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The Use of Number Tree Media in Developing Cognitive Ability of Group B Children at RA Nurul Hidayah Bangsalsari, Jember

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Abstract

The recognition of number symbols is a core cognitive attainment expected of children in Group B, yet instruction in many Islamic kindergartens still relies on abstract worksheets that do not match the concrete-operational needs of five- to six-year-olds. This study aimed to describe how number tree media are used in the numeracy learning of Group B children at RA Nurul Hidayah Bangsalsari, Jember, and how the children's cognitive ability in recognising number symbols becomes visible during that use. The research employed a qualitative descriptive design with a single-case study approach, bounded as the numeracy learning of one class over one semester. Data were generated across eight weeks of fieldwork through participant observation of twelve numeracy sessions attended by eighteen children aged five to six years, in-depth semi-structured interviews with the class teacher, the head of the institution, and three parents, and documentation comprising lesson plans, work samples, and photographs. Analysis followed the interactive model of Miles, Huberman and Saldaña, moving from open and axial coding through matrix display to conclusion drawing and verification, with credibility pursued through prolonged engagement, source and technique triangulation, member checking, and peer debriefing. Four themes were constructed. The medium is used within a stable four-part routine in which the detachable dual-faced fruit, rather than the board, carries the instructional weight. The teacher's shift from naming symbols to asking about them changes what the children are required to produce and therefore what can be seen of their understanding. Cognitive ability appears in manipulative action before it appears in speech, and unevenly across the five competences, most readily in quantity-symbol matching and most haltingly in ordering. The criterion of correctness migrates over the fieldwork from the teacher's authority to the quantity itself, a shift visible in the emergence of unprompted peer checking. The study concludes that the contribution of the medium is inseparable from the interactional arrangement in which it is placed.

Keywords Case Study; Cognitive Ability; Early Childhood Education; Number Symbol Recognition; Number Tree Media; Qualitative Research

INTRODUCTION

Early childhood is widely acknowledged as the period in which the architecture of thinking is laid down, and the quality of stimulation provided during these years shapes the ease with which later academic learning proceeds. Among the six developmental domains recognised in Indonesian early childhood education policy, the cognitive domain occupies a strategic position because it underpins the child's capacity to observe, classify, reason, and solve problems in everyday situations. Cognitive development is not an isolated attainment; it is interwoven with language, motor coordination, and social interaction, so that a delay in one domain frequently manifests as difficulty in another (Rohmah, 2025). Contemporary research on mature play further indicates that the deeper forms of learning that appear in the preschool years emerge precisely when children are given sustained opportunities to manipulate, negotiate, and represent objects rather than merely to receive information (Cheng et al., 2024).

Within the cognitive domain, the recognition of number symbols is one of the most closely monitored attainments for children in Group B. The Indonesian standard of child development attainment expects children aged five to six years to mention the sequence of numbers, to recognise the written symbols that correspond to those numbers, to arrange the symbols in order, and to connect a quantity of objects with its symbol. These four competences are not synonymous. A child may recite numbers fluently as a verbal chain while remaining unable to attach the spoken word to its printed form, a dissociation that teachers often misread as mastery (Ula et al., 2023). Studies employing structured manipulatives have shown that cardinality and one-to-one correspondence develop only when children are repeatedly required to place a discrete quantity beside a symbol and to justify the pairing (Roostin, 2021). Problem-solving approaches that begin from the child's own strategies rather than from teacher demonstration have likewise been found to strengthen number concepts more durably than rote drill (Setyaningtyas & Harun, 2020).

Despite this consensus, classroom practice in many institutions has not moved decisively away from paper-based instruction. Preliminary observation conducted at RA Nurul Hidayah Bangsalsari in the first semester of the 2025/2026 academic year revealed a familiar pattern. Numeracy activities in Group B were dominated by tracing and colouring worksheets; the classroom possessed few manipulative materials; and children who finished early were left without a follow-up task. Only a small number of children could place a set of objects beside the correct symbol without being told; several routinely exchanged the symbols for six and nine; and a further group abandoned the task once the sequence passed ten. The teacher described attention as dissipating within the first ten minutes of a numeracy session, and reported that the completed worksheets gave her no way of telling which children understood the notation and which had copied a neighbour. Similar conditions have been documented elsewhere in Indonesia, where worksheet-driven approaches were found to depress engagement and to produce recognition that did not transfer to new contexts (Iz, 2025). Open-ended tasks, by

contrast, have been shown to influence number concept attainment positively because they permit multiple solution paths and sustain curiosity (Rohmalina et al., 2020).

A further complication is that cognitive attainment in this area is frequently assessed in ways that reward procedural fluency over conceptual understanding. A child who can point to the correct card when the teacher says a number has demonstrated recognition; a child who can explain why five dots belong beside the symbol five has demonstrated understanding. Instruments that record only the former will register progress that the latter would not confirm, and teachers acting on such records may withdraw support prematurely. Analyses of number symbol recognition among four- to five-year-olds have drawn attention to precisely this distinction and to the difficulty of capturing it in routine classroom assessment (Rahma, 2023). The distinction is, however, difficult to reach through scoring at all, because what separates the two children is not the answer they give but the conduct that accompanies it: the pause, the recount, the fingertip moved across a cluster of dots, the glance toward a classmate. Evidence of that kind is generated by watching and listening rather than by rating, and that is the methodological premise of the present study.

