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Mathematics in the Sandbox: Investigating Spontaneous Mathematical Talk During Free Play

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Abstract:
Children often explore mathematical ideas naturally while playing, yet these moments are rarely captured in early childhood classrooms. The purpose of this research is to investigate how spontaneous mathematical talk emerges during free play in a sandbox environment and to understand the types of mathematical ideas children express. A qualitative observational approach was used to document children's conversations and interactions during unstructured sandbox play. Data were collected through field observations and audio recordings of children's dialogue while they built, measured, compared, and organized materials in the sand. The recorded interactions were then coded and analyzed to identify patterns of mathematical language and concepts. The findings show that children frequently used informal mathematical talk such as counting, comparing sizes, estimating quantities, and describing shapes while collaborating with peers. These conversations appeared naturally without direct instruction and often emerged when children negotiated roles, shared materials, or solved small problems during play. The study suggests that free play spaces can become rich contexts for early mathematical thinking. Recognizing and supporting these moments may help educators encourage mathematical language in more natural and meaningful ways during everyday classroom activities.

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INTRODUCTION

Young children often begin to develop mathematical ideas long before they encounter formal instruction in school. Everyday activities such as playing, sharing objects, building structures, or comparing quantities naturally invite children to think about numbers, size, shape, and measurement. Because of this, early mathematical experiences are increasingly recognized as important for cognitive development and later academic readiness. When children are given space to explore, talk, and experiment, they do not simply play; they also construct meaning through language and interaction with peers. Research in early childhood education suggests that informal conversations during play can support the development of reasoning, problem solving, and early numeracy skills (Chen, 2025; Payne, 2024). In this sense, understanding how mathematical thinking appears in natural situations becomes important not only for educators but also for

families and communities who support children's learning. Therefore, examining how children express mathematical ideas during play can help educators recognize valuable learning opportunities that often happen in everyday classroom activities (Lundvin et al., 2025; Granone et al., 2025).

Despite the growing recognition of early mathematics learning, many early childhood classrooms still treat mathematics as a structured activity that occurs only during planned lessons. In practice, teachers frequently introduce numbers, shapes, or counting through worksheets, guided tasks, or short teacher-led activities. While these approaches can help children practice certain skills, they may overlook the spontaneous ways children naturally talk about mathematical ideas during play. When informal learning moments are ignored, opportunities to support children's curiosity and reasoning may also be lost. As a result, early mathematical thinking may appear limited or disconnected from children's real experiences. This situation raises an important question about how mathematics actually emerges in everyday play situations and whether children already demonstrate mathematical understanding without formal instruction. Exploring these spontaneous moments becomes necessary in order to better understand how early mathematics develops in natural contexts and how educators might support it more effectively (Arslan et al., 2025; Wang et al., 2025).

In many early childhood settings, free play is one of the most common activities where children interact, negotiate, and explore materials together (Donner et al., 2024; Wang et al., 2024). During activities such as building sand structures, filling containers, or comparing the size of objects, children often use language that reflects mathematical thinking. For example, they may count objects, compare heights, discuss quantities, or describe shapes while collaborating with friends. These interactions may appear simple, yet they show how children begin to organize ideas about number, measurement, and spatial relationships. Observations in play environments also reveal that children often explain their thinking to peers while solving small problems, such as deciding how much sand is needed to build a structure or determining which object is bigger or smaller. Such moments suggest that mathematical talk can emerge naturally through social interaction and shared exploration. However, these everyday conversations are rarely documented systematically in early childhood research or classroom practice.

Several previous studies have explored the relationship between play and early mathematics development. Researchers have found that play-based environments provide rich opportunities for children to develop early numeracy, spatial awareness, and problem-solving skills (Winarti et al., 2025). Studies on classroom interaction also show that children's mathematical understanding can grow through dialogue, questioning, and collaborative activities with peers or teachers (Osuna et al., 2024; Li et al., 2024). In addition, research on mathematical discourse in early childhood suggests that language plays an important role in helping children express and refine their thinking about numbers, patterns, and measurement (Nawaz et al., 2024). However, much of this research focuses on teacher-guided activities or structured learning situations where mathematical concepts are intentionally introduced. As a result, less attention has been given to how mathematical language appears spontaneously when children are simply playing and interacting without direct instruction (Metcalfe et al., 2025).

