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EXPLORING MATHEMATICAL IDEAS IN THE RO'AN TRADITION OF AN ISLAMIC BOARDING SCHOOL

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ABSTRACT

This study addresses a gap in ethnomathematics research by examining a pesantren cultural practice that has rarely been explored as a source of mathematical ideas. Previous ethnomathematics studies have mainly focused on traditional games, crafts, architecture, and visual motifs, while everyday communal practices in Islamic boarding schools (pesantren) remain underexamined. This study explores the Ro'an tradition, a communal cleaning practice in an Islamic boarding school, to identify the mathematical reasoning embedded in its cultural routines and to consider its implications for mathematics education. Using an ethnographic design supported by observation, interviews, and documentation, the study analyzed six main aspects of ro'an: group formation, task assignment, workflow sequencing, scheduling, quantitative considerations, and rotational mechanisms. Data were interpreted from an ethnomathematics perspective and carefully formalized through ethnomodeling. The findings show that ro'an embodies various mathematical ideas, including set partitions, relations and functions, algorithms, proportional reasoning, spatial structuring, recurrence, and cyclic scheduling. These findings indicate that mathematical reasoning emerges naturally within pesantren cultural practices even without formal mathematical language. The study contributes to ethnomathematics by expanding its scope to religious-community practices and offers pedagogical implications for designing culturally responsive mathematics learning in pesantren and madrasah contexts.

Keywords: Ethnomathematics, Ro'an Tradition, Pesantren, Mathematics Education, Islamic Boarding School, Culturally Responsive Mathematics Learning.

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INTRODUCTION

Mathematics education worldwide continues to face persistent challenges related to relevance, contextual understanding, and learner engagement. Conventional pedagogical approaches often present mathematics as an abstract, decontextualized subject, disconnected from students' cultural backgrounds and everyday experiences, leading to decreased motivation, limited problem-solving abilities, and a sense that mathematics is meaningless and disconnected from students' lives (Herna & Sainab, 2025; Lubis, 2025). In contrast, a growing body of research emphasizes the need for culturally grounded mathematics education, particularly through the lens of ethnomathematics, which recognizes mathematical reasoning embedded in local practices, traditions, and lived experiences (Sandi, 2025; Shimwandi et al.,

2024). Studies integrating indigenous knowledge systems within mathematics instruction consistently demonstrate enhanced engagement, deeper conceptual understanding, and strengthened mathematical identity among learners (Pongoliu, 2025; Susanti et al., 2025).

Therefore, it is important to adopt approaches that connect mathematics learning with students' cultural experiences and ways of knowing, so that school mathematics becomes meaningful and closely linked to their real lives. Ethnomathematics is the study of how mathematical ideas, concepts, and practices are embedded within the cultural activities, traditions, and daily lives of diverse communities, emphasizing that mathematics exists not only in formal academic settings but also in local knowledge systems across the world (Nst & Batubara, 2024). It explores how different cultural groups understand and apply mathematical ideas through activities such as counting, measuring, designing, and locating (Umbara et al., 2021). As a framework, ethnomathematics bridges informal cultural knowledge with school mathematics and supports learning approaches that build on students' lived experiences, thereby increasing engagement, motivation, achievement, and cultural appreciation (Abdul et al., 2024; Rosa & Orey, 2023; Wulandari et al., 2024). Overall, ethnomathematics presents mathematics as a universal human activity expressed through culturally diverse forms, promoting equity, cultural relevance, and meaningful learning across educational contexts (Rosa & Orey, 2023).

In the Indonesian context, Islamic boarding schools, known as pondok pesantren, are among the oldest and most influential educational institutions. These schools are not merely academic spaces but cultural ecosystems characterized by strong communal values, discipline, moral education, and collective responsibility. Millions of students (santri) in Indonesia are shaped by the daily routines, rituals, and traditions of pesantren life (Hamzah & Turmudi, 2022; Nabilla, 2025). Despite the richness of this cultural environment, mathematics education in pesantren-affiliated schools or madrasahs remains aligned with mainstream national curricula, often overlooking the cultural knowledge embedded in the everyday practices of santri (Ma'Arif, 2018; Mustafa & Aminah, 2025). As a result, there is a pedagogical and epistemological disconnect between students' lived experiences and the mathematical content they study.

In pesantren life, ro'an refers to a regular communal work activity in which santri clean and maintain shared spaces such as dormitories, classrooms, corridors, bathrooms, courtyards, and prayer areas. It is not merely a cleaning routine, but a disciplined collective practice that reflects the values of cooperation, responsibility, obedience, and khidmah (service). Because ro'an is organized through group coordination, task division, spatial arrangement, scheduling, and rotation, it provides a concrete cultural context in which mathematical ideas may emerge naturally through everyday practice.

