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GANAMAT PILOT FINAL REPORT—DRAFT

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DISCLAIMER

The authors' views expressed in this document do not necessarily reflect the views of the United States Agency for International Development or the United States Government.

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ACRONYMS

CNV	Community Numeracy Volunteer
DEO	District Education Officer
EGMA	Early Grade Mathematics Assessment
FOI	Fidelity of Implementation
GENA	Ghana Early Numeracy Assessment
GES	Ghana Education Service
HT	Head Teacher
ICT	Information and Communications Technology
IRR	Interrater Reliability
KG1	Kindergarten 1
KG2	Kindergarten 2
MOE	Ministry of Education
NAC	Numeracy Advisory Committee
P1	Primary 1
P2	Primary 2
P3	Primary 3
P4	Primary 4
P6	Primary 6
PD	Professional Development
PMEP	Project Monitoring and Evaluation Plan
SBI	School-Based In-Service Professional Development Program
SD	Standard Deviation
SES	Socioeconomic Status
SMS	Short Message Service
STS	School-to-School International
USAID	United States Agency for International Development

EXECUTIVE SUMMARY

The USAID Partnership for Education: Learning Activity (*Learning*), implemented by FHI360 and its partner School-to-School International, developed a Math Pilot. The purpose of the Math Pilot was to provide the Government of Ghana through the Ghana Education Service (GES) a model for operationalizing proposals put forward in the 2014 report, *Reforming Science and Mathematics Education in Basic Schools in Ghana* (MOE, 2014), and the accompanying *Roadmap 2020*. The conceptualization of the Math Pilot began in 2014 when Ghana’s Ministry of Education (MOE) established a national committee to examine the state of mathematics and science teaching and learning and to develop recommendations to ensure that future learners develop the mathematics understandings and skills required to meet the needs of an increasingly technological society. The Commission’s report argued that pupil learning outcomes on national assessments in math and science could be improved by bringing the syllabus in line with international trends in primary mathematics education.

Based on this recommendation, a National Advisory Committee (NAC) composed of key actors within the MOE and GES was established to provide guidance related to the implementation of the Math Pilot. A mathematics syllabus panel, led by Professor D. Mereku and supported by *Learning* mathematics education technical advisor Dr. Norma Evans, revised the math syllabus for Kindergarten (KG1) to Primary 3 (P3), reducing the number of topics per grade level and thereby placing greater emphasis on essential topics for each grade level. Learning outcomes were also developed to focus specifically on ensuring pupils develop strong conceptual understandings of these topics as well as assessment tasks to measure whether they have done so.

Learning worked with the MOE and the NAC to support the creation of mathematics standards and with the assistance of the syllabus panel, produced syllabi for KG1 through P3. Additionally, the NAC was instrumental in ensuring that there was dedicated time during the school day for professional development (in-service training). The NAC also ensured that pilot schools delivered mathematics instruction in local language as per the pilot design. Importantly, the Math Pilot launched an in-service training program for early grade teachers modelled on the in-service teacher support approach outlined in the MOE’s teacher in-service policy. The materials development panel then developed materials for in-service training to assist teachers with implementing the revised syllabus. Through the Math Pilot, the MOE has been able to learn the extent to which this approach can be operationalized.

CHAPTER I: INTRODUCTION

I.1 Overview of Primary Education in Ghana

During the past 30 years, many experts within and outside Ghana have contributed to the ongoing discussion of Ghanaian pupil performance in mathematics. The media, politicians, and educationalists have all expressed concern about pupils’ low levels of performance on national numeracy studies and tests (Acquaye, 2011; Gadugah, 2011; Mereku, 2013; MOE, 2014a), particularly concerning key or foundational mathematical understandings. For example, the 2013 National Education Assessment (NEA) and Early Grade Mathematics Assessment (EGMA) revealed that while children in the early primary grades in Ghana have acquired basic procedural understandings in mathematics (RTI, 2014), they have significant gaps in their conceptual understanding of these same basic concepts. These concepts include the ability to identify and describe relationships between numbers and number quantities, to deal fluidly and flexibly with numbers and number concepts, and to bring these understandings to bear when solving problems. Weak conceptual understanding of fundamental mathematics concepts is a significant barrier to pupils’ success in higher-level mathematics.

