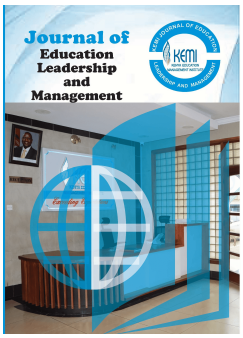

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Mind the Gap: Evidence on Grade 3 Numeracy Learning Gaps and the Role of Instructional Leadership in Kenya

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Abstract

Foundational numeracy remains a critical bottleneck to learning progression in Kenya, with persistent gaps in conceptual understanding, procedural fluency, and problem-solving in the early grades. Despite policy reforms and increased attention to foundational learning, national assessments continue to show low mastery of higher-order numeracy skills. This paper sought to examine Grade 3 learners' gaps in solving addition and subtraction tasks involving regrouping and to interrogate the instructional and leadership conditions shaping these outcomes. The paper used a mixed-methods design. It assessed learners' cognitive knowledge through structured mathematics tasks and conducted qualitative interviews to explore learners' reasoning processes and teacher perspectives. The target population comprised all Grade 3 learners in selected counties of Kenya. A total of 103 learners (51 boys and 52 girls) were sampled from 15 schools across three regions (Central, Eastern, and Nairobi), selected to reflect urban, peri-urban, rural, well-resourced, under-resourced, public, and private school contexts. The key findings revealed persistent deep conceptual gaps in place value and regrouping where only 37.3% of learners correctly solved subtraction involving regrouping, while 29.1% failed to answer any of the three items correctly; over-reliance on concrete and procedural strategies, with 75.4% using body-based counting (fingers, toes, head), indicating limited progression toward abstract mental strategies and weak procedural fluency beyond algorithmic presentation. A survey with teachers revealed minimal instructional support from school leaders and curriculum support teams, and limited opportunities for professional development related to numeracy teaching. The paper

recommends the need to strengthen diagnostic and concept-focused instruction at classroom level through systematic error analysis, deliberate progression from concrete to abstract strategies, and explicit teaching of mathematical language as well as institutionalizing instructional leadership for foundational numeracy, requiring school leaders to set clear benchmarks, conduct regular instructional supervision, define accountability for learning structures, establish communities of practice, and use assessment data to drive accountable improvement.

Key terms: numeracy learning gaps, regrouping and instructional leadership

1.0 Background

This section presents the background to the paper focusing on foundational numeracy, learning progression and error analysis, teachers' pedagogical knowledge, instructional leadership and conceptual framework

1. Foundational Numeracy

Foundational numeracy, early competencies such as number recognition, counting, place value, and basic operations represent a critical bottleneck for later learning and progression, and are increasingly framed as a systems-level priority within the broader foundational learning agenda (UNICEF, 2023). This agenda is explicitly organized around foundational learning as a triad of literacy, numeracy, and socio-emotional skills, which together constitute the essential building blocks for all subsequent learning (UNICEF, 2023). UNICEF's (2023) RAPID Framework analysis, drawing on survey data from 94 low- and middle-income countries, found that while governments are beginning to prioritize these fundamentals in national curricula and policy, implementation remains uneven, with most countries' policy-action scores clustering at early rather than advanced stages of institutionalization. The analysis further situates numeracy as foundational not only to mathematics achievement but to the development of problem-solving, logical reasoning, and critical-thinking capacities more broadly (UNICEF, 2023), reinforcing its status as a cross-cutting rather than subject-specific concern.

Recent global syntheses reinforce this framing, situating numeracy alongside literacy and socio-emotional skills as core, interdependent components of foundational learning, and emphasizing that post-COVID learning losses have widened pre-existing inequities, thereby intensifying the urgency of early-grade recovery strategies (UNICEF, 2023). This synthesis work has increasingly moved from broad global framing toward regionally grounded diagnostic evidence. In Africa, the second Spotlight Report in the UNESCO GEM Report ADEA series, Learning Counts, constitutes a major recent evidence synthesis positioning foundational numeracy as central to basic education completion and learning outcomes (UNESCO, 2024b). The synthesis is based on a systematic mapping of four pedagogical inputs national curricula, learner textbooks, teacher guides, and learning assessments across five focus countries: Niger, Mauritania, South Africa, Uganda, and Zambia. Its central finding is that these four inputs are frequently misaligned with one another. Curricular intentions are often not carried consistently into textbooks or assessment items, producing a disconnect between what the curriculum specifies and what is taught or tested. Compounding this, teachers struggle to translate curricular expectations into classroom practice, largely because teacher guides are often outdated, linguistically inappropriate for the classroom context, or otherwise insufficient to bridge the gap between curricular intention and instructional implementation.

On this evidentiary basis, the report calls for greater coherence between curricula, textbooks, teacher guides, and assessments, and for system-level actors to ensure that classroom practice remains aligned

with intended learning progressions (UNESCO, 2024b). Taken together, the global (UNICEF, 2023) and regional (UNESCO, 2024b) syntheses converge on a common diagnosis: foundational numeracy deficits are not confined to any single system but reflect a cross-cutting failure of coherence across policy, curriculum, and classroom practice a failure that remains especially acute across the African focus countries examined, where at most one in five children attain minimum proficiency in reading and mathematics by the end of primary school (UNESCO, 2024b).

2. Learning Progressions and Error Analysis

In Kenya, foundational learning reports continue to show that many learners struggle with Grade 3-level numeracy tasks and that outcomes vary by context, reflecting persistent inequities (Usawa Agenda, 2023; Usawa Agenda, 2024). Parallel efforts to strengthen evidence use through national assessments and related initiatives illustrate increasing attention to measuring learning and to using data for instructional improvement (KNEC, 2023; Government of Kenya, 2023). For example, the NASMLA Grade 3 midline paper is positioned within the Kenya Primary Education Equity in Learning (KPEEL) program cycle, reflecting a policy shift toward routine system monitoring and the use of assessment information to guide reform (KNEC, 2023). These reports point out a consistent problem: many learners have not consolidated core numeracy ideas early enough, which constrains their ability to solve problems and reduces confidence and engagement.