Ro'an is performed regularly—daily, weekly, or in special events—and includes structured processes such as task distribution, group coordination, management of space, scheduling, tool allocation, and sequential procedures for completing work (Saini, 2020; Zahid et al., 2023). While ro'an is primarily understood as a moral, social, and religious practice that cultivates discipline, cooperation, responsibility, and environmental awareness, the activity also contains rich mathematical structures. These include grouping and partitioning, proportional distribution, measurement, spatial reasoning, time scheduling, optimization, algorithmic processes, and functional relationships. Thus, ro'an constitutes a significant yet overlooked cultural practice with embedded mathematical knowledge that can be systematically explored through the lens of ethnomathematics.

A review of the literature reveals a clear *research gap*. Ethnomathematics studies in Indonesia have predominantly focused on traditional arts such as batik, weaving, dance structures, and architectural motifs (Astanti & Fitroh, 2022; Deda et al., 2024; Muhtadi et al., 2017; Utami & Putri, 2024; Zayyadi et al., 2018). Very few studies have examined cultural-

mathematical practices emerging from Islamic educational environments, especially pesantren traditions. To date, there is no substantial body of research analyzing ro'an as a site of mathematical activity, nor uncovering how santri intuitively employ mathematical reasoning in task distribution, scheduling, spatial organization, or collaborative problem solving. Furthermore, there is limited work on how cultural practices in pesantren can be transformed into meaningful mathematics learning resources, despite their potential to bridge cultural identity and academic content.

Investigating the ethnomathematical dimensions of the ro'an tradition offers several important contributions. Theoretically, it expands the ethnomathematics discourse by incorporating religious-community practices, an area that has received limited international attention. Practically, it provides teachers and curriculum designers with culturally responsive instructional materials that reflect the lived realities of santri. Pedagogically, it helps create mathematics learning experiences that are meaningful, relevant, and aligned with local values. Socially and culturally, it positions pesantren traditions not only as moral and religious practices but also as sources of intellectual and mathematical knowledge. Accordingly, the objectives of this study are to explore and identify mathematical practices in the ro'an tradition, analyze how these practices reflect ethnomathematical constructs, and propose pedagogical implications for integrating pesantren-based cultural knowledge into mathematics education. The findings are expected to contribute to ethnomathematics scholarship, support culturally grounded mathematics instruction, and enrich the understanding of Islamic educational culture within the global mathematics education community.

In this study, ethnomathematics is used as the broader perspective for identifying mathematical ideas embedded in cultural practices, while ethnomodeling serves as the analytical bridge for interpreting these cultural practices into formal mathematical language. Thus, ethnomathematics helps reveal that ro'an contains mathematical reasoning in lived practice, whereas ethnomodeling enables the researcher to describe these cultural patterns as sets, functions, sequences, proportions, or cycles without losing their emic meaning. To avoid over-formalization, all mathematical interpretations in this study are grounded in field data, including observed procedures, participant explanations, and documented organizational routines. Accordingly, this study aims to identify mathematical ideas embedded in the ro'an tradition, analyze how these ideas can be interpreted through an ethnomathematical and ethnomodeling lens, and formulate pedagogical implications for culturally responsive mathematics learning in pesantren and madrasah contexts.

METHOD

This study employed an ethnographic design in one Islamic boarding school (pesantren) in East Java, Indonesia. The site was selected purposively because ro'an is practiced regularly and is strongly embedded in the daily life of santri. The pesantren accommodates male students from junior and senior secondary levels and maintains a structured communal culture characterized by collective routines, dormitory-based organization, and regular religious and social activities.. Ethnography was chosen because it allows researchers to understand cultural practices from the insider's perspective, consistent with the goals of ethnomathematics to uncover mathematical reasoning situated within cultural systems (Umbara et al., 2021). The research was conducted in a pesantren located in Java, Indonesia, selected based on three cultural boundaries: (1) a community sharing linguistic characteristics, particularly the use of Indonesian and Javanese with pesantren-specific registers; (2) a community defined by clear physical and administrative boundaries; and (3) a community shaped by shared historical experiences, especially participation in collective practices such as *ro'an*. Data were collected over approximately four weeks, covering routine weekly ro'an and larger monthly communal cleaning sessions. Participants were selected purposively and consisted of six pesantren

leaders/ustadz, twenty senior santri who coordinated ro'an, and ninety six active santri who regularly took part in the activity. These participants were chosen because they represented different roles in planning, organizing, and carrying out ro'an. Semi-structured interviews were conducted to explore participants' perceptions of the procedures, cultural values, and implicit reasoning underlying *ro'an*, while institutional documents, such as schedules and organizational structures, were reviewed to complement the primary data (Price & Smith, 2021).

Data collection included participant observation, semi-structured interviews, and documentation. Observations focused on group formation, task allocation, use of tools, spatial division, sequence of work, and rotation mechanisms. Interviews explored participants' understanding of ro'an procedures, values, and practical reasoning. Documentation included ro'an schedules, organizational notes, photographs, and field records.