The theoretical justification for shifting toward concrete media is well established. In Piagetian terms, children aged five to six occupy the preoperational stage, in which thinking is bound to perceptible attributes and symbolic reasoning is still fragile; abstract notation therefore has to be anchored to objects that can be seen, held, and rearranged. Bruner's account of enactive, iconic, and symbolic representation supplies the instructional sequence that follows from this premise, while Vygotsky's zone of proximal development explains why the presence of a more capable partner determines how far a child can travel beyond independent performance. Empirical syntheses of early childhood media confirm the pattern: varied concrete media raise cognitive attainment more reliably than any single method used in isolation (Hanifa et al., 2024), and media that combine visual attractiveness with a manipulable component sustain attention long enough for consolidation to occur (Putri et al., 2025). Even reviews that focus on multimedia arrive at a comparable conclusion, namely that the decisive variable is the quality of the child's active engagement rather than the technological sophistication of the medium itself (Pangarti & Yaswinda, 2023).

Number tree media belong to this family of concrete manipulatives. The medium consists of a tree-shaped board bearing branches to which detachable elements—usually fruit, leaves, or cards printed with number symbols—can be attached and removed. Its instructional value lies in the combination of three affordances: a visually salient context that children associate with a familiar object, a detachable component that invites physical action, and a spatial arrangement that makes ordering and grouping visible. Evidence for its effectiveness has accumulated steadily. Studies report gains in cognitive attainment among children aged four to six (Maharani & Widjayatri, 2024), improvements in the recognition and naming of number symbols following systematic development and expert validation (Laksana et al., 2024), and increases in visual knowledge of the symbols one to ten among four- to five-year-olds (Firmansah, 2019). Related counting-tree variants have produced comparable results for the concept of number symbols

one to ten (Syafitri et al., 2018) and for early numeracy more broadly (Febiola, 2020; Hasanah et al., 2023). Applications in Islamic kindergarten settings have also been reported (Saripah et al., 2024), as have adaptations that add a smart-tree component for counting (Azizah et al., 2023) and digital renderings of the same structure (Arkas & Rakimahwati, 2023).

Three gaps nevertheless remain. First, the great majority of existing studies were conducted in general kindergartens rather than in *raudhatul athfal*, where the curriculum integrates religious habituation with the developmental domains and where instructional time for numeracy is correspondingly compressed. Second, almost all of them report the medium's contribution as a change in an aggregate score, which establishes that something moved but not what the movement consisted of; the child's hand on the fruit, the wording of the teacher's question, and the moment a classmate intervenes all disappear into a single percentage. Third, few studies document the process side of use, such as the sequencing of group size, the phrasing of teacher prompts, and the handling of children who dominate the material, even though that process is what a practitioner must reproduce. What is missing, in short, is a close description of the medium in use. The present study addresses these gaps by generating and analysing qualitative data on the use of number tree media in a rural Islamic kindergarten in Jember, attending to the interactional detail that scored instruments necessarily discard.

Accordingly, this study set out to answer two questions. First, how are number tree media used in the numeracy learning of Group B children at RA Nurul Hidayah Bangsalsari, Jember? Second, how does the children's cognitive ability in recognising number symbols become visible during that use, considered across the five competences named in the standard of child development attainment? The findings are intended to give teachers in comparable settings a description concrete enough to act upon, together with a realistic sense of which competences appear readily in children's conduct and which remain difficult to elicit.

METHODS

This study used a qualitative descriptive design with a single-case study approach. The design was chosen because the research questions ask how a practice is carried out and how a capacity becomes visible within it, and questions of that form are answered by describing conduct in its setting rather than by measuring change against a criterion (Creswell & Poth, 2018). The case was bounded as the numeracy learning of one Group B class at one institution across one semester, following the convention that a case study examines a contemporary phenomenon within its real-world context, where the boundary between phenomenon and context is not self-evident (Yin, 2018). No treatment was assigned, no comparison group was constructed, and no threshold of success was fixed in advance. The researcher entered the classroom to document what the teacher and the children did with the medium, what they said while doing it, and what could be inferred from both.

The research was carried out at RA Nurul Hidayah, Bangsalsari District, Jember Regency, East Java, during the first semester of the 2025/2026 academic year, across eight weeks of fieldwork between September and November 2025. The site was selected purposively on three

grounds: the institution serves a rural catchment in which few families provide numeracy stimulation at home, the school had not previously used manipulative numeracy media, and the class teacher was willing to admit an observer for a sustained period. The observed case comprised the eighteen children of Group B, ten boys and eight girls aged between five years two months and six years one month. Informants were selected on the criterion of direct knowledge of the practice under study: the class teacher, who taught every observed session; the head of the institution, who could speak to curriculum allocation and procurement; and three parents, chosen because their children's participation in the sessions differed markedly from one another. The researcher took the role of moderate participant, seated within the learning area, handing over materials when asked, but neither leading the session nor confirming the children's answers.

Ethical procedures followed the norms applying to research with young children. Permission was obtained from the head of the institution before fieldwork began, and written consent was sought from the parents or guardians of all eighteen children, each of whom received a written explanation of the study's purpose, procedures, and data handling. Children were told in age-appropriate language that they could decline to take a turn at the medium or to be observed, and no child was required to participate in an activity they declined; on two occasions a child asked the researcher not to write while she worked, and the request was honoured. Because the activity observed was an ordinary numeracy session delivered by the children's own teacher, no child was exposed to a procedure outside the normal range of classroom practice. All names were replaced with codes at the point of transcription, photographs were taken only with parental consent, and no image identifying an individual child appears in any research output. The instruments, the consent materials, and the researcher's reflexive account of her prior relationship with the institution were reviewed by the supervising lecturer before fieldwork commenced.