A People's Action for Learning (PAL) Network, 2025 publication on Strengthening government partnerships to advance foundational numeracy through error analysis in Kenya emphasizes that assessment-for-learning approaches should move beyond "right/wrong" scoring and diagnose misconceptions and missing building blocks in early mathematics. The report notes that only a small share of assessed learners solved all addition/subtraction items correctly and that a high proportion made factual errors, suggesting weak mastery of basic number facts and conceptual foundations. CEMASTEA-linked materials and policy briefs similarly position diagnostic error analysis as a practical strategy for strengthening foundational numeracy instruction in Grade 2 settings (CEMASTEA, 2025).

3. Teacher Pedagogical Knowledge

Teacher knowledge and teacher learning systems remain central explanatory factors in contemporary foundational numeracy research. Recent measurement-focused work argues that specialized early-grade mathematical knowledge for teaching can be assessed to identify growth areas but should be used primarily to support teacher development rather than punitive accountability (Sitabkhan et al., 2024). Kenya-oriented evidence also points to practical gaps in teachers' ability to anticipate learner strategies and support progression from counting-based approaches toward more efficient and conceptually grounded methods—an issue directly reflected in the abstract's claim that pedagogical content knowledge (PCK), concept progression, and curriculum interpretation remain weak in many contexts.

4. Instructional Leadership

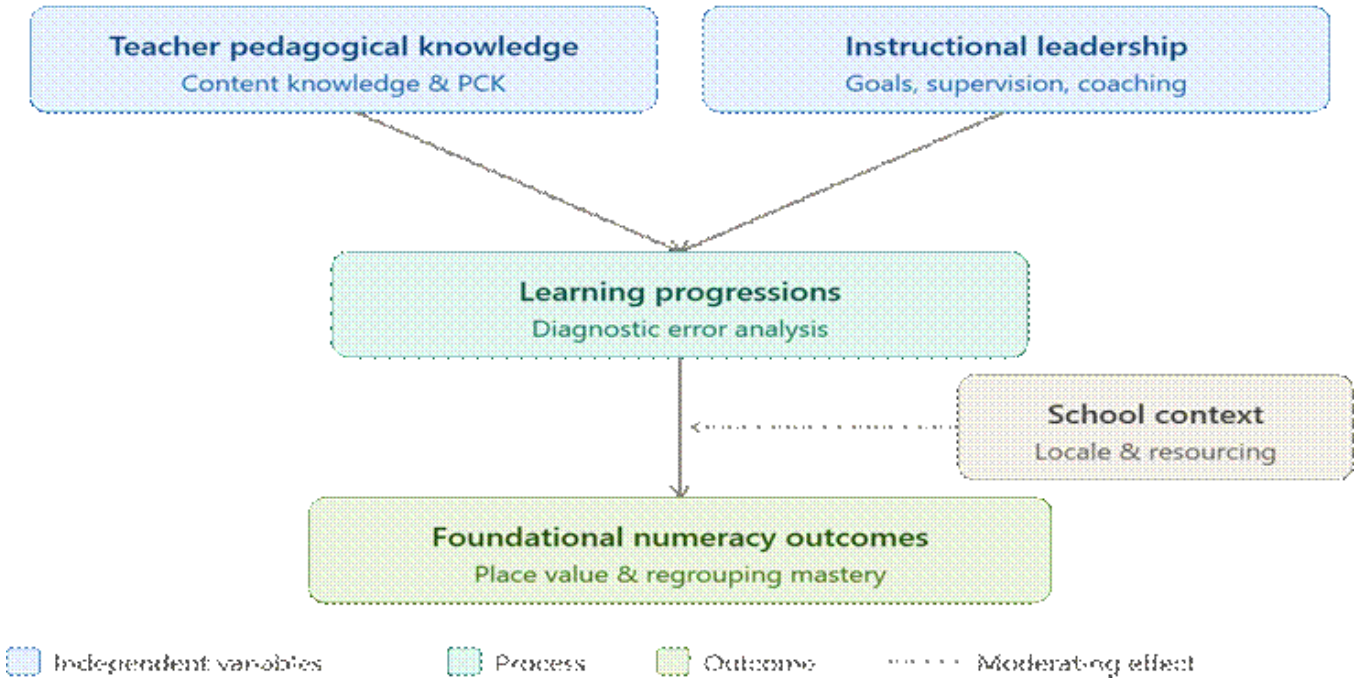
At the system level, mapping work on foundational literacy and numeracy research in Kenya further underscores that evidence exists but is unevenly translated into routine instructional support, signaling the need for stronger linkages between evidence producers, implementers, and education leadership structures (ESSA & REAL Centre, 2024).

Leadership and governance are increasingly treated as instructional practices and not merely administrative determinants of foundational learning outcomes. The GEM Report on leadership (2024/5) frames effective education leadership as enabling teaching and learning through clear goals, support and supervision, and use of evidence to improve learning outcomes (UNESCO GEM Report, 2024). The

Spotlight series on foundational learning in Africa which focused on instructional leadership also emphasized the role of principals and local education officials in aligning classroom practice with foundational learning goals and ensuring that monitoring and support systems function (UNESCO GEM Report, 2025).

Kenya's country-focused Spotlight work explicitly positions evidence use and instructional leadership as key levers for strengthening foundational learning, reinforcing the abstract's core argument that school leaders must play a more urgent, accountable role in improving early-grade numeracy instruction (UNESCO GEM Report, 2025).