Data analysis was conducted through triangulation across observations, interviews, and documentation. Ethnomathematics was used to identify mathematical ideas embedded in cultural practice, while ethnomodeling was used cautiously to formalize these patterns into mathematical concepts. To ensure that mathematical interpretations remained grounded in culture, each formal interpretation was traced back to observed routines and participant explanations. Member checking with pesantren leaders and senior santri was also conducted to confirm the cultural validity of the interpretations. In this study, ethnomathematics is used as the broader perspective for identifying mathematical ideas embedded in cultural practices, while ethnomodeling serves as the analytical bridge for interpreting these cultural practices into formal mathematical language. Thus, ethnomathematics helps reveal that ro'an contains mathematical reasoning in lived practice, whereas ethnomodeling enables the researcher to describe these cultural patterns as sets, functions, sequences, proportions, or cycles without losing their emic meaning. To avoid over-formalization, all mathematical interpretations in this study are grounded in field data, including observed procedures, participant explanations, and documented organizational routines. Researchers identified cultural procedures within *ro'an*, examined recurring patterns of counting, grouping, task distribution, proportional reasoning, spatial organization, sequencing of activities, and strategies for efficiency, and then interpreted the underlying mathematical structures. The analytical process followed Spradley's ethnographic sequence, beginning with identifying relevant cultural scenes, observing them through quantitative, relational, and spatial (QRS) perspectives, recognizing significant mathematical elements, and finally interpreting their cultural and educational meanings (Prahmana & D'Ambrosio, 2020). To ensure the validity of findings, member checking was conducted with pesantren leaders and senior santri, while triangulation across participants and data sources reinforced the trustworthiness of interpretations. Through this methodological approach, the study sought to capture how *ro'an* reflects naturally occurring mathematical reasoning and how these insights can inform culturally grounded mathematics education.

RESULT

The ethnographic investigation conducted in the pesantren setting revealed that the ro'an tradition, commonly understood as a collective act of service, contains a range of structured practices that extend beyond its cultural and spiritual significance. Through prolonged observation, interviews, and triangulation of data, it became evident that the organization, execution, and coordination of ro'an activities are governed by patterned reasoning that aligns with various mathematical constructs. These findings demonstrate how cultural practices naturally generate mathematical ideas and how these ideas can be interpreted within formal mathematical frameworks. The following section presents the field findings in

detail, highlighting both the cultural procedures of ro'an and the mathematical structures inherent within them.

Group Formation and Organizational Structure

Field observations revealed that the *ro'an* system in the pesantren follows a structured grouping mechanism, similar to the partitioning of a set into non-overlapping subsets. Santri are divided into relatively fixed work groups consisting of 8–15 members, depending on dormitory size and area coverage. These groups represent disjoint subsets of the pesantren population, each responsible for specific work zones such as dormitories, classrooms, the mosque, courtyard, kitchen, and sanitation areas.The process of group formation follows culturally codified rules,

Santri are grouped by dormitory block or academic cohort, a classification system analogous to equivalence classes.Each group is assigned a coordinator, functioning as the "node" through which task instructions flow.Membership remains stable for one month, after which rotation occurs to ensure fairness across work areas.

The grouping structure used in the ro'an tradition reflects several embedded mathematical ideas. At its foundation, the division of santri into work teams demonstrates concepts from set theory, including the creation of subsets, the formation of disjoint partitions, and the assignment of individual members to specific sets. The process also involves elements of combinatorics, as the pesantren must determine various possible group arrangements to achieve balanced and effective team compositions. Additionally, the assignment of individuals to particular work areas or responsibilities illustrates relations, where each santri is mapped to a role or location according to predetermined criteria. Importantly, the pesantren leadership carries out this grouping manually, basing decisions on factors such as reliability, physical capability, seniority, and the overall distribution of workload. This practice reflects an underlying form of optimization, where leaders aim to create the most efficient and equitable configuration of groups to ensure smooth ro'an activities. Through these processes, the cultural tradition naturally incorporates mathematical reasoning even though it is not explicitly recognized as such by the community.

Workflow Sequence and Procedural Structure

Across weekly and monthly *ro'an*, the work process follows a clear, algorithmic sequence, observed consistently over multiple sessions, ool preparation (collecting brooms, dustpans, mops, buckets), Area clearing (removing obstacles, opening windows, arranging footwear), Primary cleaning (sweeping, scrubbing, wiping surfaces), Waste consolidation (moving dirt toward central disposal points), Final checking by the group coordinator, Tool return and confirmation of completion. This sequence reflects a deterministic algorithm, where each step must be completed before the next is initiated. Deviations from the order often result in repeated work or inefficiency, according to both coordinators and *ustadz*.

The workflow sequence observed in the ro'an tradition reflects a deterministic algorithm, in which each stage of the process must be completed before the next can begin. This ordered progression—from tool preparation, to area clearing, to primary cleaning, and finally to inspection—creates a structured procedural flow that ensures efficiency and prevents redundancy. Both coordinators and ustadz noted that when the sequence is disrupted, such as beginning detailed cleaning before clearing the area, the group often has to repeat tasks or spend additional time correcting inconsistencies. This pattern illustrates the presence of algorithmic thinking, where actions follow a predefined series of steps; sequential logic, which governs the logical progression of activities; and optimization strategies, as the structure is designed to minimize time and effort. It also involves conditional operations, since movement from one stage to the next typically depends on the successful completion of the previous

task—for example, transitioning to mopping only after sweeping is finished or moving to a new area only when the current zone has passed inspection. Together, these practices demonstrate how procedural discipline within ro'an embodies mathematical reasoning grounded in everyday cultural activity.