Other researchers have also examined how children use mathematical language in informal learning environments such as play centers, block areas, or outdoor activities (Durmaz & Burcu, 2025). These studies highlight that children often use words related to

counting, comparing, and measuring while exploring materials together. Although such findings show the potential of play as a context for mathematical learning, many studies still concentrate on identifying specific mathematical skills rather than closely examining children's natural conversations. In many cases, children's talk is recorded only as supporting evidence rather than as the main focus of investigation. Consequently, there remains limited understanding of how spontaneous mathematical talk develops during free play and how children negotiate meaning through everyday dialogue with peers. This gap suggests the need for research that carefully observes and analyzes children's natural conversations during play to better understand how mathematical thinking emerges in authentic situations (Zeng & Annie, 2025; Lüken & Miriam, 2025).

The novelty of this research lies in its focus on spontaneous mathematical talk that appears during free play, particularly in sandbox activities where children interact with open-ended materials. Rather than focusing on structured lessons or teacher-guided instruction, the study pays attention to the natural language children use while building, comparing, estimating, and solving small problems together. Sandbox play offers a unique environment where children can manipulate materials freely, test ideas, and communicate their thoughts in ways that feel meaningful to them. By observing these interactions closely, the study seeks to reveal how mathematical ideas appear naturally through everyday conversations. Understanding these moments can help educators recognize that meaningful mathematical learning does not always begin with formal instruction, but often grows from children's curiosity, exploration, and collaboration during play.

Based on these considerations, the research focuses on investigating how spontaneous mathematical talk emerges during free play and what kinds of mathematical ideas children express while interacting with peers. The study assumes that when children are given open opportunities to explore materials and communicate freely, they will naturally use language related to counting, comparing, estimating, and spatial reasoning. Examining these interactions can provide insight into how mathematical thinking develops in authentic learning environments. The findings are expected to contribute to early childhood education by showing how play-based settings can support mathematical language and reasoning in natural ways. By highlighting children's own conversations as a valuable source of learning, this research also encourages educators to pay closer attention to everyday interactions that may support early mathematical development.

RESEARCH METHODS

This research used a qualitative case study design to explore how spontaneous mathematical talk appears during children’s free play (Fragkandreas, 2025; Viera, 2023). A qualitative approach was chosen because the study focuses on understanding children’s natural conversations, interactions, and behaviors rather than measuring numerical outcomes (Haq & Yasin, 2025; Henline-Hall, 2024; Tisdell et al., 2025). The case study design allowed the researcher to observe a specific learning environment in depth and to capture detailed examples of how children communicate mathematical ideas while playing. Instead of testing predetermined variables, the study focused on exploring real situations where children interact with materials and peers in a natural way. Through close observation of everyday play activities, the researcher was able to document how

counting, comparing, estimating, and describing shapes or quantities emerged in children's conversations. This design was considered suitable because spontaneous mathematical talk often appears in subtle and unpredictable moments that are better captured through detailed qualitative observation.

The research was conducted in an early childhood education setting where children regularly engage in outdoor play activities, including sandbox play. The location was selected because it provides a learning environment that encourages exploration, collaboration, and open-ended play. Sandbox activities are particularly useful for observing early mathematical thinking because children frequently build structures, fill containers, compare sizes, and organize materials while playing with sand. These actions naturally invite discussion and negotiation among peers, which often leads to the use of mathematical language. The setting also allowed the researcher to observe children in a familiar environment where they could play comfortably without feeling that they were being formally evaluated. This helped ensure that the conversations and behaviors recorded during the study reflected children's authentic interactions during free play.

Data were collected through direct observation, field notes, and audio recordings of children's conversations during sandbox play sessions. The researcher observed how children interacted with materials and peers, paying close attention to moments when mathematical ideas appeared in their talk. Field notes were used to document important situations, gestures, and interactions that supported the conversations being recorded. The collected data were then analyzed using an interactive process consisting of data condensation, data display, and data verification. In the condensation stage, the researcher selected and simplified segments of conversations that contained mathematical language or ideas. After that, the data were organized and displayed in categories to identify patterns of counting, comparison, measurement, and spatial language. Finally, the researcher reviewed and verified the findings by rechecking the recorded conversations and observation notes to ensure that the interpretations accurately reflected the children's interactions during play.