5. Conceptual Framework



This paper is guided by a conceptual framework in which teacher pedagogical knowledge and instructional leadership operate as independent variables shaping foundational numeracy outcomes. These two inputs act through an intervening process, learning progressions and error analysis, whereby diagnostic assessment identifies learner misconceptions and supports progression from concrete to abstract numeracy strategies. This process, in turn, produces the paper's dependent variable: foundational numeracy outcomes, operationalized as learners' mastery of place value and regrouping. School context, encompassing locale and resourcing, is treated as a moderating variable, consistent with evidence that numeracy outcomes vary markedly across urban, peri-urban, rural, well-resourced, and under-resourced settings. The framework thus reflects the paper's central premise: that persistent numeracy gaps stem from fragile conceptual foundations and uneven pedagogy, and that improvement requires the joint, coordinated action of diagnostic instructional practice and accountable school leadership.

1.1 Statement of the Problem

Foundational numeracy remains a major challenge in Kenya despite sustained government reforms, including the Competency-Based Curriculum (CBC), the Primary Education Development (PRIEDE) project, teacher retooling programmes, CEMASTEA professional development, and strengthened national assessments aimed at improving mathematics instruction. National and citizen-led assessments continue to show that many Grade 3 learners fail to attain foundational numeracy competencies, suggesting that

system reforms have not consistently translated into improved classroom learning. While evidence increasingly identifies teachers' pedagogical content knowledge (PCK) and instructional leadership as critical, modifiable determinants of learner achievement, little is known about how gaps in teachers' mathematics pedagogy influence learners' cognitive development or how instructional leadership supports effective teaching and learning. This paper addresses that gap by examining the relationship between teachers' pedagogical content knowledge, school instructional leadership, and Grade 3 learners' cognitive learning in mathematics, providing evidence to strengthen instructional support and improve foundational numeracy outcomes in Kenya.

1.2 Objective

To assess Grade 3 learners' gaps in solving addition and subtraction tasks by regrouping.

2.0 Methodology

This study employed an explanatory sequential mixed-methods design consisting of two consecutive phases. In the first (quantitative) phase, learners' cognitive knowledge of addition and subtraction with regrouping was assessed using structured assessment tasks. In the second (qualitative) phase, the same learners participated in interviews to explain the reasoning processes and problem-solving strategies underlying their performance, consistent with nested sampling in explanatory sequential mixed-methods research (Zhou et al., 2024).

2.1 Target Population

The target population comprised Grade 3 learners enrolled in public and private primary schools in three purposively selected counties representing diverse educational contexts in Kenya: Nyandarua (Central), Isiolo (Eastern), and Nairobi. These counties captured variation in geographical setting (urban, peri-urban, and rural), school type (public and private), and resource levels (well- and under-resourced), reflecting the range of contexts in which the Competence-Based Education (CBE) curriculum is implemented.

2.1.2 Sample Size

The study involved 103 Grade 3 learners (51 boys and 52 girls; median age = 8 years) drawn from 18 schools: five in Nyandarua, five in Isiolo, and eight in Nairobi. The sample size was determined by the intensive nature of the one-on-one cognitive interview design, in which each learner completed three structured mathematics tasks followed by verbal reasoning probes. Such qualitative cognitive assessment studies typically prioritize depth of data collection over statistical representativeness, making a sample of 103 learners appropriate for examining learners' mathematical thinking and solution strategies while ensuring balanced gender representation.

2.1.3 Sampling Procedure

A three-stage stratified purposive sampling approach was employed. First, Nyandarua, Isiolo, and Nairobi counties were purposively selected to capture contrasting educational, socio-economic, and linguistic contexts. Second, 18 schools were selected to ensure diversity in location (urban, peri-urban, and rural), school type (public and private), and resource availability. Finally, approximately six Grade 3 learners were purposively selected from each school, with deliberate gender balance, to participate in individual cognitive interviews on addition and subtraction involving regrouping

2.2 Instrument piloting

The learner cognitive assessment tool was adapted from a previously validated Zizi Afrique Foundation

instrument by converting symbolic computation items into contextualized word problems to assess learners' ability to interpret real-life situations into arithmetic operations, consistent with NASMLA Level 4 proficiency. The adapted instrument was piloted with a mathematics education expert, Grade 3 teachers, and learners from a school outside the study sample to evaluate item clarity, age appropriateness, administration procedures, and the probing protocol. Feedback informed minor refinements to the wording of items and interviewer prompts.

2.2.1 Content Validity

Content validity was established through alignment with the Grade 2 and Grade 3 Competence-Based Curriculum (KICD, 2017, 2018, 2024) and the instrument's prior validation by the Zizi Afrique Foundation. Expert review during piloting confirmed that the adapted items adequately assessed foundational numeracy concepts, including place value, addition and subtraction with regrouping, and interpretation of mathematical word problems, consistent with the intended curriculum outcomes.

2.2.3 Reliability test

The internal consistency of the three-item learner cognitive assessment was evaluated using Cronbach's alpha based on responses from 103 Grade 3 learners, with items scored dichotomously (1 = correct; 0 = incorrect/no response). The instrument yielded a Cronbach's alpha coefficient of 0.71, indicating acceptable internal consistency for research purposes (Taber, K. S. 2018)

2.3 Ethical considerations

Ethical approval and all required institutional permissions were obtained before data collection. As the study involved Grade 3 learners, a layered consent process was followed, involving approval from school heads, consent from class teachers, and informed assent from learners, who were informed of the study in age-appropriate language and their right to decline or withdraw at any time Kelly et al. (2025). Learner confidentiality was ensured through anonymization of all data, secure storage of records, and reporting of findings in aggregate form.

