checking are used by verifying key findings with the participating teachers. The unit of analysis was defined as meaningful interactional episodes, which included verbal or non-verbal exchanges between the teacher and children related to problem-solving activities using ethnomathematical content. The analytical process involved the following steps:

2.3.4 Episode identification: Observational data were segmented into episodes that showed teachers' pedagogical strategies or children's responses.

2.3.5 Coding and categorization: Each episode was open-coded and grouped into conceptual categories such as problem identification through cultural artifacts or verbal scaffolding using traditional patterns.

2.3.6 Theme development: categories were then synthesized into broader themes representing core teaching strategies (Ethnomathematical exploration for problem-solving, culturally responsive ethnomathematics, and facilitation of ethnomathematical dialogue).

Cross-referencing interview insights and documentation for consistency and depth supported this process. The analytical steps are summarized in Table 1 below.

Table 1. Analytical Process of Observational Data.

Data Source	Unit of Analysis	Coding Process	Category	Theme
Observation, Interview	Meaningful interactional episodes, teacher explanation and reflections	Open coding of teaching strategies	Use of local motifs, classification activities, and the use of traditional games	Ethnomathematical exploration for Problem-solving
Interview	Teacher explanation and reflections	Thematic grouping of pedagogical intent	Emphasis on cultural context in instruction	Culturally responsive ethnomathematics
Observation, Documentation	Meaningful interactional episodes,	Interpretation of cultural	Scaffolding prompts using	Facilitation of ethnomat

Data Source	Unit of Analysis	Coding Process	Category	Theme
	lesson plans, artifacts, student work	integration	local symbols	hematical dialogue

Ethical Considerations

Formal ethical approval was not required for this study. However, a research permit was obtained from the school authorities, and informed consent was secured from both teacher participants. All data were anonymized to protect participants' identities, and participation was entirely voluntary.

RESULTS

RQ1: How do teachers integrate ethnomathematics into their teaching strategies to enhance preschoolers' problem-solving skills?

Analysis of observational data, interviews, and documentation showed that teachers meaningfully integrated ethnomathematical elements through a culturally based learning approach. Three main themes emerged from the data analysis: Ethnomathematical Exploration for Problem-Solving, Culturally Responsive Ethnomathematics, dan Facilitation of Ethnomathematical Dialogue.

Ethnomathematical Exploration for Problem-Solving

From the results of observation of meaningful interactive episodes in the classroom, it was found that teachers actively use learning strategies based on local culture. Teachers utilize classification and measurement activities based on cultural artifacts, such as traditional clothing, traditional games, traditional house shapes, and *Manggarai songke* motifs. Children were asked to group clothing motifs and traditional house shapes based on geometric shapes that looked like triangles, squares, or symmetrical patterns, arranging the bottom stones from the largest to the smallest in a "boy" game. These activities stimulate their ability to recognize, connect, compare, and explain basic mathematical concepts through culturally relevant contexts. These activities encourage children to solve problems through observation, grouping, and decision-making.

“I chose traditional clothes because children are immediately interested, they like to see the motifs and can distinguish which ones are similar and which are not” (Teacher B, interview).

“I use images of traditional houses, children are interested in connecting each shape with the shape of the traditional house" (Teacher A, interview).

"The children love the traditional game, they are engrossed in playing and arranging stones so that the stone arrangement does not collapse” (Teacher B, interview).

These activities are not only fun, but also encourage children to think logically, classify, and solve problems in contexts that are familiar to children. This open coding process of observation data produces categories of strategies, such as the use of cultural symbols in classification games and manipulative activities.

Culturally Responsive Ethnomathematics

The results of the interviews with teachers provide a deeper insight into the pedagogical intentions behind the use of cultural elements in learning. Through thematic grouping, it is known that teachers consciously emphasize the importance of delivering mathematics material in a cultural context that is close to children's lives.

“I see that children understand math concepts more easily when connecting shapes to traditional house drawings" (Teacher A, interview).

“When introducing the regional clothes worn by each child and playing traditional games, it helps children build confidence and self-identity" (Teacher B, interview).

The categories that emerged from these interviews included an emphasis on cultural context in the delivery of materials and the adaptation of locally relevant learning content.

Facilitation of Ethnomathematical Dialogue

During the learning session, the teacher actively encourages the child to discuss the reasons they chose or grouped a particular motive. This approach reflects the use of verbal scaffolding to develop children's reasoning. The teacher uses open-ended questions like, "What makes these forms of traditional houses similar?" (Teacher A, observation), "How do you know which shape is the same or different in the picture of a traditional house?" (Teacher B, observation), "What did you do to prevent the stone arrangement from collapsing before it was thrown away?" (Teacher B, observation), "What if you look for the same shape as the drawing of this traditional house?" (Teacher A, observation).

The children's work shows that educators use local symbols as a tool in scaffolding or learning assistance such

as the use of regional clothing, images of traditional houses, and traditional games.

