REPUBLIC OF KENYA

Centre for Mathematics, Science and Technology Education in Africa (CEMASTEA)

STEM RESEARCH AND INNOVATION

Research & Development Knowledge Management (R&D KM)

POLICY BRIEF FROM

A STUDY ON THE EFFECTIVENESS OF ERROR ANALYSIS TO IMPROVE FOUNDATIONAL NUMERACY LEARNING OUTCOMES

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CEO, CEMASTEA

Citation

CEMASTEA (2025). Policy brief from research titled; **Effectiveness of error analysis to improve Foundational numeracy learning outcomes.**

This study was undertaken as part of a data-driven **proof-of-concept** initiative to strengthen foundational numeracy in early grade classrooms. The project explored how error analysis could be used as a pedagogical approach to help teachers diagnose learner difficulties and improve instructional practices in mathematics at early years of education.

The study began with a baseline assessment in Bungoma West Sub-County, focusing on Grade 2 learners' performance in addition and subtraction. The baseline revealed low learner performance; with the majority of learners struggling with number facts, procedural steps, and conceptual understanding. Teacher data, similarly pointed to gaps in classroom practice; including insufficient skills in identifying errors, documenting and limited use of formative assessment feedback to continually improve pedagogical instruction. These findings provided the foundation for designing an intervention aimed at addressing both learner and teacher challenges.

1.1 What was the issue?

This policy brief summarizes findings from a quasi-experimental study conducted by CEMASTEA to assess the effectiveness of error analysis in improving foundational numeracy among Grade 2 learners in Bungoma West Sub-County. The study addressed the following objectives:

a) Assess the nature and types of errors learners make in addition and subtraction.
b) Strengthen teachers' capacity to identify, categorize, and respond to learner errors through structured error analysis.
c) Evaluate changes in learner performance and methods of problem solving between baseline and endline.
d) Compare outcomes between experimental and control schools.

The objective of this policy brief is to position the research work and findings within the broader policy context, including policy strategies and inform decision- making processes.

1.2 Justification of the study

Kenya's education reforms under Competency-Based Education (CBE) emphasize the need for foundational literacy and numeracy. However, national and regional assessments reveal persistent learning gaps in early numeracy, particularly in addition and subtraction. Teachers often lack structured methods to identify and address learner errors. This study responds to that gap by demonstrating how error analysis can serve as a diagnostic and formative assessment tool to strengthen both learner outcomes and teacher practices in foundational numeracy.

1.3 Significance of the Study

The study contributes to evidence-based interventions for improving numeracy instruction and teacher practice. By embedding error analysis in daily teaching, teachers become reflective practitioners capable of transforming learner errors into learning opportunities. The approach also enhanced formative assessment, enabling data-driven instruction and learner-centered pedagogy. The findings support Kenya's national goals for foundational learning as articulated in the National Education Sector Strategic Plan (NESSP 2023–2027) and complement initiatives under the Presidential Working Party on Education Reform (2023).

1.4 Key Findings and Recommendations

Key Findings and Recommendations from research on **"Effectiveness of Error Analysis to improve Foundational numeracy outcomes":**

This report presents the key findings and recommendations from the research on the Effectiveness of Error analysis to improve Foundational numeracy outcomes. The findings are structured according to the four research objectives.

Objective 1: Assessing the nature and types of errors learners make in addition and subtraction

1. *Finding 1:* Baseline data revealed low numeracy performance with only 18.1% of learners giving correct responses and with 73.2% of the learners making factual errors.
2. *Finding 2*: Factual errors (FE1) were the most common errors across both addition and subtraction, accounting for nearly half of the responses in most tasks. For

instance, 46.8% of learners made factual errors in Addition Task 1, while 57.1% did so in Subtraction Task 2. This points to weaknesses in learners' number sense and recall of basic facts, which hindered their ability to calculate accurately. Additionally, learners' accuracy diminished as task complexity increased.