3.0 Results

3.1 Learner Cognitive Assessment Tool for Foundational Numeracy Skills

Three mathematics items from Grade 2 curriculum were administered to Grade 3 learners to assess higher-order numeracy skills, focusing on addition with regrouping and subtraction with and without regrouping. All items were in statement format. This was meant to corroborate findings from National Assessment for Monitoring Learner Achievement System (NASMLA) 2016 and 2020, with a specific focus on learners' cognitive abilities in higher-order mathematics, particularly Level 4 Items. According to NASMLA, Level 4 proficiency involves the ability to translate sentence-based information into arithmetic operations and apply multiple operations correctly on whole numbers, key indicators of conceptual understanding and problem-solving skills.

Table 3.1: Descriptive statistics for learners' age

Statistic	Age

Maximum Age	15
Minimum Age	7
Median Age	8

The age distribution, with a maximum age of 15, suggests the presence of over-age learners in the sample. This is particularly notable among learners in the frontier county of Isiolo, indicating that contextual factors such as special needs or geographic disadvantage may contribute to educational delays. This finding aligns Usawa Agenda (2024) study which also established that there are overage learners in grade three especially in northern frontiers counties like Isiolo.

3.2 Mathematical Items: Performance in Addition Tasks

3.2.1 Six out of 10 learners could add with regrouping

Item 1. Ali had 49 marbles. His friend gave him 44 more. How many marbles does Ali have in total?"

This item tests Grade 3 learners' ability to solve a Grade 2 real-life addition word problem by combining two quantities. It assesses their understanding of the addition operation, number sense with two-digit numbers, and ability to interpret and solve problems from everyday situations.

Figure 1 pupils' performance on problem set 1: addition with regrouping

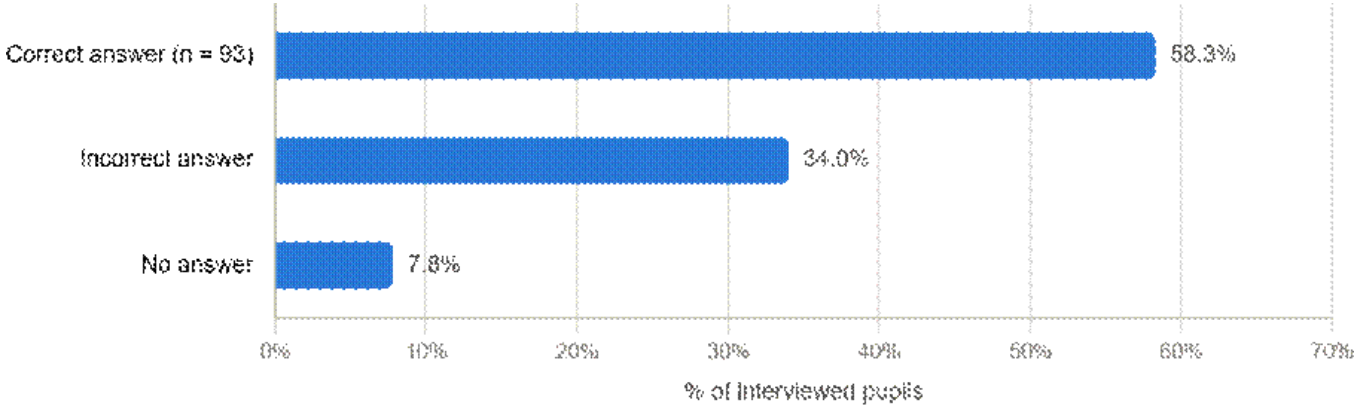


Figure 3.1: Learner performance on Addition task with regrouping

Out of all the pupils assessed, 58.3% provided the correct answer, demonstrating an adequate understanding of two-digit addition within a real-life context. However, 34.0% gave an incorrect response, which suggests challenges in either applying appropriate addition strategies or interpreting the structure of the word problem. Additionally, 7.8% did not respond at all, possibly indicating a lack of confidence, comprehension difficulties, or disengagement with the Item.

The finding is consistent with Mao et al., (2026) who established that word-problem errors typically arise either from misapplying the underlying problem structure or from computational slips such as regrouping errors during execution of an otherwise correctly identified addition operation. For the 7.8% of learners who did not respond at all also align with Mao et al., (2026) who argue that non-response on word problems is more often linked to comprehension overload and task disengagement than on purely

computational, suggesting some learners may have found the linguistic demands of the item, rather than the arithmetic itself, the primary barrier.

3.2.2 Eight (8) out of ten learners used algorithm to solve tasks involving regrouping

The findings show a strong use of algorithm presentation (81.6%), particularly among girls (88.5%), indicating that most learners rely on a structured format to solve two-digit addition problems. This mirrors patterns documented in recent longitudinal research, where written algorithms were the dominant strategy profile among elementary learners and were consistently more prevalent among girls than boys (Sievert et al., 2025). It also aligns with the CBE curriculum for Grades 2 and 3, which emphasizes algorithm for clarity in operations involving regrouping.

The Grade 2 curriculum explicitly requires learners to “add and subtract numbers vertically with and without regrouping” and to “record operations using algorithm.” (KICD, 2017). However, in Grade 3, learners are introduced to problem-solving in vertical and horizontal formats (KICD, 2018).