Figure 1. The Work of Sticking Puzzles and Coloring Regional Clothes.

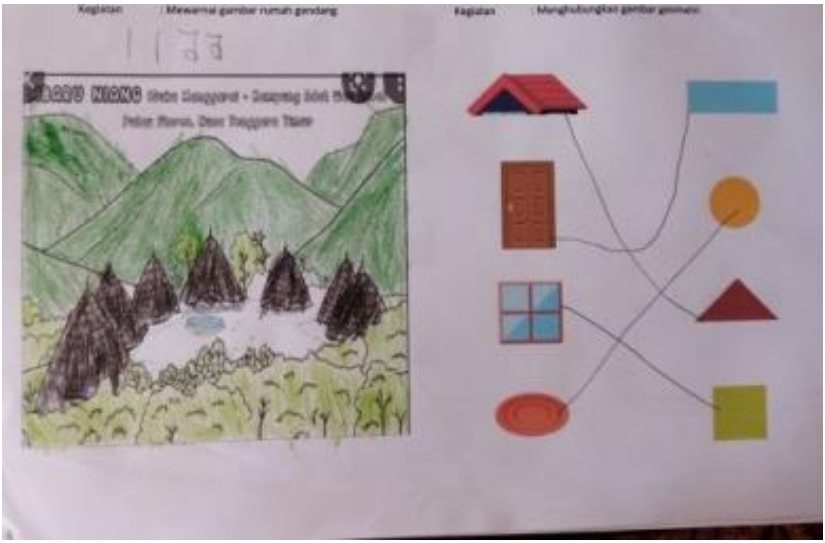

Figure 2. Works of Connecting Geometric Shapes and Coloring Traditional House Drawings.

Figure 3. Kids Play Traditional Games“Boy”.

In addition, teachers design lesson plans that include objectives that integrate cultural aspects in basic math topics, such as matching, classification, comparing, shapes, patterns, and geometry. This integration provides a contextual, meaningful, and motivating learning experience for children.

RQ2: In what ways do teachers differ in their use of cultural elements and scaffolding techniques to support preschoolers' problem-solving?

Both teachers demonstrate a commitment to a child-centred approach, but they differ in how they explore local cultures in learning as well as in providing step-by-step support (scaffolding) to develop children's problem-solving skills.

Teacher A focuses more on traditional house images and the use of geometric shapes in the context of local culture. Teacher A uses traditional house drawings as a tool to help children connect geometric shapes (e.g., triangles, squares) with patterns or structures they are familiar with in everyday life. Teacher A emphasizes the visual relationship between forms and cultural objects, which encourages children to recognize them in a context that is familiar to them.

"I help children think slowly, for example, where to start, what they see first. Sometimes I repeat the question in another way," (Teacher A, interview).

Teacher B, emphasizes more on traditional clothing and traditional games as cultural tools to teach mathematical concepts. Teacher B chooses cultural elements that are more directly related to the children's experiences, such as clothes and games they are familiar with. The use of traditional clothing helps children in distinguishing patterns and motifs, while traditional games allow children to physically group and measure through fun activities. This difference suggests that Teacher A uses more visual representations of cultural elements (images of houses), while Teacher B integrates cultural elements that are more practical and directly relate to the child's sensory experiences (traditional clothing and games).

Teacher A uses a scaffolding approach that focuses more on open-ended questions to encourage the child's logical thinking and reasoning. Teacher A often asks children to explain what they are doing in relation to the shapes and patterns they see in traditional house drawings. This technique encourages children to think more deeply about the relationship between cultural forms and objects, as well as improve their ability to communicate their thought processes.

Teacher B, meanwhile, uses a scaffolding in the form of practical, reflective questions that focus more on physical and manipulative activity. Teacher B encourages children to reflect and explain strategies they use in traditional games (such as "boy" games with rocks). This technique places more emphasis on the manipulative processes that occur in play and how children solve practical problems in the context of play.

Teacher A uses more scaffolding techniques based on conceptual questions that encourage children to relate mathematical ideas to cultural objects theoretically, while Teacher B focuses more on practical questions that support problem-solving through physical and manipulative experiences.

DISCUSSION

This research contributes to the growing study of the integration of ethnomathematics in early childhood education, particularly in its role in improving preschoolers' problem-solving skills through culturally meaningful pedagogical approaches. The most significant finding of this study is the way teachers use cultural symbols not only as learning content but also as scaffolding tools that highlight the pedagogical duality in which culture plays a role as a curriculum as well as an instructional support.