The number tree used in the observed sessions had been assembled by the class teacher from locally available materials at a total cost of under fifty thousand rupiah. Its construction is described here because its physical properties bear directly on the conduct it affords. A trunk and canopy were cut from used cardboard, reinforced with plywood at the base, and painted with non-toxic water-based paint. Twenty circular fruit pieces, each eight centimetres in diameter, were cut from coloured flannel and fitted with hook-and-loop fastening so that they could be attached to and removed from the branches by the children themselves. Each fruit bore a number symbol from one to twenty on the front face and a corresponding cluster of dots on the reverse, so that a single manipulable object carried both representations of the same value. The finished board measured one hundred by seventy centimetres and stood on a folding easel at the children's eye level. A second, smaller board was added midway through the fieldwork when the teacher reorganised the class into groups.

Data were generated through three techniques across twelve numeracy sessions of approximately sixty minutes each. Participant observation was recorded in a two-column field note in which descriptive entries, covering who held the medium, what was said, in what order,

and with what result, were kept separate from the researcher's interpretive remarks, so that the two could be distinguished during coding. Sessions one to six were observed while the teacher worked with the whole class at a single board; sessions seven to twelve were observed after she had reorganised the class into three groups of six, with a second board and a turn-taking card. That reorganisation was the teacher's own decision, taken after she read the researcher's field notes at the midpoint of the fieldwork, and it is treated here as part of the phenomenon under study rather than as an intervention introduced by the research. In-depth semi-structured interviews were conducted with the class teacher at the beginning, midpoint, and end of the fieldwork, with the head of the institution once, and with three parents once each; all were audio-recorded with consent and transcribed verbatim. Documentation comprised the daily lesson plans, the children's work samples, and photographs of the learning process.

The principal instrument was the researcher herself, and the guides she carried were designed to direct attention rather than to produce scores. The observation guide listed the five competences named in the standard of child development attainment, namely mentioning the number sequence one to twenty, recognising the symbols one to twenty, arranging the symbols in ascending order, matching a quantity of objects to its symbol, and grouping objects according to a stated numerical attribute. These were treated as sensitising concepts, that is, as directions in which to look rather than as categories into which conduct was to be sorted, and no rating scale was attached to them. For each competence the guide asked what the child did with her hands, what she said while doing it, whom she addressed, and what happened when she was wrong. The interview guide covered prior practice, the teacher's account of what she noticed in the children, her reasons for the changes she made, and the constraints she perceived; questions were open and follow-ups were shaped by the informant's own wording. Documentation was used to corroborate what observation and interview had suggested rather than as an independent source of claims.

Analysis followed the interactive model of Miles, Huberman and Saldaña, in which data condensation, data display, and conclusion drawing with verification proceed concurrently with data generation rather than after it (Miles et al., 2019). Field notes and transcripts were read line by line and assigned open codes that stayed close to the participants' own language; the first cycle produced 214 codes, condensed to 46 once duplicates and near-synonyms had been merged. Second-cycle coding grouped these into eleven categories according to the relations among them, and the categories were displayed in matrices, one arraying the five competences against the forms of conduct observed and another arraying the two phases of classroom arrangement against the teacher's prompts and the children's responses. Four themes were constructed from those displays, and each was verified by returning to the codes that contradicted it. Trustworthiness was pursued along the four criteria of credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1985): credibility through eight weeks of prolonged engagement, triangulation across sources and techniques, and member checking in which the teacher read the theme statements and disputed one formulation, which was then revised; transferability through thick description of the setting and the medium;

and dependability and confirmability through an audit trail comprising the raw notes, the coding record, and the analytic memos, examined by a peer debriefer not otherwise involved in the study. The overall logic of the study is summarised in Figure 1.