RESULTS AND DISCUSSION

Results

During sandbox play, several forms of spontaneous mathematical talk emerged as children interacted with materials and peers. These types of mathematical expressions were identified through observation and conversation analysis and are summarized in Table 1.

Table 1. Types of Spontaneous Mathematical Talk Observed During Sandbox Play

Type of Mathematical Talk	Example of Children's Words	Mathematical Idea
Counting	"One, two, three scoops."	Counting and quantity
Comparing	"Mine is bigger."	Size comparison
Quantity estimation	"We need more sand."	Informal estimation
Spatial language	"Put it under the bridge."	Spatial relationship
Shape description	"Let's make a round wall."	Early geometry

Counting and Quantifying During Play

One of the most visible forms of spontaneous mathematical talk during sandbox play appeared when children counted objects or estimated quantities of sand. While filling buckets, building small hills, or collecting shells and stones, several children

naturally used counting words to keep track of materials. For example, one child counted scoops of sand while filling a container and told a friend that five scoops were enough to make a “big castle.” Another child counted small stones that were placed on top of a sand structure, explaining that the tower needed “more pieces” to look complete. These counting actions were usually accompanied by gestures such as pointing, moving objects, or arranging items in a line.

In many situations, counting was not used only to determine quantity but also to organize play activities. Children often counted turns when sharing tools such as small shovels or buckets. For instance, one child suggested that each friend could dig sand three times before passing the shovel to another player. Through this simple agreement, counting became a tool for managing cooperation and fairness within the group. These interactions showed that numbers were not introduced by adults but emerged naturally as children negotiated their play.

Children also used counting when comparing quantities. When two groups were building sand structures, one child compared the number of shells decorating each structure and stated that their castle had “more shells.” Another child responded by adding additional shells while counting aloud. Such moments demonstrated how counting helped children evaluate differences and adjust their creations. Even when their counting was not always accurate, the process itself revealed how children were experimenting with numerical ideas through conversation.

Overall, these interactions illustrate that counting and quantifying emerged frequently during free play without formal instruction. The sandbox environment provided many opportunities for children to manipulate objects, group materials, and estimate quantities. As a result, counting became a natural part of children's communication and collaboration while they explored their ideas through play.

Comparing Size, Amount, and Height

Another form of spontaneous mathematical talk appeared when children compared objects, structures, or quantities of sand. During the construction of sand castles and tunnels, children frequently used words such as “bigger,” “smaller,” “higher,” or “more.” For example, when two children were building hills of sand next to each other, one child observed that the friend’s hill was taller and suggested adding more sand to make theirs higher. This comparison encouraged both children to continue modifying their structures while discussing the results of their efforts.

In several moments, children also compared the amount of sand inside containers. When filling buckets or cups, they often checked whether their containers were “full,” “almost full,” or “not enough.” One child shook a bucket gently and explained that it needed more sand because it did not feel heavy yet. Another child poured sand from one container to another while commenting that the second container was “bigger.” These comparisons showed how children were exploring the idea of quantity and capacity through physical interaction with materials.

Comparisons were also expressed through collaborative discussions. When children worked together to build a large structure, they sometimes debated which wall of the sandcastle was stronger or taller. One child suggested making the wall thicker so it would not collapse easily. Through this conversation, children were indirectly exploring ideas related to measurement, balance, and structure. Although the language used was simple, the reasoning behind these comments reflected early mathematical thinking.

These observations show that comparison played an important role in children's play conversations. Rather than learning these ideas through formal explanations, children developed their understanding by observing differences between objects and describing them verbally. The sandbox provided a rich context where such comparisons naturally occurred as children manipulated materials and evaluated the results of their actions.

Spatial Language and Shape Descriptions

Spatial language also appeared frequently in children's conversations during sandbox play. When building tunnels, towers, and pathways, children often described the position and direction of objects using words such as "under," "on top," "inside," "next to," and "around." For example, one child explained to a friend that a small toy car should go "through the tunnel and under the bridge." This instruction helped coordinate the play activity while simultaneously reflecting spatial reasoning.

Children also talked about shapes while designing their sand structures. In some cases, they described their creations using familiar terms such as "circle," "square," or "round." One group of children attempted to make a circular wall around their sandcastle and discussed how the shape should look from above. Although the shapes were not always precise, the conversation showed how children connected geometric ideas with the objects they were creating.