Task Distribution and Functional Relationships

Within each group, tasks are assigned individually, forming a one-to-one mapping:

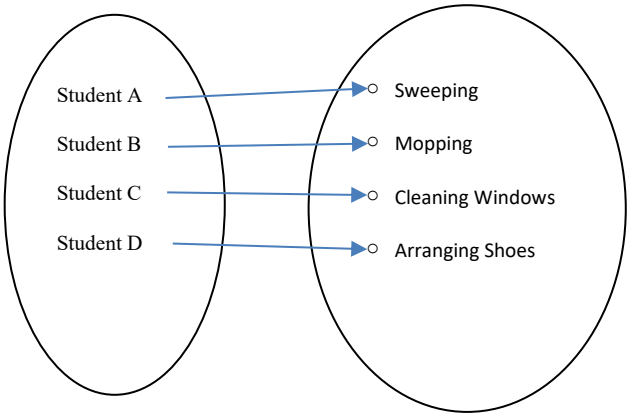

Figure 1. Mapping the İndividual Student Corresponds to Exactly One Specific Task Assigned

The assignment of tasks within each ro'an group reflects a function-like structure, in which every input—represented by an individual student—corresponds to exactly one output, namely the specific task assigned to them at a given time. This establishes a clear mapping relationship that mirrors the mathematical definition of a function. Over time, these task assignments do not remain static; instead, they rotate cyclically to maintain fairness and distribute responsibility evenly among group members. Such rotation gives rise to several mathematical phenomena. When tasks eventually return to previous holders, the pattern resembles an inverse function, for example.

Context:

A group of four santri rotates tasks weekly.Let the original task assignment be a function:

$f = \{(A, sweeping), (B, mopping), (C, dusting), (D, trash)\}$

After rotation, each santri receives the next person's previous task:

$f^{-1} = \{(sweeping, A), (mopping, B), (dusting, C), (trash, D)\}$

Interpretation: The inverse function maps each task back to the student who originally performed it.

This matches the *ro'an* rotation where tasks eventually return to previous holders. The repeated process of reassigning roles across cycles can also be viewed as function composition, where each round of rotation produces a new mapping derived from the previous one.

Function Composition (f ∘ g)

Context: Rotation occurs in two stages:

- g = weekly rotation
- f = reassignment for monthly *ro'an*

Example:

$$g = \begin{cases} A \to \text{mopping} \\ B \to \text{dusting} \\ C \to \text{trash} \\ D \to \text{sweeping} \end{cases}$$

Next month, tasks change again according to f**:**

$$f = \begin{cases} \text{mopping} \to \text{trash} \\ \text{dusting} \to \text{sweeping} \\ \text{trash} \to \text{sweeping area supervision} \\ \text{sweeping} \to \text{mopping} \end{cases}$$

The composition:

$$(f \circ g)(A) = f(g(A)) = f(\text{mopping}) = \text{trash}$$

Interpretation:
Function composition captures how multiple layers of rotation interact over time.

Additionally, the continuous shifting of tasks among the same set of students forms permutation cycles, illustrating how role assignments move systematically within a closed set. Through these interconnected patterns, the ro'an tradition reveals a rich embedded system of functions and their inverses, mapping relationships, and permutations and rotational structures, demonstrating the presence of sophisticated mathematical reasoning within its cultural practice.

Scheduling System and Periodicity

The pesantren implements ro'an through two interconnected scheduling scales: weekly sessions for routine cleaning and monthly sessions for larger, more comprehensive maintenance. These schedules operate in recurring cycles that reflect underlying mathematical structures. Weekly ro'an follows a predictable pattern in which the same tasks and areas are revisited at fixed intervals, demonstrating the behavior of a periodic function. When combined with the broader monthly cycle, the interaction between the two schedules aligns with GCM (Greatest Common Divisor) and LCM (Least Common Multiple) principles, particularly when determining the points at which weekly and monthly responsibilities overlap or reset. Additionally, the monthly cycle, which restarts after every four weekly rotations, illustrates a form of recurrence relation, where the schedule depends on repeated patterns across time. Together, these scheduling practices show how the temporal organization of ro'an naturally embodies mathematical concepts related to periodicity, sequencing, and cyclic structures.