With international support and guidance, the effort to reform and improve the national curriculum has been led by members of the Ghanaian Ministry of Education (MOE). In 2014, the MOE attempted to address concerns about pupils' performance by forming a 20-member committee to deliberate on ways and means to reform mathematics education in the country. The committee's report—*Inspiring Science and Mathematics in Basic Schools: Report of the committee that reviewed basic science and mathematics education in Ghana*—identified a number of factors that contribute to pupils' poor performance, including the nature of the curriculum, weak teacher content knowledge, teachers' use of ineffective mathematics teaching practices, and an inadequate supply of mathematics teaching/learning materials (MOE, 2014b). The committee's recommendations included shifting from a focus on procedures and memorization to constructivism and conceptual understanding of mathematics.

These recommendations were far-reaching and required a significant effort to operationalize. Accordingly, the United States Agency for International Development (USAID) provided support to the MOE through its USAID Partnership for Education: Learning Activity to test these recommendations in an effort called the Math Pilot. The initiative was rolled out in two phases. First, new strategies and materials for teaching mathematics were developed and tested in a limited number of schools during the 2016-2017 school year in a Pre-Pilot. Second, lessons learned from the Pre-Pilot were applied to a larger number of schools the following school year in the Full Pilot, with an impact evaluation conducted by an external evaluator, funded by USAID, in these schools to examine this new approach and its impact on pupil's learning outcomes in math.

1.2 Introduction to Learning and the Math Pre-Pilot

The project primarily aimed to improve literacy outcomes for children in the early grades in Ghana and was implemented by a consortium of organizations led by FHI360. The *Learning* Activity also assisted the Government of Ghana in the development of new strategies for teaching primary school math in the early grades. School-to-School International, contracted by *Learning*, served as an advising partner to the MOE/Ghana Education Service (GES) on the development of revised standards, syllabi, and materials for implementation of the Math Pilot, as well as providing a system for training, coaching, monitoring, evaluation, and learning throughout the Math Pilot process. The MOE/GES guided overall implementation and consulted on appropriate adaptations and modifications. This close involvement was central to the design of the interventions and the long-term sustainability of the Math Pilot, ensuring that intellectual capital and ownership resides in the Ghanaian system if the government decides to roll out the Math Pilot nationwide.