One of the key findings was the differences in scaffolding techniques used by educators that revealed variations in instructional responses. This difference demonstrates the flexibility of ethnomathematics-based teaching approaches and their ability to be adapted to each teacher's pedagogical style and goals. This is in line with sociocultural theory (Vygotsky, 1978), which states that learning is mediated by tools, both symbolic and material in the context of children's cultures. In this context,

cultural artifacts such as motifs and games became mediation tools that allowed for mathematical exploration and reasoning. These tools are not used superficially, but rather embedded in the context of authentic problem-solving, which requires the child to analyze, compare, and justify their reasoning. Furthermore, this study shows that cultural relevance increases children's engagement and cognitive investment in problem-solving tasks. Culturally responsive teaching encourages deeper understanding by building on students' cultural strengths (Gay, 2000). When teachers use familiar and meaningful materials, such as Manggarai songke motifs or traditional games such as "boy", children show higher levels of participation and independent reasoning.

Another important contribution is the observation that teachers' instructional strategies reflect their beliefs about learning and culture. One educator's use of ethnomathematical dialogue shows an emphasis on cognitive development through reflective questions, while the other educator's approach highlights experiential and social learning. This difference is in line with the thinking of Rogoff (2003), who distinguishes the structure of participatory learning across cultures, while affirming that different paths to mathematical understanding can coexist and be equally effective (Rogoff, 2003). Other findings suggest that ethnomathematics plays an important role in introducing early math and problem-solving skills in early childhood. Educators use ethnomathematics to introduce matching, classification, comparison, shapes, patterns, and geometry. Problem-solving skills are shown through children's activities such as solving problems when arranging stones, comparing stone sizes, solving puzzles, as well as classifying and connecting shapes. In early childhood, activities related to matching, classification, comparing, shapes, patterns, and geometry are part of the

early mathematics concept. Early mathematics concepts in early childhood include matching, classification, comparing, ordering or seriation, space, shape, geometric, pattern, early algebra, function, graphing, and number sense (Smith, 2001). Meanwhile, in developing problem-solving skills, in addition to educators utilizing scaffolding, educators also facilitate children to find solutions to problems encountered during learning. Problem-solving in early childhood is defined as a complex set of skills in which children demonstrate the ability to recognize the occurrence of a problem, seek and apply solutions for problem-solving, and engage in reflection to determine the effectiveness of the solutions applied (Diamond & Hsiao, 2019). Ethnomathematics can be used in early childhood learning to introduce early mathematical concepts and problem-solving skills.

Based on these findings, this study offers a new understanding of how ethnomathematics can function not only as content but also as a responsive pedagogical approach. These findings show the potential of ethnomathematics in mediating conceptual learning and identity formation when applied by paying attention to the cultural background and learning style of children. These findings also have practical implications for teacher education and curriculum development. The researchers suggest that early childhood educators be supported in recognizing and utilizing local cultural resources, as this can lead to more meaningful math learning and improved problem-solving skills. Future professional training should include training on how to design learning experiences that integrate cultural content and adaptive scaffolding techniques. This research expands the understanding of responsive ethnomathematical pedagogy by showing how the use of different cultural elements and scaffolding methods can encourage early mathematical thinking and

problem-solving skills. This research shifts the cultural view as a mere background, and instead places it as a dynamic instructional resource, empowering children to explore, reason, and solve problems in a personally relevant way.

CONCLUSION

This study explores how early childhood educators integrate ethnomathematics into their teaching strategies to support preschoolers' problem-solving skills. Through a qualitative case study approach, it was found that elements of local culture, such as traditional house shapes, traditional motifs, regional clothing, and traditional games, are not only effective as learning resources but also function as scaffolding tools rooted in culture. Teachers use these cultural references to encourage meaningful thinking, classification, comparison, and decision-making skills for children. One of the main contributions of this research is how ethnomathematics can encourage cognitive development while strengthening cultural identity in early childhood. This study highlights the differences in scaffolding strategies used by teachers, reflecting their pedagogical intentions as well as sensitivity to children's cultural identities. These findings reinforce the importance of culturally responsive teaching and show that math learning can be academically rigorous but still culturally relevant. However, this study has some limitations. First, the research was conducted in a specific cultural and geographical context, namely Manggarai, Indonesia, which may limit the generalization of the findings to other regions. Second, the study only involved two teachers, which although providing in-depth data, remained a limited sample. Third, the child's perspective is not collected directly, but is interpreted through observation

and interviews with teachers, so it may not fully describe the child's internal thinking process.

Further research can expand on these findings by involving a larger sample of different regions and cultural backgrounds to see how ethnomathematical strategies vary in different contexts. Longitudinal research is also recommended to explore how continued exposure to culturally responsive math teaching affects children's cognitive and social-emotional development in the long term. In addition, future research should explore children's perspectives directly to better understand how they interpret culturally rooted mathematical learning experiences. In closing, this study emphasizes the importance of integrating local culture in mathematics learning in early childhood education as a way to make learning more relevant, inclusive, and effective. By bridging culture and cognition, ethnomathematics can empower children to engage in problem-solving with confidence, curiosity, and pride in their culture.

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