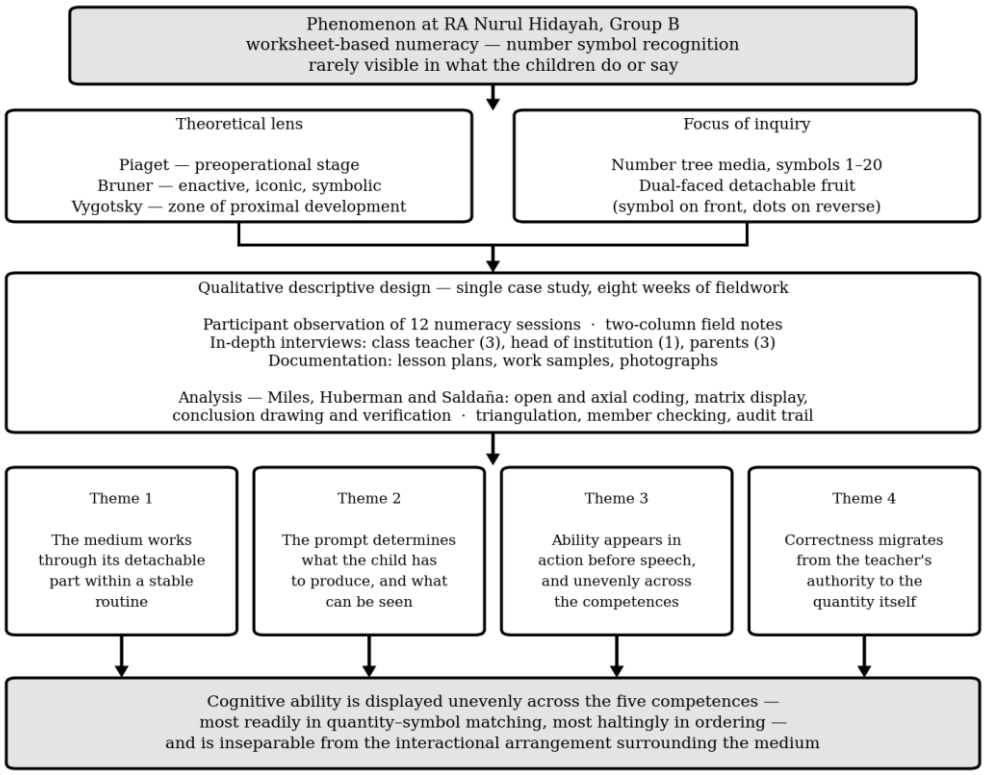

Figure 1. Research design and analytical flow of the study

RESULTS AND DISCUSSION

Results

Fieldwork generated a corpus of twelve observation records, seven interview transcripts, and three bodies of documentary material, assembled over eight weeks. The provenance and volume of these data are set out in Table 1, together with the codes used throughout this section to identify their source. An entry marked OB-08 refers to the field note of the eighth observed session, IT-02 to the second interview with the class teacher, IH-01 to the interview with the head of the institution, and IP-01 to IP-03 to the parent interviews.

Table 1. Data sources and the corpus generated during fieldwork

No	Technique	Source or object	Volume generated	Code
1	Participant observation	Numeracy sessions, Group B	12 sessions; 148 pages of field notes	OB-01 to OB-12
2	In-depth interview	Class teacher	3 interviews; 96 minutes	IT-01 to IT-03
3	In-depth interview	Head of the institution	1 interview; 34 minutes	IH-01

No	Technique	Source or object	Volume generated	Code
4	In-depth interview	Parents of three children	3 interviews; 71 minutes	IP-01 to IP-03
5	Documentation	Lesson plans, work samples, photographs	12 plans; 84 samples; 63 photographs	DK-01 to DK-03

Source: research data, September to November 2025

The corpus divides at the midpoint of the fieldwork. In the first six sessions the teacher worked with the whole class at a single board: she named a symbol, attached the corresponding fruit while the children watched from the carpet, and then called children forward one at a time to repeat the action. In the remaining six she worked with three groups of six, two of them at the boards and one at a related task, with a turn-taking card that fixed the order of access and with prompts phrased as questions rather than as statements. The teacher made this change herself after reading the researcher's field notes, in which she recognised what she later described as the two things she had not been able to see while teaching: that most children touched the medium once in an hour, and that she had been supplying every answer she asked for (IT-02). Because the two phases differ in arrangement while the medium and the content remain constant, the corpus permits the contribution of the arrangement to be examined separately from that of the material, and much of what follows turns on that contrast.

Coding began with the descriptive column of the field notes and with the interview transcripts, read line by line without reference to the five competences, so that categories arising from the classroom would not be pre-empted by the categories of the standard. The first cycle produced 214 open codes, a large proportion of which described bodily conduct rather than speech: turns the fruit over, holds it against the branch and withdraws it, counts the dots with a fingertip, looks at the teacher before releasing the fruit, waits with the fruit in hand until another child moves away. Codes describing speech were at first sparse and repetitive, consisting largely of single number words repeated after the teacher, and they became differentiated only in the records of the later sessions.

Condensation reduced the 214 codes to 46 by merging near-synonyms, and second-cycle coding grouped these into eleven categories according to the relations among them: the fixed order of the lesson; the detachable component as the site of the task; access and turn-taking; the form of the teacher's prompt; the direction in which children addressed their talk; the appeal to the dots as an arbiter; hesitation and recount; error and repair; the hierarchy of competences displayed; material wear; and the compression of instructional time. Three of these categories, namely access, prompt form, and the direction of talk, distinguished the two phases sharply, while the remainder appeared throughout the corpus at differing densities.

Four themes were constructed from these categories. The first is that the medium is used within a stable four-part routine in which the detachable fruit, rather than the board, carries the instructional weight. The second is that the teacher's shift from naming symbols to asking about them changed what the children were required to produce, and with it what could be seen of their understanding. The third is that cognitive ability appeared first in what children did with

their hands and only later in what they said, and that it appeared unevenly across the five competences. The fourth is that the criterion of correctness migrated over the fieldwork from the teacher's authority to the quantity itself, a shift visible in the emergence of unprompted peer checking. The relation between codes, categories, and themes is set out in Table 2.

The themes were returned to the class teacher in written form at the end of the fieldwork. She accepted three without amendment and disputed the fourth, objecting that peer checking had not emerged during the study but had always been present in other classroom activities and had simply become visible in numeracy for the first time. The theme statement was revised to reflect her reading, and her objection is treated below as data rather than as a correction, since what it identifies is a change in the domain in which children were willing to arbitrate rather than a change in their capacity to do so.