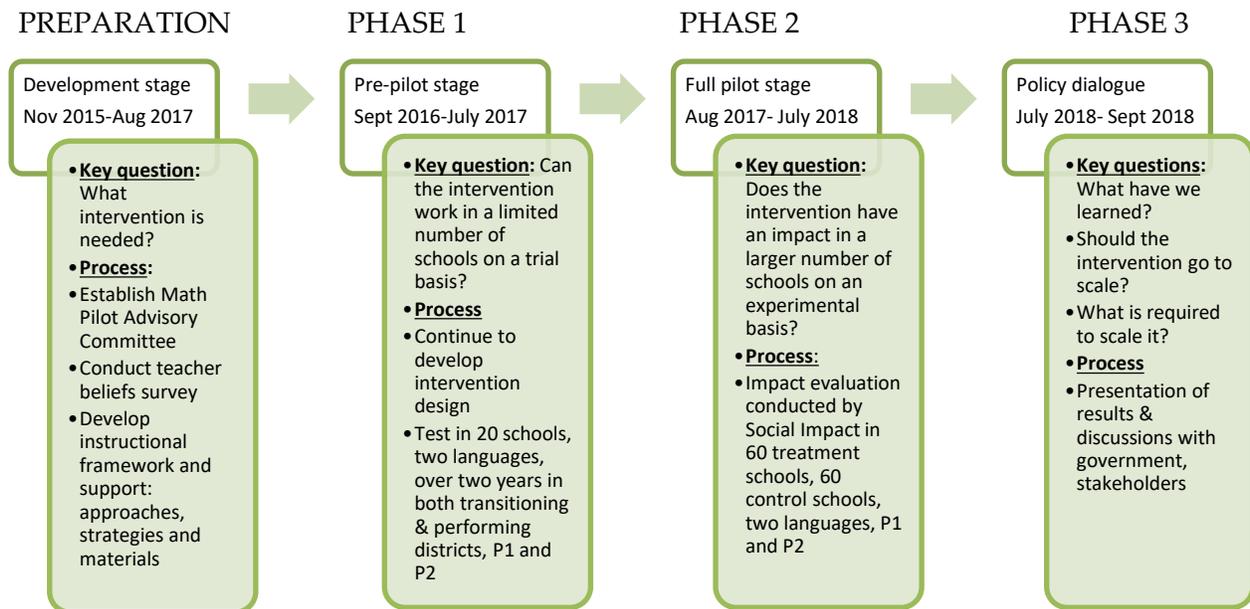
Purpose

The purpose of the Math Pilot was to develop and test a model for operationalizing the Government of Ghana's proposed numeracy reform. To do this, *Learning* collaborated with the MOE/GES and a Numeracy Advisory Committee, initiated by *Learning*, to revise the numeracy syllabus, develop a school-based in-service model, and to test these interventions in a small sample of schools. If research shows that the model is successful, it may be rolled out to a larger number of schools and be adopted as part of the national curriculum.

Development

The Math Pilot was implemented from 2015-2018 through a phased approach. During the Development Stage, from November 2015-August 2017, the program established the Numeracy Advisory Committee, conducted surveys of teacher beliefs, and developed the instructional framework and support. Phase 1, the Pre-Pilot stage, ran from September 2016 to July 2017 in 20 schools in Ada West and Ga West districts and two languages for grades Kindergarten 1 (KG1), Kindergarten 2 (KG2), Primary 1 (P1), Primary 2 (P2), and P3. Phase 2, the Full Pilot stage, ran from August 2017 to July 2018 in 60 new schools in two new districts, New Juaben and Shai Osudoku.

Figure 1: Phases of the Math Pilot



A mathematics syllabus panel, established by the GES, chaired by Professor D. Mereku, and supported by *Learning* mathematics education technical advisor, Norma Evans, revised the math syllabus in 2016-2017. The revised syllabus requires teachers to teach ten 30-minute math lessons per week for a total of five hours of weekly mathematics instruction. Teachers are also expected to teach mathematics every day. The revised syllabus reduces the number of topics per class and places a greater emphasis on essential topics for each grade level. It also includes learning outcomes that focus specifically on ensuring pupils develop strong conceptual understandings of these topics, as well as assessment tasks that measure the extent to which pupils have done so. During the 2016-2017 academic year, the panel finalized the revised syllabus for KG1 to P3.

The Pre-Pilot launched in the fall of 2016. A baseline assessment was conducted in October 2016, at the beginning of the 2016-2017 school year, in the 20 pre-pilot schools in Ada West and Ga West. The purpose of the baseline assessment developed by the project—the Ghana Early Numeracy Assessment (GENA)—was to provide a data point against which to measure learning gains in the 20 Pre-Pilot schools and suggest areas for revision and reform of Math Pilot materials and practices to enhance the Full Pilot. The GENA is comprised of a series of assessment tasks based on prior EGMAs conducted in Ghana and elsewhere for P2 classes, and others drawn from assessments conducted in other jurisdictions. The additional tasks measured skills not covered in previous mathematics assessments for the early grades in Ghana. The chosen tasks were adapted to the end-of-year expectations for P1 and P2 in the revised syllabus. The GENA baseline was collected in P1 and P2 classes in all 20 Pre-Pilot schools. The assessment was mostly administered orally to a total of 240 P1 and P2 pupils, half of whom attend schools in Ada West, and the other half in Ga West, while a small number of tasks were administered in a small group setting where pupils wrote or circled responses. To assess program progress, make changes to improve program implementation, and validate instruments, the project conducted a Pre-Pilot endline GENA at the end of the 2016-2017 school year.

The second phase of the Math Pilot was built on the results of the Pre-Pilot endline assessment and took place between August 2017 and July 2018. During this time, the intervention worked in 60 new schools in two new districts, New Juaben and Shai Osudoku, and Social Impact conducted an impact evaluation in these schools.