Recommendations:

a) CEMASTEA to scale up teacher in-service training in identifying and categorizing learner errors using structured tools such as error analysis logs.

b) CEMASTEA to incorporate error analysis as a diagnostic pedagogy across all STEM learning areas and make it accessible to more teachers.

3. *Finding 3:* Learners demonstrated a strong tendency to rely on rudimentary counting strategies (dots, strokes, and manipulatives), with more than 60% of learners depending on these methods.

Recommendation:

a) CEMASTEA and KICD should develop structured numeracy progression frameworks that guide teachers in transitioning learners from concrete to abstract strategies through scaffolded instruction.

4. *Finding 4:* Conceptual errors, although fewer in frequency, were most pronounced in subtraction tasks involving regrouping, indicating weak understanding of place value and number decomposition.

Recommendation:

a) CEMASTEA in collaboration with TSC should include targeted modules on place value and regrouping in Early Grade Mathematics TPD, emphasizing diagnostic questioning and conceptual modeling.

Objective 2: Strengthening teacher capacity in diagnosing and responding to learner errors

5. *Finding 1*: Teachers trained in error analysis improved their diagnostic and formative assessment skills. Experimental schools recorded significant gains, with correct responses rising to 65.8% compared to 30.9% in control schools.

6. *Finding 2:* Teachers in experimental schools who used error analysis logs consistently were able to provide specific, actionable feedback and tailor remediation, unlike those in control schools.

Recommendations:

a) CEMASTEA to embed error analysis in Teacher Professional Development (TPD) programs and Communities of Practice (CoPs) to sustain reflective teaching practices.

b) CEMASTEA in collaboration with MoE and TSC to in-service Diploma Teachers Training College (DTTC) tutors on error analysis as a formative assessment pedagogy.

c) CEMASTEA in collaboration with MoE, TSC and County Governments to implement an INSET for ECDE and Lower primary school teachers on error analysis as a formative assessment pedagogy.

d) CEMASTEA in collaboration with TSC through CSOs and MoE through QASOs should institutionalize error analysis logs as part of teacher lesson documentation tools, to be monitored as part of school-based assessment and support.

Objective 3: Evaluating changes in learner performance and problem-solving methods.

7. *Finding 1*: Learners in experimental schools shifted from rudimentary counting (DOT method, 61.8%) to structured place value strategies (PLV, 98.6%).

   Recommendations:

   a) KICD and MoE should integrate structured problem-solving and error analysis frameworks into CBE numeracy learning materials and teacher guides.

   b) CEMASTEA to implement school-based teacher support from ECDE to lower primary level.

8. *Finding 2:* Between the baseline and endline, correct responses increased from 18.1% to 48.4%, while factual errors reduced from 73.2% to 38.5%, confirming that structured feedback loops enhance content mastery.

   Recommendation:

a) CEMASTEA in collaboration with strategic partners should expand pilot implementation to more counties to validate the scalability of the error analysis approach in different learning contexts.

Objective 4: Comparing outcomes between experimental and control schools

9. *Finding 1:* Learners in experimental schools demonstrated fewer factual errors (19.1% vs. 57.8%) and greater conceptual understanding.
10. *Finding 2:* Teachers in experimental schools, effectively used formative feedback and differentiated instruction.

Recommendations:

a) MoE, County Governments (ECDE) and TSC to institutionalize school-based support and supervision on use of formative assessment and error analysis tools.
b) CEMASTEA to ensure that a session on improvisation of learning resources using locally available materials is always part of its TPD programs.

11. *Finding 4:* Teachers in experimental schools scored higher across all pedagogical domains; concept development, mathematical language, and formative assessment compared to control schools.

Recommendation:

a) CEMASTEA should embed pedagogical performance indicators in school-based Monitoring, Evaluation, Learning and Support (MELS) tools to track the integration of error analysis within lesson delivery.

Conclusion

Error analysis proved effective in improving both learner performance and teacher professional practice in foundational numeracy. It offers a scalable, low-cost intervention aligned with Kenya's commitment to improving early grade learning. CEMASTEA recommends integrating error analysis into national teacher training frameworks and foundational learning programs across all basic education levels.