Another interesting observation was how spatial language supported collaboration. When one child asked a friend to place a bucket "closer" to the sand structure or to dig "deeper" in a specific area, the instructions helped guide shared actions. These expressions allowed children to coordinate their efforts and adjust the placement of objects in space. In this way, spatial talk functioned not only as communication but also as a tool for organizing group activities.

Overall, the presence of spatial language suggests that children naturally use positional and geometric ideas when interacting with physical materials. Sandbox play provides a dynamic environment where children can test spatial relationships directly, making it easier for them to express these ideas through conversation and action.

Discussion

The findings of this study show that spontaneous mathematical talk often appears when children are involved in free play, especially when they interact with open materials such as sand. During the activity, children naturally used counting, comparison, and spatial descriptions while working together and exploring their ideas. These results support the idea that early mathematical thinking does not always begin with formal instruction, but can grow from everyday interactions and playful exploration (Zeng & Annie, 2025; Siregar& Torang, 2025). When children play together, they frequently talk, negotiate, and explain what they are doing. In these moments, mathematical language becomes part of their communication as they try to solve small problems, organize materials, or complete a shared task (Fadzil et al., 2025; Santos-Trigo & Manuel, 2024). This suggests that play environments can provide meaningful opportunities for children to express and develop early mathematical ideas.

The presence of counting in children's conversations shows how numbers can emerge naturally as practical tools during play. Children counted objects, turns, or scoops of sand not because they were asked to do so, but because counting helped them manage

their activities and communicate with friends. In this way, numbers became useful for organizing actions, sharing resources, and keeping track of materials. Previous studies have also suggested that early numeracy skills often develop through informal experiences where children interact with objects and people in meaningful situations (Graven et al., 2024; Cohrssen et al., 2025). When children use numbers for real purposes during play, they may develop a deeper understanding of quantity compared to situations where counting is introduced only through structured lessons.

Comparative language such as “bigger,” “smaller,” “higher,” or “more” also appeared frequently during sandbox activities. Children used these words to evaluate their sand structures, compare the amount of sand in containers, or decide how to improve their creations. These comparisons often encouraged children to experiment further by adding more sand, adjusting shapes, or changing the design of their structures. Such interactions reflect early forms of mathematical reasoning, where children observe relationships between objects and modify their actions based on what they notice (Mendez et al., 2024). Informal comparison during play has been recognized as an important foundation for later understanding of measurement and quantity (Chen et al., 2025).

Spatial language was another important element in children's conversations. Words such as “under,” “on top,” “inside,” and “next to” helped children describe where objects should be placed and how structures should be built. These expressions allowed children to coordinate their activities and work together more effectively. Research in early childhood learning has shown that spatial language plays an important role in helping children develop ideas about position, movement, and geometric relationships (Ersan et al., 2025). When children manipulate physical materials and talk about what they are doing, they gradually build a clearer understanding of spatial concepts (Presser et al., 2025).

Overall, the results highlight that free play can become a rich setting for early mathematical learning. Instead of viewing mathematics only as a subject taught through formal activities, educators may also consider everyday play as an important moment where mathematical language and reasoning naturally appear. Observing and responding to these conversations can help teachers recognize children's developing ideas and support them in meaningful ways (Pyle et al., 2024). Encouraging open exploration, collaboration, and dialogue during play may therefore strengthen children's early mathematical understanding while keeping the learning process enjoyable and connected to their experiences (Wickstrom et al., 2025).

CONCLUSION

The most important finding of this study is that young children naturally express mathematical ideas during free play, even without direct instruction from adults. Through activities such as building sand structures, filling containers, sharing tools, and negotiating with peers, children frequently used counting, comparison, and spatial language, showing that mathematical thinking can grow from simple interactions and everyday conversations during play. This study highlights that open-ended play environments can become meaningful spaces for early mathematical exploration because children develop mathematical ideas naturally when they are free to experiment, communicate, and collaborate. In addition, this research contributes to the academic discussion on early childhood mathematics by emphasizing spontaneous mathematical talk as an important

aspect of learning that is often overlooked in classroom research. By focusing on children's natural conversations during sandbox play, the study provides insight into how mathematical language emerges in authentic situations. However, the study is limited by its focus on a single play setting and a relatively small group of participants. Therefore, future research is recommended to explore similar interactions in different play environments, age groups, and cultural contexts, as well as to utilize longer observation periods and video analysis to gain deeper insights into children's mathematical thinking during play.

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