3.2.3 Seven (7) out of ten demonstrate proper sequencing in addition

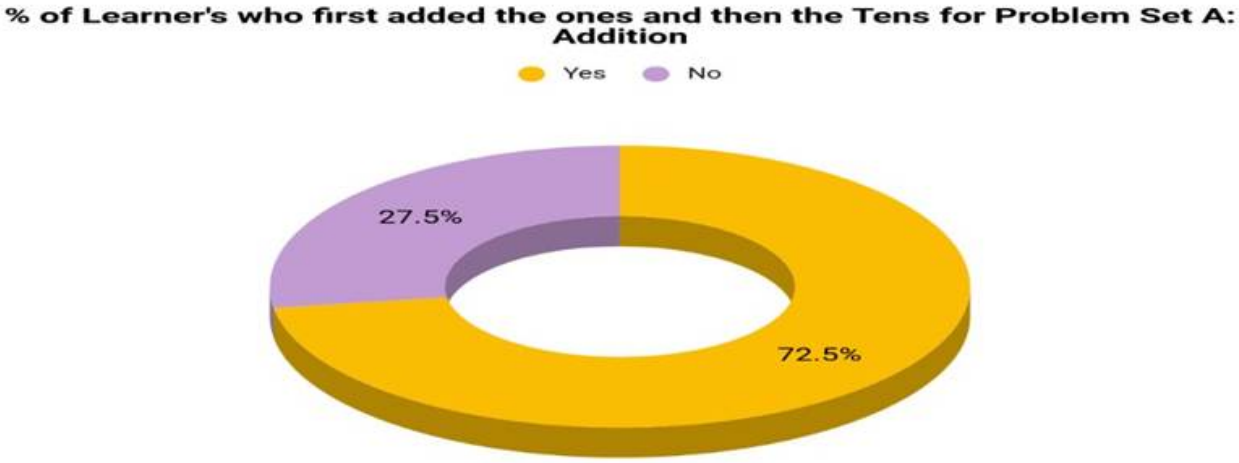


Figure 3.2: Learners who first added the ones and then the tens for word problem: Addition

The data indicates that 72.5% of learners sequenced their addition by adding the ones before the tens, demonstrating procedural mastery of addition of two digit with regrouping as emphasized in the curriculum. Additionally, 63% of learners used their fingers to count, and of these, 75.4% relied on body-based counting methods such as fingers, toes, or head highlighting a strong preference for concrete strategies. The continued use of fingers to count as primary strategy from around age 8–9 onward is associated with incomplete internalization of mental computation strategies. This aligns with Krenger & Thevenot, 2025 and Poletti et al., 2025) who argue that the use of fingers at grade is a clear indicator that the learner has not yet transitioned to abstract mental strategies.

3.2.4 Nearly 8 out of 10 learners rely on concrete or semi concrete counting strategies

Table 3.2: Counting strategies used by learners

Counting Strategy Learners	Count	of % of Learners
Body-based counting (fingers/toes/head)	46	75.4%
Mental Counting/ Counting Aloud	11	18.0%
Use of Objects or Drawings	4	6.6%
Total	61	100.0%

The results indicate that learners over-rely on concrete counting strategies**.** The data reveals a pronounced reliance on concrete body-based counting strategies, with 75.4% of learners using fingers, toes, or head movements to solve problems indicating a preference for concrete, tactile methods of computation. Mental counting or counting aloud was used by 18.0%, showing emerging internalization of number concepts, while only 6.6% of learners used objects or drawings, suggesting limited exposure to or comfort with visual representations. These findings point out that the learners rely on concrete math strategies.

Table 3.2 also indicates that some learners were stuck on formative stages of 'addition as putting together and counting all'. 6.6% of learners turned to visual representations, including: "*Drawing 9 circles then counted with fingers to get to 13*", "*Drew 44 circles and then drew 49 then counted all of them*", or "*Drew tally marks and confirmed with fingers*". Some learners combined methods. This implies that learners are still stuck in the very initial concept of addition as 'putting together and counting all' yet they should be at abstract levels.

"The learner used both his fingers and circles (balls) to do the counting". This variety of tactile and visual tools reflects a learning stage consistent with the concrete-representational-abstract (CRA) developmental framework, in which learners progress from physical manipulatives (fingers, drawn objects) to visual representations (tallies, drawings) and finally to abstract numeral-based computation (Ebner et al., 2025)

■ A subset of learners confused the mathematical operation altogether, performing subtraction instead of addition, even when they had arranged the problem vertically. These trends suggest that while procedural familiarity is growing, many learners need deeper conceptual clarity, especially around place value, regrouping, and interpreting mathematical language.

■ The results also indicate that 11% of learners showed signs of emerging mental strategies such as counting on, a desirable concept taught in grade 3. Through observation as learners handled the task, some learners counted 9 mentally and then added *4 using the fingers, implying that they used counting-on* strategy.

These observations underscore the importance of reinforcing conceptual understanding, supporting language development, and providing access to diverse, learner-appropriate strategies, including visual, tactile, and verbal methods in early mathematics instruction.

3.3: Mathematical Items: Performance in Subtraction Tasks

3.3.1: Nearly half of the learners assessed were proficient in simple subtraction.

Item 2 Mary had 47 sweets. She gave 23 sweets to her brother. How many sweets did Mary

keep?

This question was designed to test learners' ability to solve a real-life subtraction word problem involving two-digit numbers. Specifically, it assessed their understanding of the subtraction operation to determine the remaining number after part of a whole is given away. This aligns with the Grade 2 Mathematics Curriculum under the strand *Numbers – Subtraction (1.5)*, which expects learners to "solve real-life subtraction problems involving two-digit numbers with or without regrouping" (KICD, 2024). The question also evaluates learners' skills in interpreting word problems, selecting the correct operation, and applying basic computation strategies.