CHAPTER 2: MODEL AND ROLLOUT PROCESS

2.1 In-service Model

A GES-appointed instructional materials development panel created a host of materials for various groups participating in the Math Pilot. The panel designed training materials for school-based math coaches to use during weekly school-based in-service sessions to support the implementation of the school-based in-service program. They also developed resources for Head Teachers to use during classroom observations and resources for community numeracy volunteers (CNVs)—mostly university graduates completing their national service and assigned to the program—to use when implementing remedial support sessions for struggling pupils. The model is presented in the following figure:

School-Based Intervention (SBI) model, pre-pilot stage

	Structure	Content	Materials
Face-to-face teacher training workshops	<ul style="list-style-type: none"> Term 1: 5 days training Terms 2, 3: 3 days training Led by National Training Team 	<ul style="list-style-type: none"> Syllabus: Mastery of math procedures & concepts Focus: Teachers' conceptual understanding 	<ul style="list-style-type: none"> Teacher resource guide & performance standards Weekly schemes of work Biweekly assessment tasks
Coaching	<ul style="list-style-type: none"> Coaches meet with teachers in groups once every week for in 1 to 1.5 hr. sessions during release time - alternates with learning circles Lead by trained peer coach* 	<ul style="list-style-type: none"> Design, teach lessons, create materials, peer observation Discuss research on teaching math 	<ul style="list-style-type: none"> Support: video, SD card, WhatsApp, SMS
Learning circles	<ul style="list-style-type: none"> Teachers meet once every 2 weeks in 1 to 1.5 hr. sessions during release time - alternates with coaching sessions Led by trained teacher 	<ul style="list-style-type: none"> Builds community of practice Discuss instructional practices, create materials, Discuss research on teaching early grade math 	<ul style="list-style-type: none"> Support: video, SD card, WhatsApp, SMS
Instructional leadership	<ul style="list-style-type: none"> Head Teacher observes teachers giving math lessons once every 2 weeks, provides feedback 	<ul style="list-style-type: none"> Instructional support to teachers: lesson plan preparation, feedback to support struggling teachers 	<ul style="list-style-type: none"> Lesson Observation checklist Head Teacher journal: documentation of support to teachers
Community Numeracy Volunteers	<ul style="list-style-type: none"> CNVs join numeracy lessons when they are happening Role: Support struggling pupils with math games & activities 	<ul style="list-style-type: none"> Trained to observe lesson, give support to pupils, share information during coaching sessions and learning circles 	<ul style="list-style-type: none"> CNV Activity Manual

* Coach also leads sessions in 2 neighboring schools

Teacher Training

The face-to-face training teachers receive consists of 5 days of training in Term 1 and three days each of training in Terms 2 and 3. In these workshops, teachers learn how the revised syllabus was designed to enable students to master not only math procedures but also concepts, with a focus on developing teachers' conceptual understanding as well (e.g., Why is it important to do mental math? How do we ask questions where there is more than one answer?). In the first workshop, each teacher receives a training guide containing weekly schemes of work for the year ahead, a list of performance standards, and advice on how to

organize biweekly and end of year pupil assessments to gauge or monitor progress. With these materials, teachers design daily lesson plans using the weekly schemes of work and learn new ways to explain numeracy concepts, including key terms in the local language. As part of their training, teachers also learn how to make and use manipulatives with locally available resources. Examples include addition and subtraction frames and the use of bundles of straws or sticks. Teachers are also encouraged to integrate activities similar to those proposed in the weekly schemes of work when developing their weekly lesson plans.

Coaching Sessions

During the Full Pilot, KG-P3 teachers participate in Coaching Sessions, held once every week for 1-1.5 hours on days when schools closed early for professional development as per the requirements of the NAC. In these Coaching Sessions, teachers solve problems together and discuss topics in the teaching of early primary mathematics, explore research on effective mathematics teaching, practice explaining mathematical concepts and activities in local language, develop lesson plans with their peers, and engage in collaborative learning activities to explore effective practices for primary classrooms.