The use of GCD (Greatest Common Divisor) and LCM (Least Common Multiple) within the ro'an tradition demonstrates how mathematical reasoning naturally emerges from pesantren practices. Various ro'an activities operate on different time intervals—such as daily cleaning, room cleaning every three days, outer-area cleaning every five days, and large-scale ro'an akbar every seven days—creating authentic contexts in which the LCM is implicitly applied to determine when multiple activities coincide. For example, if room cleaning occurs every three days and corridor cleaning every five days, both take place on the same day after fifteen days, reflecting LCM(3,5). Similarly, GCD is embedded in the equitable distribution of tasks, cleaning tools, and work areas. When 24 santri, 16 tools, and 8 cleaning zones must be divided fairly, GCD(24,16,8) = 8 allows the formation of eight balanced teams, each consisting of three santri and equipped with two tools. GCD also appears in rotational scheduling; for instance, if

two groups contain 12 and 18 members, GCD(12,18) = 6 enables both to form fair rotation teams of six members. LCM likewise supports the coordination of major pesantren activities—for example, determining that ro'an akbar every seven days, communal recitation every fourteen days, and room inspection every twenty-one days overlap every forty-two days. These examples show that GCD and LCM arise organically from the practical knowledge of santri and the organizational needs of the pesantren, demonstrating how mathematical ideas are deeply embedded in cultural practice. As an ethnomathematical context, ro'an authentically illustrates how mathematics supports fairness, efficiency, scheduling, and cooperative work, making it a powerful foundation for culturally grounded mathematics learning and project-based activities that connect formal concepts to lived

Quantitative Considerations: Number of Santri, Time, Tools, and Area

The quantitative dimensions of the Ro'an tradition reveal additional layers of mathematical reasoning embedded in everyday decision-making. First, the allocation of tasks is closely tied to the number of available santri, the size of the area to be cleaned, the type of work required, and the time constraints set by the pesantren. When a group has fewer members than usual, such as when several santri are absent, tasks are redistributed proportionally among those present. This redistribution demonstrates intuitive use of ratios and proportional reasoning as coordinators adjust workloads to maintain balance and ensure that all areas remain adequately covered.

Time estimation is another quantitative process that reflects mathematical relationships. Weekly Ro'an typically lasts 45–60 minutes, whereas monthly Ro'an may extend to two or three hours depending on the complexity of the tasks and the condition of the environment. Coordinators determine the required duration by considering the number of workers, the area's physical size, and the anticipated level of dirt. These judgments implicitly draw on linear relationships and rate-of-work reasoning, as coordinators mentally model how changes in workforce or area size will affect the time required.

Tool distribution further illustrates embedded mathematical thinking. The allocation of brooms, mops, dustpans, and other cleaning equipment is based on the number of santri in a team, the type of area being cleaned, and the need to maximize efficiency. Coordinators often perform mental arithmetic to ensure that each group has enough tools without creating shortages or redundancies. This process reflects basic combinatorial thinking, as it determines how to distribute a limited set of tools among multiple groups. It also involves optimization, since effective distribution must minimize idle time, prevent tool scarcity, and ensure smooth workflow. Through these routine practices, Ro'an demonstrates a natural integration of proportional reasoning, arithmetic operations, combinatorial logic, and optimization, all emerging organically from cultural and organizational needs rather than formal instruction.

The division of work areas during Ro'an reflects clear spatial reasoning and geometric structuring embedded in the pesantren's daily routines. To ensure efficiency and prevent overlapping tasks, large cleaning areas, such as dormitory halls, courtyards, and corridors, are systematically divided into smaller zones, each assigned to specific santri or sub-groups. This practice demonstrates geometric partitioning, as coordinators mentally divide irregular spaces into manageable sections. The cleaning process itself often follows symmetrical patterns, such as parallel sweeping or mopping lines, which help maintain order and ensure uniform coverage. In some pesantren, the arrangement resembles a coordinate-like system, where students are assigned positions as if on an informal grid, allowing them to identify their exact starting and ending points. Moreover, coordinators frequently estimate the surface area of each zone to balance workloads, ensuring that larger sections are assigned more helpers while smaller zones require fewer. Through these practices, the Ro'an tradition embodies essential geometric and

spatial concepts, illustrating how mathematical thinking naturally emerges from cultural procedures aimed at maintaining cleanliness, efficiency, and cooperation.

Rotational Mechanisms

Rotation serves as a central organizational principle in the ro'an tradition, ensuring fairness, a balanced workload, and shared responsibility among santri. These rotations occur across multiple dimensions, group area assignments, individual cleaning tasks, tool management duties, and, in some pesantren, even leadership roles. The rotation system operates on consistent weekly or monthly cycles, creating predictable temporal patterns that mirror mathematical structures. The repeated shifting of tasks and areas creates cyclic permutations, in which roles circulate among the same set of students in a closed loop. Because rotations recur after fixed intervals, they also produce recurrence sequences, demonstrating how responsibilities return to their initial state after a series of steps. When different rotation schedules intersect, such as weekly area assignments and monthly leadership changes, the alignment of these cycles reflects LCM-based timing, indicating when multiple roles reset simultaneously. Furthermore, because each student is assigned exactly one new role in every rotation, the system functions as a bijective mapping, ensuring a one-to-one correspondence between individuals and tasks over time. Through these structured yet culturally grounded mechanisms, the ro'an rotation system exhibits sophisticated mathematical reasoning that is naturally embedded within the pesantren tradition.

The following synthesizes these findings by presenting an integrated summary of the mathematical concepts embedded in Ro'an, highlighting how everyday cultural activities naturally embody principles typically associated with formal mathematics.

