National Educational Assessment and Examinations Agency, Ministry of Education, Ethiopia

EARLY GRADE MATHEMATICS ASSESSMENT (EGMA) IN ETHIOPIA: BASELINE STUDY REPORT

December, 2014
Addis Ababa

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A study carried out by

National Educational Assessment and Examinations Agency

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Acronyms and Abbreviations

1 to 1 corresp	One to One Correspondence
Add L1	Addition Level 1
Add L2	Addition Level 2
EBNLA	Ethiopian Baseline National Learning Assessment
EFA	Education For All
EFNLA	Ethiopian Fourth National Learning Assessment
EGMA	Early Grade Mathematics Assessment
EGRA	Early Grade Reading Assessment
EMIS	Educational Management Information System
ESDP	Education Sector Development Program
ESNLA	Ethiopian Second National Learning Assessment
ETNLA	Ethiopian Third National Learning Assessment
GEQIP	General Education Quality Improvement Program
GTP	Growth and Transformation Plan
Miss Num	Missing Number
MLC	Minimum Learning Competency
MOE	Ministry of Education
MOFED	Ministry of Finance and Economic Development
NEAEA	National Educational Assessment and Examination Agency
Num ID	Number Identification
Patt Ext	Pattern Extention
Quant Disc	Quantity Discrimination
READ TF	Russia Education Aid for Development Trust Fund
RTI	Research Triangle Institute
ShaReco	Shape Recognition
SNNPR	South Nations, Nationalities and Peoples Region
Subt L1	Subtraction Level 1
Subt L2	Subtraction Level 2
TGE	Transition Government of Ethiopia
TOT	Trainings of Trainers

UNESCO	United Nations Educational Scientific and Cultural Organizations
USAID	United States Agency For International Development
Word prob	Word Problem

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Executive Summary

The education system of Ethiopia made a significant progress in achieving universal primary education for all. According to the 2012/2013 MOE statistics, the gross enrollment rate of primary education reached to 95.3% and there has been a 2.9% average annual increase in primary education enrolment. It also designated that there is a decrease in repetition rate for grade 1 to 8 from 8.5% to 7.9%, dropout rate for grade 1-8 from 16.3% to 16.1 % in the year between 2010 and 2011. Furthermore, the Ministry of education exerts considerable efforts to ensure quality of education at all levels. There were important improvements in the availability of trained teachers and some other inputs which are indispensable for a high quality education system. And also to monitor the quality of education at a regular scheme national learning assessment frameworks are given much emphasis (TGE, 1994; MoE, 2008; MoE, 2010). The Ministry started to conduct national learning assessments to monitor its system since 2000 (grade 4 and 8) and 2010 (grade 10 and 12, and EGRA).

However, quality of education, as indicated in successive national learning assessments, is still a crucial challenge for the nation. The national learning assessment, conducted since 2000 to four rounds on grade 4 and 8, confirmed the mean score of students' achievement in the assessed subjects was beneath 50%. Besides, the EGRA (2010) result showed that a significant number of children that were in grade 2 and 3 couldn't read a single word and understood a story at all. These can be strong evidences for children in lower grades are not acquiring the proper knowledge and skills in schools. If children at early stage do not get the right education, it will be difficult in future times to make them competent.

Hence, in order to curb these problems of quality of education and the government's great interest in science and mathematics education encouraged assessment to be conducted in early grade mathematics.

Purpose and Design of EGMA

EGMA was designed to measure the extent to which school children in the early primary grades are learning mathematics and, more specifically, number and operations, and geometry skills. It provides information about children's basic skills and abilities which should typically be

mastered in the very early grades, and without which students will struggle, or potentially drop out. Those competencies were drawn from extensive research on early mathematics learning and assessment and were constructed by a panel of experts on mathematics education and cognition.

Therefore, the purpose of EGMA is to inform the system on how children are doing in mathematics, and give feedback as to where improvements need to be made. It also give insight into both student characteristics with foundational skills and to better understand characteristics of schools associated with students' performance.

To assess whether children are learning basic mathematics skill or not, EGMA Ethiopia posed the following basic questions: To what extent do students perform in learning mathematics at early grades? To what extent do students' achievements significantly vary by grade, region, gender, location and age? What are the characteristics of students, teachers and principals that have an impact on the performance of early grade mathematics achievement? What are the areas of competency that need improvement?