Each school had a math coach who did the following:

- Led coaching sessions on a weekly basis
- Attended an initial training as well as training activities before each term
- Attended 2-day coaches' forum mid-way through each term to discuss successes, challenges, content and to share strategies
- Communicated with other coaches and project staff via WhatsApp to exchange questions and information.

Coaches were identified by district officers based on their interest in being trained to become peer math coaches. For their training, coaches attended training for 2-3 days at the beginning of each term on the revised syllabus and coaching practices relevant to that term. *Learning* provided coaches with a Coaching Manual containing plans for the coaching sessions of each term, weekly schemes of work with exemplar activities teachers are encouraged to explore, and expectations regarding what coaches are to do during the different sessions.

Head Teachers

The Math Pilot called for Head Teachers to become numeracy instructional leaders. To that end, *Learning* trained the Head Teachers on the revised curriculum and leadership role. This training included instructions on the use of a school leadership self-assessment checklist to guide their actions and the use of an FOI/Head Teacher leadership tool. Head Teachers used their observation checklists provided by *Learning* to observe each P1 and P2 numeracy teacher twice per month, beginning with Term 2. Also, Head Teachers received training to observe classroom teachers and support uptake of the new syllabi and materials. In addition to attending their training, Head Teachers attended the Coaches training.

Community Numeracy Volunteers

Learning (through the districts) selected Community Numeracy Volunteers (CNVs), made up of National Service Personnel, to conduct and support numeracy games and activities in Full Pilot schools. The role of the CNVs was to support teachers in the classroom and to help raise awareness and generate excitement among pupils around math using games. Support was provided during and outside of class time. Activities consisted of extra-curricular reinforcement of key content for groups of students and working with struggling students. CNVs also engaged in community activities such as walks and taking math clubs to the market. CNVs received two days of training before each term and were provided with a CNV Handbook, which included activities to help support learners in the classroom, in small groups outside of the classroom, and in school-wide and community-oriented activities. Due to teacher shortages at participating schools, some

CNVs were asked by schools to serve as full teachers, therefore limiting their ability to participate in the math pilot.

Electronic media

Two types of electronic media were used in the full pilot year:

- **SMS:** Teachers, coaches, and Head Teachers received one SMS every week about the use of the new syllabus and materials. Teachers received an SMS every week on teaching content and practices.
- **Videos:** Links to videos were shared with Coaches via the WhatsApp platform

District Officers

District staff, including officers and Circuit Supervisors, were included in all training activities. Circuit Supervisors were involved in conducting FOI evaluations. Some district staff from the pre-pilot were trained alongside Coaches to become Master Trainers and take on the responsibility of subsequently training teachers for the full pilot. Some district officers were also involved in conducting Fidelity of Implementation activities.

2.2 Description of Curriculum Materials

Under the guidance of a Mathematics Syllabus Panel and its head, Professor D. Mereku, *Learning* supported the revision of the numeracy syllabus with the support of advisor Norma Evans. The revised syllabus was organized around five key content standards, derived from the previous syllabus, each of which represents essential learning in primary mathematics. These include:

- Number and Number Sense
- Number Operations
- Patterns and Relations
- Shape, Space, and Measurement
- Collecting and Handling Data

The syllabus panel developed a package of materials to assist teachers with implementing the revised syllabus, including a teacher resource guide, including end-of-year performance standards for each grade level; weekly schemes of work; and biweekly assessment tasks.

The materials development panel assisted in designing the resources required to support the in-service training program for early grade teachers. The panel produced weekly coaching sessions aligned with the revised syllabus that focused on developing the mathematical content knowledge that teachers required to implement the pilot. Through the Math Pilot, the MOE was able to learn the extent to which this approach can be operationalized.

The panel also developed a package of materials for school-based math coaches to use during weekly coaching sessions as described below.