Table 2. Codes, categories, and themes constructed from the data corpus

No	Illustrative open codes	Categories	Theme
1	Opens with the number song; teacher demonstrates; children rotate to the board; children recount what they did; carries the fruit back to the carpet	Fixed order of the lesson; detachable component as the site of the task	The medium works through its detachable part within a stable routine
2	Teacher names the symbol and the child repeats; teacher asks how the child knows; child pauses before answering; waits until another child moves away	Form of the teacher's prompt; access and turn-taking	The prompt determines what the child has to produce
3	Turns the fruit over; counts the dots with a fingertip; places three symbols and loses the sequence; explains the pairing aloud	Hesitation and recount; hierarchy of competences displayed; direction of talk	Ability appears in action before speech, and unevenly across competences
4	Removes a classmate's fruit; recounts the dots aloud; concludes the dispute without the teacher; verifies before accepting the correction	Appeal to the dots as an arbiter; error and repair	Correctness migrates from the teacher's authority to the quantity

Source: research data, September to November 2025

The first theme concerns the shape of the activity in which the medium was used. Every observed session followed the same four parts: an opening circle with a number song and a statement of the day's range; a demonstration in which the teacher attached a fruit while naming the symbol; a working phase at the board; and a recall phase in which children described what they had done. The routine did not vary across the twelve sessions, and its stability appears to be what allowed the children to attend to the material rather than to the procedure: by the third session no child asked what would happen next, and the teacher stopped explaining the

sequence (OB-03). Within that routine, however, it was consistently the fruit and not the board that occupied the children. Field notes record children carrying a fruit back to the carpet, turning it over repeatedly, and holding it against several branches before committing; the board itself was treated as a destination rather than as an object of attention. The teacher reached the same conclusion independently, remarking that she had built the tree because it looked attractive but that the children would have been equally occupied by the fruit alone (IT-03). What the medium afforded, on this evidence, was not a picture to look at but a small object that could be turned over, and the two faces of that object correspond precisely to the relation the children were being asked to grasp. That relation did not, however, present the same difficulty across the five competences, as Table 3 sets out.

Table 3. Qualitative profile of the five competences as displayed during the observed sessions

No	Competence	How it was displayed	Illustrative evidence
1	Mentioning the number sequence 1–20	Displayed readily and early, but as a verbal chain detached from the objects; children recited while looking away from the medium	Recites to twenty during the opening song, then cannot say which fruit is fifteen (OB-02)
2	Recognising number symbols 1–20	Displayed with hesitation on the teen numbers and on six and nine; children checked the reverse face before naming the symbol	Turns the fruit over, counts the dots, and only then names the symbol (OB-05)
3	Arranging number symbols in order	The most halting of the five; children placed the first few confidently, then lost the sequence and frequently restarted from one	Places one to four, pauses, sweeps them off the branch and begins again (OB-09)
4	Matching a quantity to its symbol	The most readily displayed and the most talked about; the dual-faced fruit made the pairing checkable by the child herself	Counts eleven dots aloud twice and exchanges the fruit for the correct symbol (OB-05)
5	Grouping objects by a numerical attribute	Displayed only when the teacher named the attribute; children rarely grouped spontaneously or sustained a grouping once made	Sorts the fruit into odd and even only after the prompt is repeated a third time (OB-11)

Source: research data, September to November 2025

Two features of this profile recur throughout the corpus. Matching a quantity to its symbol was the competence children displayed most readily and discussed most often, and it is also the competence for which the medium provides direct support: because both representations sit on a single object, a child who is unsure can settle the question by turning the fruit over, without appealing to anyone. Ordering was the most halting, and no comparable support was available for it, since a child arranging symbols must hold a sequence in memory while placing several

pieces, and nothing in the medium can be turned over to check a sequence. Field notes record the same breakdown repeatedly: the first three or four symbols placed with confidence, a pause, and then either a restart from one or an appeal to the teacher (OB-04, OB-09, OB-12). The contrast is not one of degree but of kind, in that one competence could be verified by the child and the other could not, and it is this rather than any ranking of difficulty that the data support.

The second theme concerns the teacher's talk. In the first six sessions her prompts were almost entirely confirmatory: she named a symbol and asked the child to repeat it, or pointed to a fruit and supplied its name before the child could answer. The children's contributions under this arrangement were single words, and the field notes of the first phase contain almost no instance of a child saying anything the teacher had not just said (OB-01 to OB-06). After the reorganisation her prompts were rephrased as questions, asking how many dots were on the reverse, which symbol belonged beside them, and how the child knew; the character of the children's speech changed within two sessions. The teacher's own account of the change is worth reproducing in substance: she said that when she named the symbol she had been the only one thinking, and that she had not noticed this until she saw it written down in the notes (IT-02).

The third theme concerns the order in which ability became visible. Across the corpus children were able to do a thing correctly well before they were able to say why it was correct, and the interval between the two was substantial. In the second session a child placed the fruit bearing eleven beside a cluster of eleven dots on three consecutive attempts and, asked how she knew, said only that it was the right one (OB-02). By the tenth session children were producing unprompted accounts of the same relation, telling one another that a fruit belonged in a particular place because of the number of dots on its reverse, and revising the account when it was challenged (OB-10). The competence had not appeared between those two points; what had appeared was the requirement to articulate it, supplied by the change in the teacher's prompts. An assessment conducted at the second session and one conducted at the tenth would have recorded different things about the same child, and only the second would have registered understanding, which is a reason for caution about instruments that record the response alone.

The interview data corroborate this reading and add to it. The class teacher reported that the small-group arrangement had given her the opportunity to watch individual children closely for the first time, since she was no longer managing the attention of eighteen at once, and that she had revised her judgement of two children whom she had previously considered slow but who, at close range, turned out to be checking their work rather than hesitating (IT-03). The head of the institution located the practice within the institution's constraints, observing that numeracy competes with religious habituation for a fixed allocation and that any approach requiring longer sessions would not survive the term (IH-01). Two of the three parents reported that their children had begun counting objects at home and asking what a written number was called, neither of which they had done before; the third, whose child attended fewer than half the sessions, reported no change and named transport as the reason for the absences (IP-01 to IP-03). Illustrative exchanges from the two phases of the fieldwork are presented in Table 4.