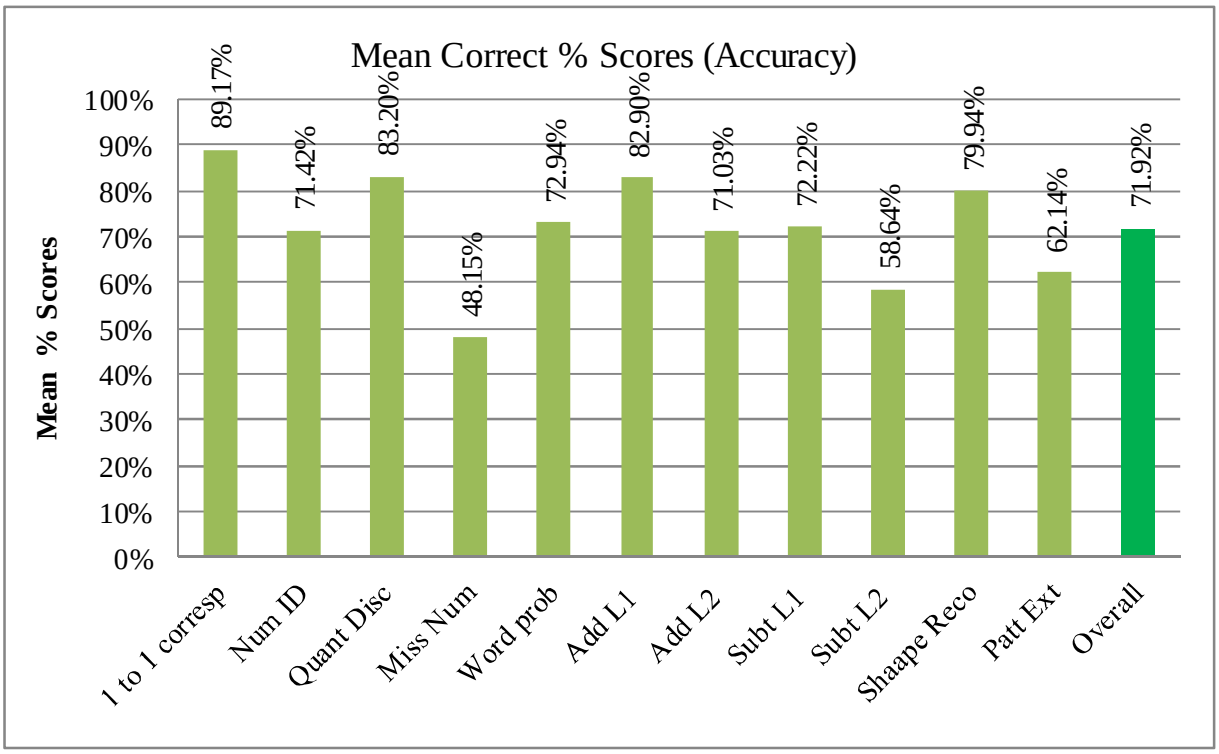
To answer these questions about mathematics learning and the factors influencing it, a study was carried out in a sample of school in all regions of Ethiopia. The sampling strategy followed the theory and practice of a stratified-two-stage clustered sampling. Proportional allocation of schools to regions based on their size was executed. Early Grade Mathematics Assessment (EGMA) was administered to a total of 15,962 grade 2 and 3 students from randomly selected 400 schools out of 23,447 schools located in all regions of Ethiopia. In addition to student tasks, questionnaires were also administered to sampled students, teachers and school principals.

The data collection took place in all 9 regions and 2 city administrations between May 7- 22/ 2014 after five day intensive training on EGMA assessor and supervisor manuals for data collectors. The data collectors were selected from federal and regional experts and teachers. More specifically, assessors and supervisors were selected from regions and city administrations who were teaching mathematics and fluent/native speakers of the instructional language of the selected sample schools.