CHAPTER 3: GHANA EARLY NUMERACY ASSESSMENT & FIDELITY OF IMPLEMENTATION TOOLS OVERVIEW

3.1 Description of tools

Ghana Early Numeracy Assessment (GENA)

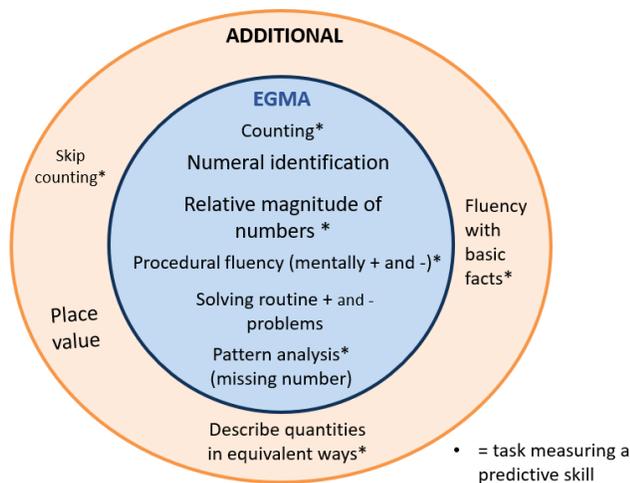
The main purpose of the GENA is to provide a measure of early grade pupils’ mathematics procedural and conceptual knowledge and skills with respect to the P1 and P2 performance standards outlined in the draft syllabus. It provides a snapshot of P1 and P2 pupils’ progress with respect to the early grade numeracy knowledge, skills and competencies outlined in the revised syllabus.

The Early Grade Math Assessment (EGMA) was developed with funding from USAID and the World Bank. It measures pupils’ performance on some of the foundational skills young children must develop if they are to gain more advanced mathematical understandings. Globally, policymakers have used the results of EGMA to identify gaps in pupils’ understandings or skills, and by extension measures that must be taken, at the classroom or national level, to fill these gaps. Results have also been used to develop pupil performance standards that communicate to both teachers and parents’ minimal levels of performance pupils must demonstrate, at key stages in their learning, to be successful math learners.

Like the EGMA, the GENA consists of a series of tasks, each focusing on a specific math competency. These include number identification, reasoning about magnitude (Number Discrimination), relationships between numbers, recognition of number patterns (Missing Number), addition and subtraction (Addition and Subtraction, Levels 1 and 2), and word problems (Word Problems). Tasks are administered in either one-on-one interviews, or in the case of P2, in both one-on-one interviews and in a group setting.

Unlike EGMA, GENA is a grade or class-specific and curriculum or syllabus-based. It is designed to measure the extent to which pupils have met the end of year performance standards for P1 and P2. GENA integrates EGMA tasks, adapted to the expectations of the P1 and P2 syllabus. It also includes new tasks that measure pupils’ conceptual understanding of key topics, for example, the extent to which they can represent quantities in multiple but equivalent ways. The GENA was developed in English, and two GES-approved languages of instruction in the selected districts, Akuapem Twi and Dangme.

Figure 2: Relationship between EGMA tasks and GENA tasks



The first draft of the GENA was developed by Mathematics Expert Dr. Norma Evans in September 2016. The associated tasks were reviewed by syllabus panel members, under the direction of the panel chair, Professor D. Mereku. During the training of enumerators, tasks were piloted at Amasaman MA School and this, coupled with inter-rater reliability testing, led to the rewording of some task items in the local language.

FOI

The main purpose of the Fidelity of Implementation (FOI) data collection was to allow the project to learn from the Math Pilot and provide for refinement and improvement. For FOI research, three interview tools were designed—one each for Head Teachers, Coaches, and Teachers. A classroom observation tool was also developed. The tools were developed by STS technical staff, vetted by District Education Office staff in October 2016, and used to collect baseline data in November 2016. The tools were revised in February 2017 based on the results of the baseline data collection. The same set of tools were used during the March and June 2017 data collection, allowing project staff to track changes over time.

FOI data were collected through interviews and classroom observations. The Head Teacher interviews focused on the level of participation in professional development activities, as well as evidence attesting to the implementation of different evidence-based instructional leadership practices addressed in the previous trainings. The practices that were checked included whether teachers were using lesson plans that followed the schemes of work, whether measures were implemented to track teacher and pupil attendance, and whether a system to reward those using new numeracy practices was implemented. The Coach interviews provided data on the experiences of numeracy coaches in the program, including participation in coaching sessions, the perceived increase in knowledge of mathematics, and changes to enjoyment in teaching mathematics. The Teacher structured interviews provided data on the level of teacher participation in professional development activities, as well as access to and use of the *Learning* numeracy materials, including the number of days numeracy was taught each week and number of minutes focused on numeracy.