Table 4. Illustrative exchanges from the two phases of classroom arrangement

No	Phase and source	Teacher's prompt	Child's response
1	Whole class (OB-02)	This is fifteen. Say fifteen.	Fifteen. (attaches the fruit at the point the teacher indicates)
2	Whole class (OB-04)	Which one is eight? Here, this one is eight.	(takes the fruit the teacher is holding out; says nothing)
3	Small group (OB-08)	How many dots are on the back?	(turns the fruit over and counts aloud) Six. So this one is six.
4	Small group (OB-10)	How do you know it goes there?	Because there are eleven on the back. I counted it twice.
5	Small group (OB-11)	(says nothing; watches from beside the group)	(to a classmate) No, count it again. That one is twelve.

Source: research data, September to November 2025

The fourth theme concerns where the authority to decide correctness was located. Throughout the first phase children resolved disagreements by appealing to the teacher: a child who was contradicted looked up, and the matter was settled by whoever the teacher addressed first. In the later sessions this pattern gave way to an appeal to the quantity. Children who disagreed counted the dots, and the count rather than the teacher determined the outcome; on four occasions during the eleventh and twelfth sessions a dispute was concluded without the teacher being drawn into it at all, and on two of those she was watching but did not intervene (OB-11, OB-12). The teacher's objection during member checking bears on this directly. She insisted that the children had always corrected one another in other activities, and that what was new was their willingness to do so about number, where previously they had assumed that only she knew the answer. Read alongside the observational record, her objection sharpens the theme rather than contradicting it: what changed was not the children's capacity to arbitrate but their recognition that number was a domain in which something other than the teacher could arbitrate.

Documentary evidence supported this account at one further point. The children's work samples, compared across the fieldwork, showed a change in the character of errors rather than simply in their number. In the samples collected during the first phase, incorrect responses were frequently unrelated to the stimulus, with children writing a symbol that bore no discernible relation to the quantity presented. In the final samples the remaining errors were systematic and interpretable: reversals of six and nine, and the omission of the teen numbers between thirteen and sixteen when a sequence was written out. Errors of this kind indicate that a rule is being applied imperfectly rather than that no rule is available, which is a developmental advance even though the response remains incorrect. The lesson plans, compared across the two phases, document the procedural changes described above, in particular the substitution of the rotation for the whole-class arrangement and the rewriting of the teacher's prompts as questions.

One episode recorded in the field notes of the eleventh session illustrates the shift compactly. A child had attached the fruit bearing the symbol twelve to a branch on which a cluster of eleven dots was displayed. A second child objected, removed the fruit, counted the

dots aloud twice, and replaced it with the symbol eleven. When the teacher asked the first child whether she agreed, the child counted the dots herself before accepting the correction. Neither child appealed to the teacher for adjudication, and the exchange was concluded before she intervened. Comparable episodes were recorded four times during the final two sessions and not at all during the first phase (OB-11, OB-12). Nothing in the episode would appear on a checklist: no answer was recorded, no child was rated, and the child who was corrected ended the exchange having been wrong. What it displays is the criterion of correctness in the children's own hands, which is the conceptual move the whole activity was oriented toward.

Discussion

The account assembled here converges with the existing literature on number tree media on the direction of the medium's contribution, while differing from it in what is claimed. Studies reporting the medium's influence on the cognition of children aged four to six (Maharani & Widjayatri, 2024), its development and expert validation for recognising and naming number symbols (Laksana et al., 2024), and its use in early numeracy more broadly (Febiola, 2020; Hasanah et al., 2023) all report that children who work with the medium end better placed than they began. The present study does not dispute that and could not test it. What it adds is a description of what the working consists of: which part of the medium the children attend to, what the teacher has to say for understanding to become visible, and where the authority to settle a numerical question resides at different points in a term. Those are the aspects a teacher must reproduce, and they are the aspects an aggregate score cannot carry.

The unevenness across the five competences is the finding with the clearest theoretical purchase. Matching is a task of correspondence: the child holds one object, inspects two representations of a single value, and makes a binary judgement she can verify herself. Ordering is a task of relational sequencing that requires several comparisons to be held simultaneously and coordinated with fine motor placement, and no feature of the medium makes the result checkable. The dual-faced fruit therefore supports one competence directly and the other not at all, which is what the observational record shows. This reading accords with findings from studies of Montessori number rods, in which children acquired the concept of quantity substantially before they could arrange quantities in a stable series (Roostin, 2021), and with work on open-ended numeracy tasks indicating that sequencing competences respond to sustained problem solving rather than to repeated exposure (Rohmalina et al., 2020; Setyaningtyas & Harun, 2020).

The practical implication is that teachers should not expect a single medium to make all five competences equally visible or equally tractable, and should plan supplementary activity for ordering specifically. Media that present number symbols along a fixed linear track, such as counting sticks, number mazes, or smart-tree variants with a numbered ladder, may complement the number tree at precisely the point where it is weakest (Azizah et al., 2023; Dewi & Indriyanti, 2023). A comparable logic applies to grouping, which in this classroom appeared only when the teacher named the attribute; studies combining a model of local wisdom with

symbol recognition report classification work that exceeds what symbol work alone elicits (Afrida et al., 2022).