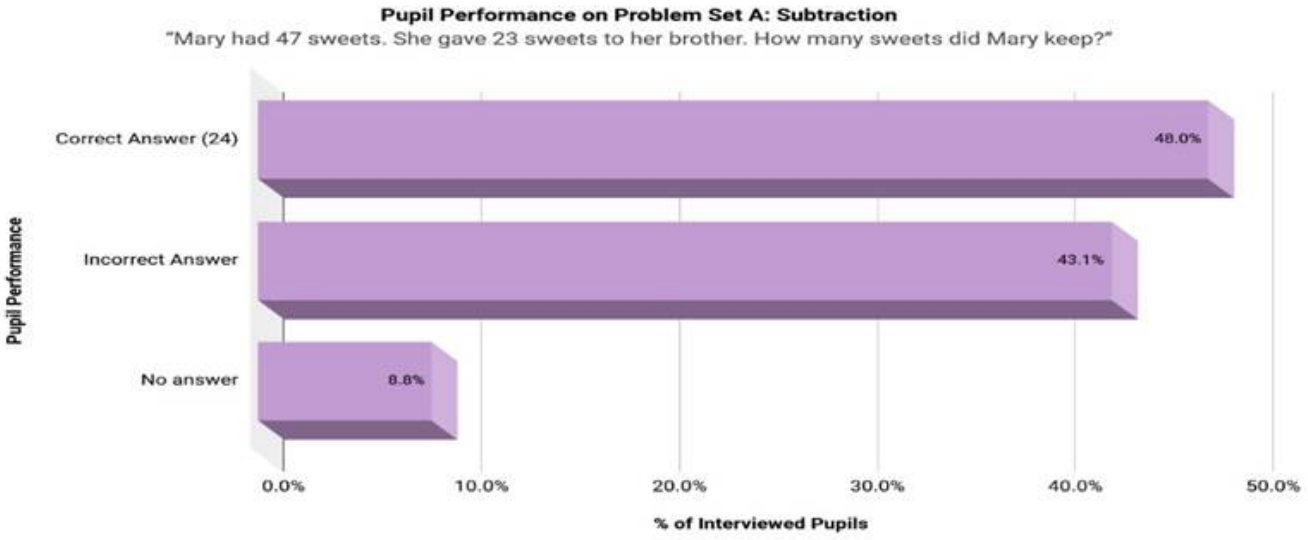


Figure 3.3: Pupils' performance on word problem: Subtraction

Overall, 48.0% of learners provided the correct answer, indicating moderate proficiency in applying subtraction in real-life contexts. However, a significant 43.1% gave incorrect responses, suggesting common challenges with selecting the appropriate operation or executing the subtraction accurately. Additionally, 8.8% gave no response, possibly due to lack of confidence or comprehension. These results highlight the need for strengthening literacy instruction to equip the learners with competency in solving a word problem and subtraction strategies as envisaged in Grade 2 curriculum under *Numbers – Subtraction.*

(1.5).

3.3.2: Only 4 out of 10 could subtract with regrouping

Item 3. James had 72 shillings. He spent 45 shillings at the shop. How much did he remain with?

This item was testing the learner's ability to carry out **subtraction by regrouping**. The problem, "James had 72 shillings. He spent 45 shillings at the shop. How much did he remain with?" requires the learner to regroup because the subtrahend (5) is larger than the minuend (2). This ensures the learner understands place value, regrouping, and accurate subtraction to find the remaining amount.

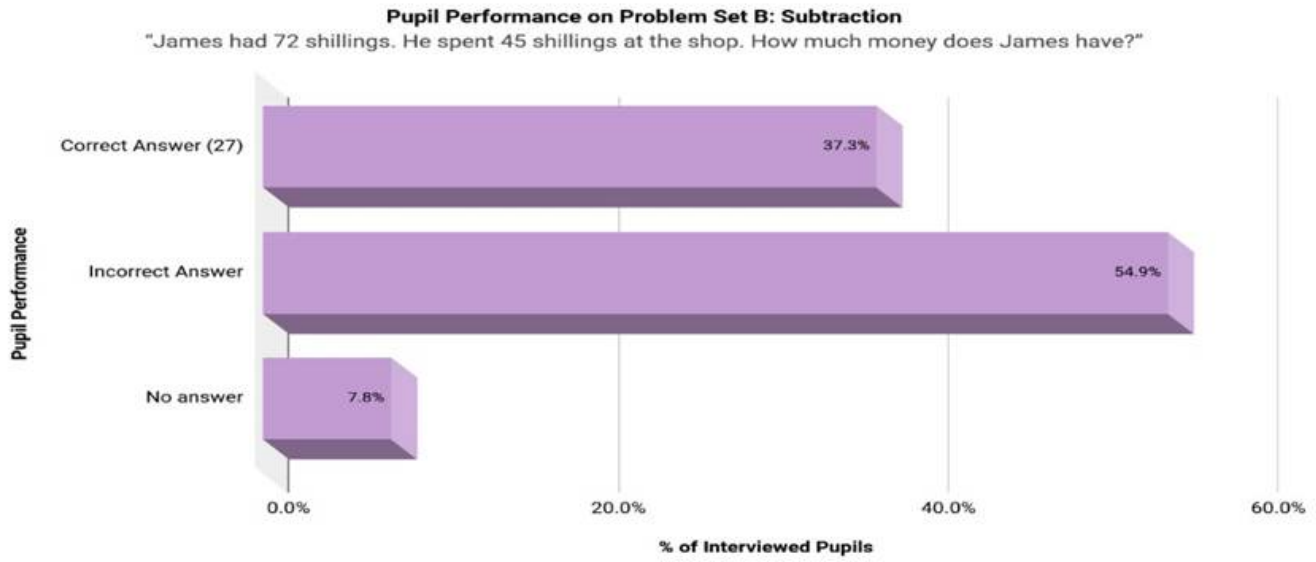


Figure 3.4 Pupils performance on word problem: Subtraction

The results show that only 37.3% of pupils (27 learners) solved the problem correctly, demonstrating ability to perform subtraction by regrouping. However, 54.9% gave an incorrect response, showing difficulty with regrouping (borrowing from the tens place). A further 7.8% did not attempt the item, suggesting low confidence or limited language comprehension. Overall, more than half of the pupils struggled with subtraction by regrouping, pointing to gaps in place value knowledge and the regrouping process. The pattern of incorrect responses is consistent with a well-documented error type in which learners subtract the smaller digit from the larger one regardless of position, effectively omitting the regrouping step rather than borrowing from the tens place (Lin et al., 2025). This highlights the need for more use of manipulatives, guided practice, and reinforcement through regular practice, approaches with a well-established evidence base for teaching subtraction with regrouping specifically (Ebner et al., 2025).