The classroom observations focused on topics including teacher practices, classroom environment, level of pupil engagement, classroom activities, and the availability and alignment of lesson plans with the revised syllabus.

CHAPTER 4: LESSONS LEARNED AND RECOMMENDATIONS

On October 16, 2018, *Learning* hosted a national workshop where the results of the pre-pilot and pilot were presented to national stakeholders by *Learning* staff and STS as well as district officers and teachers who had participated in the pre-pilot and pilot. At this workshop, participants worked in groups to answer the following questions to summarize what had worked, what had proven challenging, and what should be considered when and if the math pilot goes to scale. The following section summarizes the results of their discussions.

What have we learned about what works and what does not?

Initially, teachers had difficulty interpreting suggested activities, especially new learning activities. Some teachers lifted notes directly from the teachers' resource package without reframing them to suit their classroom situation. This resulted in inadequate preparation by the teachers. In many classrooms, language was a barrier for teachers in that they had difficulty explaining mathematical concepts and activities in the local language. This was often due to the fact that teachers' language did not match that of their students. Throughout the pilot, teachers were trained, and materials were developed to help support teachers in

overcoming these challenges. At the conclusion of the pilot, teacher training, coaching and materials were all noted as successes by key stakeholders, including teachers. Coaching and supervision initiatives were also noted as successes. Teachers and supervisors particularly noted an appreciation for the learner-centered approach to the instructional model, stating that for many of them and their students, “mathematics had become fun.” The use of manipulatives and technology (SMS, videos, WhatsApp groups) were noted as successes as well.

The main challenges noted by the participants included issues of language mismatch between pupil and teacher, use of non-indigenous recorded video, and an overemphasis on mental math. Structural challenges included the transfer of teachers and overall commitment and buy-in for training.

What have we learned from the Math Pilot about what teachers, Head Teachers and District Officers are likely to adopt? What are they likely to struggle with or resist?

Based on the results of the pilot, participants noted that teachers are likely to adopt a more activity-based, child-centered approach. The transition to a local language of instruction and additional coaching support are areas that teachers are likely to support. Specifically, the pilot was noted for creating a process of giving and receiving feedback that readily encouraged remediation. Teachers are expected to struggle with a mismatch of the language of instruction and the complexity and volume or frequency of the assessments.

Head Teachers are supportive of more frequent and structured supervision and targeted training. In particular, the lesson observation tool was cited as a tool that provided teachers with useful support.

District Officers noted that they are likely to adopt any revised manuals and role descriptions that are provided. District Officers are likely to encounter challenges with the logistics required to manage scale-up successfully.

What institutional arrangements must be made to bring the new math approach to scale?

To scale up, participants suggested first increasing the number of schools within the same districts, then moving to other districts to maximize lessons learned within currently implementing districts. Additionally, the approaches developed during the math pilot have informed the new NaCCA revised math curriculum, which stresses the importance of learning processes like reasoning and demonstrating understanding rather than only “getting the right answer,” teaches fewer topics at each grade level but covers them in greater depth, and ensures proper alignment of learning outcomes at each grade level. The Deputy Ministry (General Education) also recommended that the math pilot approach be branded and used to signal the type of teaching and learning taking place in the schools that are implementing this improved approach. During this period, training sessions should be provided for head teachers, circuit supervisors, and teachers beyond the pilot schools. The incorporation of pre-service teacher training institutions was noted as an important component to explore when considering scale up, particularly since master trainers are often part of these institutions. Certification of trainers in this new approach should be a priority. The importance of policy directives backing the new numeracy approach was highlighted as an initial step to successful scale up.

ANNEXES

Annex I: GENA Tools, June 2017

Annex II: FOI Tools, February 2018

Annex III: National Dialogue Presentation, October 2018