The contrast between the two phases of the fieldwork is as instructive as anything the medium itself afforded. Neither the material nor the content changed at the midpoint; what changed was the size of the group, the guarantee of access, and the grammatical form of the teacher's utterances. The children's speech changed within two sessions of that reorganisation, and the peer checking that constitutes the fourth theme appeared only afterwards. This cautions against attributing what was observed to the medium in isolation. What appears to matter is the frequency of each child's direct contact with the material and the cognitive demand embedded in the accompanying talk. Research on scientific learning in early childhood has reached the same conclusion, finding the questioning structure rather than the activity to be the critical variable in developing critical thinking and problem solving (Alucyana & Raihana, 2023), and an earlier study of simple science experiments reported that cognitive development advanced when children were required to predict and explain rather than to watch a demonstration (Mustika & Nurwidaningsih, 2018).

The shift from confirmatory to open questioning is best understood through Vygotsky's account of the zone of proximal development. When the teacher named the symbol and the child repeated it, the child operated at the level of independent performance and little developmental work was done. When the teacher asked how the child knew that a particular symbol belonged beside a particular quantity, the child was required to articulate a relation that had previously remained implicit, and the teacher's follow-up supplied the support that made articulation possible. The emergence of peer correction in the final sessions suggests that this scaffolding was subsequently internalised and redistributed among the children themselves, a transition that constitutes evidence of conceptual movement rather than of improved task compliance. Research on mature play reports the same trajectory, with deeper learning appearing once children begin to regulate one another's activity rather than merely responding to adult direction (Cheng et al., 2024).

The economics of the medium deserve comment because they bear on transferability. The number tree observed in this study was assembled from cardboard, plywood offcuts, and flannel at a cost below fifty thousand rupiah, and required no electricity, no device, and no technical skill beyond cutting and gluing. This matters for institutions of the kind described here, where procurement budgets are minimal and where reliance on digital media would introduce a dependency the school cannot sustain. Studies of comparably low-cost media report similar experiences: number bag media constructed from everyday materials in a rural Indonesian setting (Iz, 2025), a busy book assembled from fabric offcuts (Qomariah et al., 2025), and a fishing game built from simple household items in a kindergarten with no specialised equipment (Retnaningrum, 2016). The consistency of these accounts across two decades suggests that the decisive property of a numeracy medium is manipulability rather than production value, which is also what the first theme of this study, with its children attending to the fruit rather than to the board, would predict.

This is not an argument against digital media, but it does qualify the terms on which they should be adopted. A meta-analysis of multimedia-based learning found that cognitive gains depend on the extent to which the environment requires the child to act rather than to watch (Pangarti & Yaswinda, 2023), and a study of cube learning media reached a comparable conclusion about the importance of the manipulable component within an otherwise attractive design (Koderi et al., 2021). A digital rendering of the number tree in presentation software has been reported (Arkas & Rakimahwati, 2023); on the present evidence, the property that would need to survive such a translation is the turning over of the object, since it is that act, and not the image of a tree, that made the pairing checkable by the child. Research on smart-house media reaches a similar practical conclusion regarding the balance between attractiveness and accessibility (Febriyanti et al., 2026).

The institutional context of a *raudhatul athfal* introduces a consideration that the general literature on number tree media has not addressed. Instructional time in this setting is shared between the developmental domains and a programme of religious habituation, so numeracy activities compete for a smaller allocation than in a general kindergarten, as the head of the institution stated plainly. The rotation the teacher adopted was well suited to that constraint because it raised the density of each child's contact with the medium within a fixed period rather than extending the period itself. Teachers in comparable institutions who cannot lengthen numeracy sessions may nonetheless be able to multiply the number of turns within them, and the present case suggests that doing so changes what can be seen of the children as much as what the children do.

Several limitations qualify this account. It describes one class in one institution over one semester and makes no claim to generalisation; what a case study offers is transferability, and the judgement of whether these findings travel belongs to the reader who knows her own setting and can compare it with the description given here. The researcher was present in every observed session, and her presence will have affected what the teacher and the children did, particularly since the teacher read the field notes at the midpoint and changed her practice in response; that influence is documented rather than eliminated, but it means the second phase cannot be treated as a naturally occurring development. Coding was carried out by a single analyst, with a peer debriefer examining the audit trail rather than coding independently, so the categories reflect one disciplined reading of the corpus rather than an agreed one. Finally, fieldwork ended with the semester, and nothing in the data speaks to whether the peer checking documented in the final sessions persisted once the medium was put away.

A methodological point follows from the character of the evidence assembled here. Research on manipulative media in Indonesian early childhood education is dominated by designs that report a single figure per measurement point, and the convention is strong enough that studies which do not produce such a figure can appear to have found nothing. The present study found a good deal, but almost none of it takes a numerical form: that children attend to the detachable part rather than to the whole; that the grammatical form of the teacher's utterance determines what can be seen of their understanding; that ability appears in the hands before it

appears in speech; and that arbitration migrates from the teacher to the quantity. Each of these is directly actionable by a practitioner and none would survive conversion into a percentage. This is not an argument that scores should be abandoned, but it is an argument that they should be accompanied, since a literature composed entirely of aggregates can establish that media work without ever establishing how to use them.

The change in the character of children's errors deserves to be separated from any change in their frequency, because the two carry different implications. Fewer errors is consistent with improved recall and may reflect nothing more than repeated exposure. A change in error type, from responses unrelated to the stimulus toward systematic reversals and omissions, indicates that a rule has been acquired and is being applied imperfectly. The persistence of six-and-nine reversals and of gaps in the teen numbers at the end of the fieldwork is therefore not evidence that the medium failed for these items; it is evidence that these items require a different kind of support, oriented toward visual discrimination and toward the irregular naming of the teen numbers in Indonesian, rather than toward further repetition of quantity and symbol matching. Studies reporting residual error patterns in early numeracy reach comparable conclusions about the specificity of the remaining difficulty (Fitria et al., 2025; Ula et al., 2023).