3.5 Learners Performance by gender

3.5.1: Boys outperformed girls across all three tasks

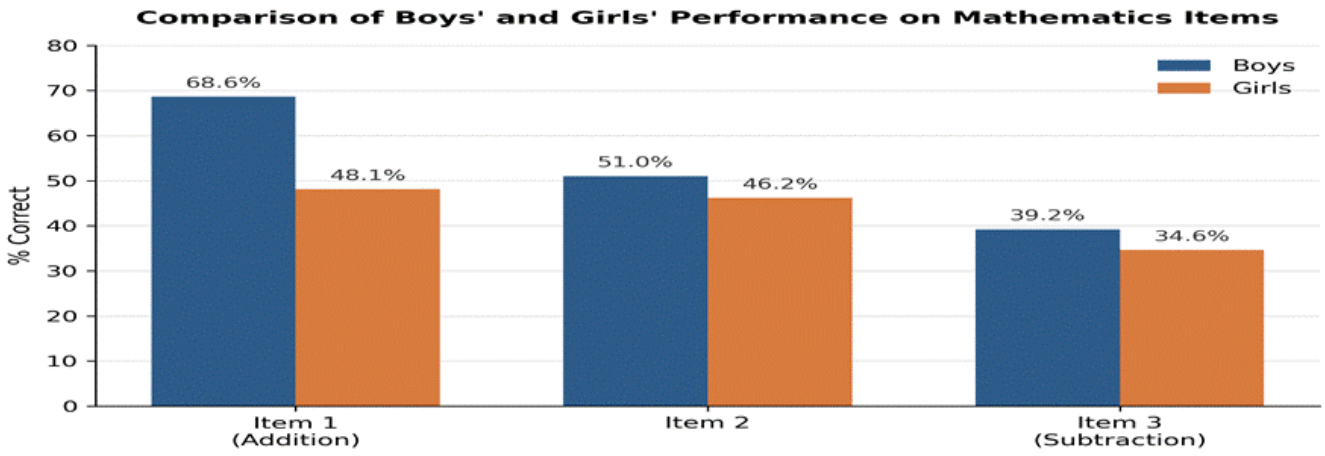


Figure 3.5: Comparison of performance of girls and boys in the three math items

The table shows that boys outperformed girls across all three items, though the gap varied. In i**tem 1** (addition), the largest difference was observed, with 68.6% of boys correct versus 48.1% of girls, and a borderline significant p-value (0.056). In i**tem 2**, boys scored 51% and girls 46.2%, while in i**tem 3**, boys scored 39.2% and girls 34.6%; both gaps were small and statistically insignificant.

3.6: Number of learners per correct answer

Table 3.4: Number of learners per correct answer

Total Correct Answers	Number of Learners	Percentage of Learners (%)
0	30	29.1
1	27	26.2
2	18	17.5
3	28	27.2
Total	103	100

The data shows a varied distribution in learner performance across three math problems. 29.1% of learners answered none of the questions correctly, while 27.2% managed to answer all three correctly, indicating a bimodal distribution with two clear extremes. The remaining learners were split between getting one (26.2%) and two correct (17.5%). This pattern highlights significant variation in learner understanding, with nearly one-third struggling completely, and another third demonstrating full mastery. The findings underscore the need for targeted instructional support to bridge gaps while reinforcing strategies that are working for high-performing learners.

The findings from the learner cognitive tool are reinforced by interviews from the teachers who indicated that addition and subtraction by regrouping is problematic to the learners especially when terms like "carrying" are replaced with "regrouping." Students frequently forget steps or fail to apply the concept correctly.

3.7: Only about half of teachers are proficient in basic numeracy pedagogy

Ten mathematics items were developed from Grade 2 mathematics curriculum, covering numbers, measurement, and algebra, and administered to Grade 3 mathematics teachers to assess their knowledge of mathematics and pedagogy. Performance in two of the items is shown in table 3.5.

Table 3.5: Teacher Proficiency in Basic Numeracy Pedagogy

Sample item	**Proportion of teachers**
Which strategy would a learner most likely use when first learning to solve 4 + 3? A. Count all B. Count on C. Recall the fact D. I don’t know	**Only 49% of teachers got this correct.**

How should learners first learn to count numbers from 1 to 10? A. By tens and ones B. By ones C. By grouping and skip-counting D. I don't know	**Only 46% of teachers got this correct.**

Overall, from the mathematical knowledge assessment,

- Teachers displayed strong mastery of core number concepts, grouping into tens, modelling, subtraction word problems, and breaking numbers apart, reflecting a solid grasp of foundational numeracy skills for early-grade teaching.
- Teachers' weakest areas were in concepts beyond number work, particularly elapsed time, spatial awareness, and sequencing of addition strategies, revealing gaps in pedagogical knowledge for geometry, measurement, and cognitive skill development.
- Teacher overall scores were low, with **1.5% scoring 0/10** and the **highest at only 5/10 (24.6%).** Most clustered at **4/10 (33.8%),** showing limited mastery of key concepts. This raise concerns that learners may not receive accurate instruction, risking early numeracy gaps.
- Coaching and mentorship for numeracy is practically absent. Nearly all teachers stated there was no subject-specific coaching in mathematics teaching. This is a missed opportunity to embed experiential, feedback-rich professional development.