Table 1. Summary Of Ro'an Cultural Practices And Their Possible Mathematical İnterpretations

No	Ro'an Component / Cultural Practice	Embedded Mathematical Concepts
1	Group Formation and Organizational Structure	Set theory, partitions, disjoint subsets, equivalence classes, classification, combinatorics, optimization in group composition
2	Workflow Sequence and Procedural Structure	Algorithms, sequential logic, deterministic procedures, conditional operations, procedural reasoning, optimization strategies
3	Task Distribution and Functional Relationships	Relations, one-to-one mappings, functions, inverse functions, function compositions, permutation cycles
4	Scheduling System and Periodicity	Periodic functions, sequences, recurrence relations, cycles, LCM for overlapping schedules, GCD for rotation alignment
5	Quantitative Considerations (Number of Santri, Time, Tools, Area)	Ratios and proportions, arithmetic operations, linear relationships, combinations, rate-of-work reasoning, optimization of resources
6	Rotational Mechanisms (Tasks, Areas, Tools)	Cyclic permutations, bijective mappings, recurrence sequences, periodic rotations, LCM-based cycle alignment

DISCUSSION

The findings extend ethnomathematics research by showing that mathematical reasoning is embedded not only in artistic or material culture, but also in pesantren communal routines. The novelty of this study lies in its focus on ro'an as a religious-social practice that organizes people, tools, time, and space in patterned ways that can be interpreted mathematically. This expands prior studies that have mostly examined games, textiles, or architecture, and brings pesantren culture into the discussion of culturally grounded mathematics education. Consistent with the principles of ethnomathematics, these mathematical elements emerge naturally from cultural activities rather than from formal instruction, and the ethnomodeling perspective helps illuminate how cultural procedures can be translated into academic mathematical ideas without losing their contextual meaning (Rosa & Orey, 2023). The grouping system used in Ro'an reflects core concepts of set theory, including sets, subsets, and partitions: students are organized into distinct work groups that function as disjoint sets, while the rotational system displays periodic structures analogous to cyclic functions. The one-to-one assignment of tasks to individuals mirrors the structure of a mathematical function, and the subsequent rotation generates inverse mappings and composite processes, offering culturally grounded representations of functions, inverses, and permutations, supporting earlier scholarship that demonstrates the presence of advanced mathematical reasoning in everyday cultural activities (Prahmana & D'Ambrosio, 2020; Umbara et al., 2021). Spatial–relational reasoning is also visible in the coordinated movement patterns, symmetrical formations, and strategic placement of tools, reflecting geometric concepts such as segmentation, symmetry, distance minimization, and spatial optimization, in line with findings from research on traditional architecture and weaving (Sandi, 2025).

Quantitative reasoning is evident in how santri adjust task distribution based on group size, demonstrating proportional thinking, arithmetic operations, and rate-of-work reasoning. Likewise, the timing and periodicity of weekly and monthly ro'an reveal temporal cycles and recurrence patterns that align with mathematical structures found in cultural rituals (Rosa & Orey, 2023; Umbara et al., 2021). Importantly, these mathematical features cannot be separated from the underlying pesantren values of discipline, cooperation, responsibility, and khidmah, which give meaning to the organization of ro'an and situate it within a moral and spiritual framework. This integration reinforces the idea that ethnomathematics supports not only cognitive development, but also cultural identity, social responsibility, and community cohesion (Rosa & Orey, 2023; Wulandari et al., 2024). Collectively, these findings highlight how the ro'an tradition embodies a holistic form of mathematical practice—one that emerges organically from communal life and offers valuable insights for culturally grounded mathematics education.

Beyond identifying mathematical structures, this study also reveals significant pedagogical potential for integrating ro'an into mathematics instruction. The observed cultural practices can be systematically transformed into meaningful learning activities aligned with formal mathematical topics. For instance, the grouping system can be used to introduce set theory and classification, with students modeling real ro'an groups as sets, subsets, and partitions. Task assignments can be translated into functions and relations, allowing students to represent mappings between individuals and tasks, explore inverse functions through rotation, and analyze compositions through multi-stage task changes. Similarly, the rotation system provides an authentic context for teaching permutations, cycles, and periodic functions, enabling students to visualize abstract concepts through familiar routines.

The ro'an workflow offers a concrete model for developing algorithmic thinking and procedural reasoning, enabling students to reconstruct, analyze, and optimize cleaning

procedures as step-by-step algorithms. Spatial arrangements and area division can be directly linked to geometry learning, including partitioning space, symmetry, coordinate systems, and area estimation. Meanwhile, scheduling systems based on weekly and monthly cycles provide a natural entry point for exploring FPB–KPK (GCD–LCM), sequences, and recurrence relations, particularly when determining when multiple activities coincide. Quantitative aspects such as time estimation, tool allocation, and workload distribution can be used to teach ratios, proportions, linear relationships, and optimization problems grounded in real-life pesantren contexts.