The emergence of unprompted peer checking deserves emphasis precisely because it is the finding least likely to be captured by any recording instrument. The episode described above involves no adult, produces no answer that could be marked, and ends with the corrected child having been wrong. Yet it displays the criterion for correctness in the children's hands, which is the conceptual move the whole activity was oriented toward. Assessment built around individual performance will not register such transfers, and teachers who rely on it exclusively may underestimate what their classrooms have achieved. This observation accords with accounts of mature play in which mutual regulation among children marks the transition to deeper learning (Cheng et al., 2024), and with research showing that scientific reasoning in early childhood becomes visible in children's talk before it becomes visible in their recorded answers (Alucyana & Raihana, 2023; Mustika & Nurwidaningsih, 2018).

The case of the child who attended fewer than half the sessions raises a question about equity that studies of media in this field rarely address. Her mother reported no change at home and named transport as the reason for the absences; the field notes place the child at the board on three occasions across the whole fieldwork, and on each of them she was still working out where to stand. A classroom account that describes what happened to the children who were present will systematically overstate what a practice delivers in a setting where absence is common, and in a rural catchment where absence is driven by household labour, illness, or transport rather than by parental indifference, this is not a marginal concern. The response available to the teacher is not to reduce absence, which lies outside her control, but to design each session so that it is intelligible on its own rather than presupposing the one before it. The sequence observed here did not meet that condition, since the range extended from ten to twenty between sessions.

A final consideration concerns whether the practice can outlast the study that documented it. The teacher reported that the flannel fruit required replacement after approximately fifteen uses because the hook-and-loop fastening lost its grip, and the observational record confirms this: by the tenth session two of the fruits were being held in place by the children's hands rather than by the fastening. This is a small observation with a large practical consequence, because a medium that degrades faster than the school can replace it will fall out of use once the observer leaves. The materials chosen favoured low cost over durability, and the trade-off was not examined when the board was built. Alternatives exist: laminated card with magnetic backing costs somewhat more but survives repeated handling, and a fabric pocket arrangement avoids adhesive fastening altogether. Studies reporting media constructed from recycled or everyday materials generally document cost but not service life (Iz, 2025; Qomariah et al., 2025; Retnaningrum, 2016), yet service life is what determines whether a practice survives the study that introduced it.

Notwithstanding these limitations, the account yields three findings of practical use. The instructional weight of the number tree rests on its detachable, dual-faced component rather than on the board, so a teacher building one should spend her effort on the fruit. The five competences are not equally accessible through this medium, since quantity and symbol matching is the one it makes checkable by the child and ordering the one for which it offers nothing, so complementary provision for ordering should be planned from the outset rather than added once the shortfall appears. And the interactional arrangement surrounding the medium determines what the children produce and therefore what the teacher can see, which implies that adopting the medium without rephrasing the questions and guaranteeing the turns is likely to reproduce the first phase of this study rather than the second. Broader analyses of media use in early childhood arrive at the same emphasis on the conditions of use rather than on the medium alone (Hanifa et al., 2024; Rahma, 2023).

CONCLUSION

This study set out to describe how number tree media are used in the numeracy learning of Group B children at RA Nurul Hidayah Bangsalsari, Jember, and how the children's cognitive ability in recognising number symbols becomes visible during that use. On the first question, the medium was used within a stable four-part routine of opening circle, teacher demonstration, work at the board, and recall, which did not vary across the twelve observed sessions. Within that routine the children attended to the detachable dual-faced fruit rather than to the board, and the decisive change during the fieldwork lay not in the material but in the arrangement around it: the teacher replaced whole-class demonstration with rotation among three groups of six, guaranteed each child's access with a turn-taking card, and rephrased her prompts from statements into questions.

On the second question, cognitive ability became visible first in what the children did with their hands and only later in what they said, and it was distributed unevenly across the five competences. Matching a quantity to its symbol was displayed most readily and discussed most

often, because the dual-faced fruit allowed a child to settle the question for herself; arranging symbols in order was the most halting, and the medium offered nothing by which a sequence could be checked. Over the course of the fieldwork the criterion of correctness moved from the teacher's authority to the quantity itself, a shift evident in the emergence of unprompted peer checking during the final sessions and in the children's speech, which changed from single words repeated after the teacher to spontaneous justification of a pairing by reference to the dots.

The study therefore concludes that the contribution of number tree media in a rural Islamic kindergarten is inseparable from the interactional arrangement in which the medium is placed, and that the medium's specific affordance is the checkability conferred by a small object bearing both representations of a value. Teachers adopting it should expect ordering to remain difficult and should plan complementary linear-sequence activities from the beginning, and should treat the phrasing of their own prompts as part of the medium rather than as a separate matter.

Three directions for further inquiry follow. First, a study extending observation across a full year would establish whether the peer checking documented here consolidates or dissipates once the novelty of the material has passed. Second, a multi-site design comparing *raudhatul athfal* with differing time allocations would clarify how far the compression of instructional time shapes what the medium can do. Third, close analysis of the teacher's talk, using audio or video recordings rather than field notes, would allow the relation between prompt form and children's justification to be specified more finely than the present data permit.

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