The findings are consistent with those of Sitabkhan et al. (2024), who reported persistent challenges among teachers in supporting young learners' progression through counting sequences and increasingly sophisticated addition strategies in low- and middle-income contexts. One plausible explanation for these instructional gaps is the limited access to sustained subject-specific professional support. As argued by Echaune (2026), continuous coaching and mentorship are critical for strengthening teachers' pedagogical practices in mathematics. However, nearly all teachers in the present study reported that they had not received subject-specific coaching or mentorship in mathematics instruction. This represents a missed opportunity, given evidence that well-implemented school-based coaching and in-service mentorship can significantly improve instructional practice among Kenyan primary school teachers (Echaune, 2026).

Conclusion

This paper set out to assess Grade 3 learners' gaps in solving addition and subtraction tasks involving regrouping and to interrogate the instructional and leadership conditions that shape foundational numeracy outcomes. The findings confirm that numeracy learning gaps remain deep, uneven, and systemically rooted. While a small proportion of learners demonstrate full mastery (27.2% answered all three items correctly), nearly one-third (29.1%) could not solve any of the items correctly

This bimodal distribution reflects widening inequities within classrooms and signals that instructional approaches are not consistently meeting learners at their level.

Several critical gaps emerge from the evidence:

1.Conceptual gaps in place value and regrouping

More than half of learners struggled with subtraction by regrouping (54.9% incorrect), revealing fragile understanding of place value and regrouping concepts. Many learners relied on counting-all strategies, misapplied operations, or produced structurally incorrect multi-digit responses (e.g., 1017 for 117), indicating confusion in number notation and abstraction.

2.Over-reliance on concrete and procedural ptrategies

A dominant 75.4% of learners relied on body-based counting (fingers, toes, head) suggesting limited progression from concrete to abstract thinking. Although algorithmic presentation was common, procedural familiarity did not consistently translate into conceptual mastery.

3.Pedagogical capacities of teachers are limited

On average, teachers scored 4 out of 10 items correct in the teacher mathematicak knowledge assessment, that sought to establish teachers' levels of understanding of basic numeracy pedagogy. Despite these gaps, instructional leadership and opportunities for professional development are insufficient or completely absent.

Recommendations

I. Classroom and Teacher Level

Strengthening Conceptual and Diagnostic Instruction

Teachers should intentionally move beyond algorithmic compliance toward conceptual teaching along the CPA (Concrete–Pictorial–Abstract) continuum, complemented with diagnostic error analysis.

- Systematically use learner errors to identify misconceptions in place value, regrouping, and operation selection, rather than treating incorrect answers as isolated mistakes
- Progress learners deliberately from concrete to semi-concrete to abstract representations, ensuring mastery at each stage before advancing
- Incorporate structured mental math strategies (e.g., counting-on, decomposition, partitioning) to reduce over-reliance on body-based counting, while recognizing that finger-based counting itself is developmentally appropriate earlier on and should be transitioned deliberately rather than discouraged outright
- Explicitly teach schema identification for word problems (e.g., total, change, difference, equal-groups structures) before requiring learners to compute, since misidentifying the underlying problem structure is not miscalculation but a single most common source of word-problem errors
- Provide direct instruction distinguishing operation symbols and meanings (e.g., explicit contrast of addition vs. subtraction cues), since learners frequently default to whichever operation they have had the most practice with, regardless of what the problem calls for
- Use formative assessment routinely to group learners by level and provide targeted support.
- Deliberately expose learners to both horizontal and vertical problem formats from Grade 2 onward, not just the vertical algorithm, since algorithm-only exposure is associated with slower development of flexible, number-based strategies

II. School Level

Institutionalize Instructional Leadership for Numeracy

Education leaders should reposition foundational numeracy as a school-wide instructional priority rather than a classroom-level issue.

- Establish clear school-level numeracy benchmarks aligned to national standards.
- Introduce regular instructional walkthroughs focused specifically on numeracy pedagogy (place value teaching, regrouping methods, learner engagement strategies).
- Create school-based Communities of Practice (CoPs) for mathematics teachers to review learner work, analyze errors, and share strategies.
- Institutionalize structured mentorship and coaching cycles rather than one-off workshops school-based in-service mentorship models have been shown to meaningfully shift classroom instructional practice in the Kenyan context specifically
- Use assessment data (NASMLA, Kenya Early Years Assessment and any other school-based assessments) to drive improvement conversations and targeted interventions.
- Establish referral and support protocols for over-age and persistently struggling learners identified through diagnostic assessment, given the documented concentration of over-age enrollment in frontier/ASAL counties and its instructional implications
- Track numeracy performance by gender using disaggregated school data, without presuming a fixed direction of gender gap
- Instructional leadership must move from administrative supervision to evidence-driven teaching support, with accountability embedded in performance management systems.

III Policy Level

- Embed explicit guidance on children's developmental progressions in addition/subtraction strategies (not just procedural content) into KICD curriculum designs and teacher guides, since teacher mathematical knowledge gaps concentrated specifically in *how children learn* rather than in the mathematics content itself and did not improve through generic training that failed to target this distinction directly
- Adopt a standardized diagnostic tool for teachers' pedagogical content knowledge in early-grade numeracy
- Scale successful school-based mentorship and coaching models' system-wide through TSC's Teacher Professional Development structures, rather than leaving instructional coaching to ad hoc, donor-funded, or one-off programs
- Review DPTE/UDPTE pre-service curricula to ensure explicit, assessed coverage of learner developmental progressions in numeracy, not only subject-matter content.
- Ensure textbook and curriculum materials explicitly model and sequence number-based mental strategies alongside the standard algorithm, since textbook quality of strategy instruction has been shown to directly shape whether learners move beyond algorithm-dependence (Sievert et al., 2025).

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