From an instructional design perspective, these findings support developing culturally responsive, context-based learning models, such as Project-Based Learning (PjBL) or Contextual Teaching and Learning (CTL). Teachers can design projects in which students analyze real ro'an schedules, create fair task-distribution models, simulate rotation systems, or design efficient cleaning plans using mathematical reasoning. Such activities not only enhance conceptual understanding but also promote higher-order thinking skills, including problem-solving, reasoning, and decision-making. In pesantren or madrasah contexts, this approach is particularly relevant because it aligns mathematical learning with students' lived experiences, thereby increasing engagement and perceived relevance.

Furthermore, integrating ro'an into mathematics instruction supports character education. As students engage with mathematical representations of ro'an, they internalize values such as cooperation, responsibility, fairness, and discipline. This dual outcome aligns with the broader goal of ethnomathematics, which seeks to connect cognitive development with the cultural and moral dimensions of learning. In this sense, ro'an-based mathematics learning not only improves mathematical understanding but also strengthens students' cultural identity and social awareness.

Overall, this study extends previous ethnomathematics research by not only identifying mathematical concepts embedded in cultural practices but also showing how to operationalize them in classroom instruction. The ro'an tradition offers a concrete, authentic, and pedagogically rich context that helps transform abstract mathematical ideas into meaningful learning experiences. Therefore, it holds strong potential as a foundation for designing culturally grounded mathematics curricula, particularly in pesantren and similar educational settings. At the same time, this study recognizes an important conceptual limitation. Not every form of social coordination should be automatically interpreted as mathematics. A mathematical reading becomes meaningful only when the cultural practice exhibits identifiable structures such as classification, relation, quantity, measurement, sequence, recurrence, or optimization, and when these interpretations are grounded in participant accounts and observed routines. Therefore, ethnomodeling must remain culturally faithful and analytically cautious.

CONCLUSION AND SUGGESTIONS

This study shows that the ro'an tradition in pesantren embeds mathematical ideas in group organization, task allocation, work sequence, scheduling, spatial division, and rotational mechanisms. These findings confirm that mathematics can emerge from everyday cultural practice and that pesantren traditions can serve as meaningful contexts for mathematics education. More specifically, the study contributes to ethnomathematics by broadening its focus to religious community practices and by demonstrating how ethnomodeling can be used carefully to connect lived cultural routines with formal mathematical concepts. For educational practice, the findings suggest that teachers in pesantren and madrasah contexts can transform ro'an into contextual learning activities, such as tasks on sets and partitions based on group formation, functions based on role assignment, GCD and LCM based on overlapping schedules, and geometry based on area division.

However, the study also recognizes that the mathematical interpretation of cultural practice must remain bounded by observable patterns and participants' meanings, so that formalization does not exceed the cultural evidence. Future research may develop ro'an-based learning materials, test their implementation in mathematics classrooms, and examine students' responses to culturally grounded mathematical tasks in pesantren settings.

REFERENCES

Astanti, A. V., & Fitroh, E. M. (2022). Eksplorasi etnomatematika pada permainan tradisional di daerah Kabupaten Batang [Ethnomathematical exploration of traditional games in Batang Regency]. (2022). *SANTIKA: Seminar Nasional Tadris Matematika*, *2*, 202–222. https://proceeding.uingusdur.ac.id/index.php/santika/article/view/805

Likur, F. A. H., Nurdin, R., Baharuddin, B., Sappa, S. R. A., & Alimuddin, F. (2024). Improving the quality of mathematics learning using an ethnomathematics approach among class IX students at Private MTS Al-Hikmatul Bahri Ternate. *Mattawang: Jurnal Pengabdian Masyarakat*, *5*(2), 37–42. https://doi.org/10.35877/454RI.mattawang2769

Deda, Y. N., Rosa, M., Disnawati, H., & Tamur, M. (2024). Ethnomathematical perspectives on Galah Asin: Investigating the mathematical and cultural significance of a traditional game. *Journal Elemen*, *10*(3), 516–532. https://doi.org/10.29408/jel.v10i3.25467

Herna, & Sainab. (2025). Contextual approach in mathematics learning for elementary school children. *Smart: Journal of Multidisciplinary Educational*, *3*(2), 137–146. https://doi.org/10.61677/smart.v3i2.588

Lubis, A. H. (2025). Efforts to ımprove student learning motivation in mathematics learning by using the realistic mathematics education approach at MIN 1 Banda Aceh. *ETNOPEDAGOGI: Jurnal Pendidikan dan Kebudayaan*, *2*(1), 420–428. https://doi.org/10.62945/etnopedagogi.v2i1.714

Ma'Arif, S. (2018). Education as a foundation of humanity: Learning from the pedagogy of pesantren in Indonesia. *Journal of Social Studies Education Research*, *9*(2), 104–123. https://jsser.org/index.php/jsser/article/view/256

Mawaddah Hamzah, A., & Turmudi. (2022). The analysis of pedagogic principles in the ımplementation of mathematics learning curriculum at ıslamic boarding schools. *12 Waiheru*, *8*(1), 95–103. https://doi.org/10.47655/12WAIHERU.V8I1.11

Muhtadi, D., Sukirwan, W., & Prahmana, R. C. I. (2017). Sundanese ethnomathematics: Mathematical activities in estimating, measuring, and making patterns. *Journal on Mathematics Education*, *8*(2), 185–198. https://doi.org/10.22342/jme.8.2.4055.185-198

Mustafa, R. Z., & Aminah, S. (2025). Madrasah mu'allimin-mu'allimat curriculum ıntegration sunan drajat lamongan ıslamic boarding school. *Harmony Philosophy: International Journal of Islamic Religious Studies and Sharia*, *1*(4), 39–53. https://doi.org/10.70062/HARMONYPHILOSOPHY.V1I4.47

Nabilla, N. (2025). Internalization of multicultural education values in ıslamic boarding schools. *Edusoshum : Journal of Islamic Education and Social Humanities*, *5*(2), 182–193. https://doi.org/10.52366/EDUSOSHUM.V5I2.158

Nst, M. I., & Batubara, N. K. (2024). The ımportance of ethnomathematics in education: A systematic literature review. *Proceedings of International Conference on Education*, *2*(1), 552–557. https://doi.org/10.32672/pice.v2i1.1412

Pongoliu, Y. H. (2025). The effectiveness of Gorontalo local wisdom-based ethnomathematics in enhancing mathematics understanding. *Journal La Edusci*, *6*(1), 79–94. https://doi.org/10.37899/journallaedusci.v6i1.2161

Prahmana, R. C. I., & D'Ambrosio, U. (2020). Learning geometry and values from patterns: Ethnomathematics on the batik patterns of Yogyakarta, Indonesia. *Journal on Mathematics Education*, *11*(3), 439–456. https://doi.org/10.22342/jme.11.3.12949.439-

456

Price, H. E., & Smith, C. (2021). Procedures for reliable cultural model analysis using semi-structured interviews. *Field Methods*, *33*(2), 185–201. https://doi.org/10.1177/1525822X20982725

Rosa, M., & Orey, D. C. (2023). Considerations about ethnomathematics, the culturally relevant pedagogy, and social justice in mathematical education. *Educação Matemática Pesquisa Revista do Programa de Estudos Pós-Graduados em Educação Matemática*, *25*(2), 145–165. https://doi.org/10.23925/1983-3156.2023v25i2p145-165

Saini, M. (2020). Tradisi ro'an (kerja bakti) dalam meningkatkan karakter sosial santri di Pondok Pesantren al-qomar Wahid Pati Anrowo Nganjuk [The ro'an tradition of communal work in strengthening the social character of Islamic boarding school students]. *Tasyri` : Jurnal Tarbiyah-Syari`ah-Islamiyah*, *27*(2), 70–83. https://doi.org/10.52166/tasyri.v27i2.101

Sandi, E. K. (2025). Exploring ethnomathematics in local culture: a bridge between tradition and classroom mathematics. *Aksioma Education Journal*, *2*(1), 38–45. https://doi.org/10.62872/aej.v2i1.18

Shimwandi, R. N., Ngololo, E. N., Kanandjebo, L. N., & Sciences, A. E. (2024). Indigenous knowledge content & mathematics curriculum: some evidence from a Namibian perspective. *Jumuga Journal of Education, Oral Studies, and Human Sciences (JJEOSHS)*, *7*(2), 1–15. https://doi.org/https://doi.org/10.35544/jjeoshs.v7i2.93 Indigenous

Susanti, R. M., Gunansyah, G., & Nasution, N. (2025). Integrating local culture into mathematics learning: ethnomathematics approach using udeng pacul gowang in elementary schools. *Journal of Innovation and Research in Primary Education*, *4*(3), 947–957. https://doi.org/10.56916/jirpe.v4i3.1472

Umbara, U., Wahyudin, W., & Prabawanto, S. (2021). How to predict good days in farming: an ethnomathematics study with an ethnomodelling approach. *JRAMathEdu (Journal of Research and Advances in Mathematics Education)*, *6*(1), 71–85. https://doi.org/10.23917/jramathedu.v6i1.12065

Utami, N. W., & Putri, A. K. (2024). Bridging culture and math: The Javanese calendar as an educational tool. *Journal of Honai Math*, *7*(3), 469–484. https://doi.org/10.30862/jhm.v7i3.681

Wulandari, D. U., Mariana, N., Wiryanto, W., & Amien, M. S. (2024). Integration of ethnomathematics teaching materials in mathematics learning in elementary school. *IJORER : International Journal of Recent Educational Research*, *5*(1), 204–218. https://doi.org/10.46245/ijorer.v5i1.542

Zahid, A., Bakhri, S., Ikayanti, R. L., & Hijazi, M. (2023). Ro'an tradition: building ecological awareness of Mamba'us Sholihin Blitar Islamic boarding school. *Dimensia: Jurnal Kajian Sosiologi*, *12*(1), 47–60. https://doi.org/10.21831/dimensia.v12i1.58127

Zayyadi, M., Hasanah, S. I., & Surahmi, E. (2018). Ethnomatematics exploration in traditional games as a form of students' social interaction. *JIPM (Jurnal Ilmiah Pendidikan Matematika)*, *6*(2), 125. https://doi.org/10.25273/jipm.v6i2.1826