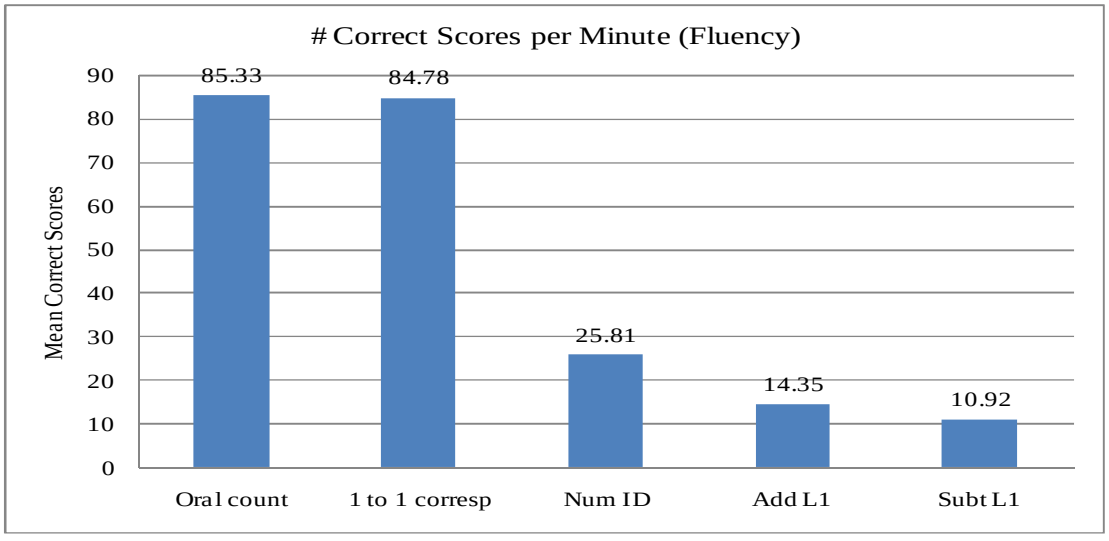
To what extent do students perform in learning mathematics at early grades?

Students achievement of basic mathematics foundational skills was orally evaluated using the Early Grade Mathematics Assessment (EGMA), which consisted of 9 subtasks: oral counting, one to one correspondence, number identification, quantity discrimination, missing number, word problem, addition and subtraction (addition level 1, addition level 2, subtraction level 1, and subtraction level 2), shape recognition and pattern extension. For oral counting, one to one correspondence, number identification, addition level 1 and subtraction level 1,students were asked to complete the task as many as they could in one minute. As with EGRA, by timing how quickly students perform these tasks, EGMA evaluates whether students have achieved a desired level of automaticity in these skill areas.

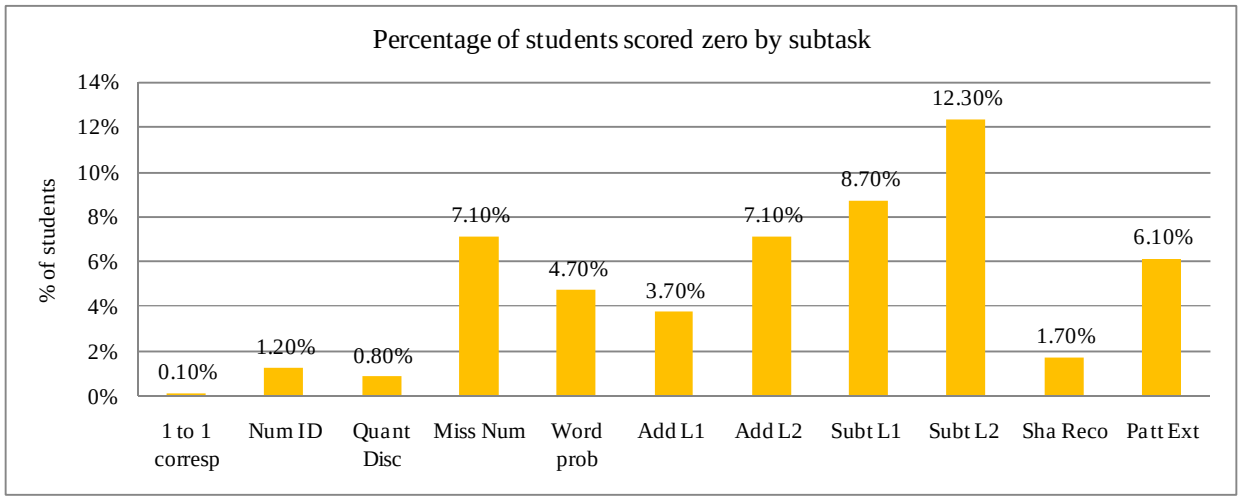
The overall percent mean score result of EGMA as illustrated by a figure below was 71.92%. The figure further indicated that the minimum score was 48.15% in missing number identification and maximum 89.17% in one to one correspondence. The percent mean score results of the subtasks in number identification, missing number, addition level 2, subtraction level 2 and pattern extension were below EGMA overall result. The addition and subtraction subtasks result showed that as the items cognitive demand increases the performance of students decreased. For instance, as it goes from addition level 1 to addition level 2 and subtraction level 1 to subtraction level 2, the performance of students' decreases from 82.9% to 71.03% and 72.22% to 58.64% respectively. Same was true from the task addition level 1 to subtraction level 1 and addition level 2 to subtraction level 2, the score of the students' decreases from 82.9% to 72.22% and 71.03 % to 58.64% respectively.



The EGMA result on fluency tasks shown in figure below also revealed that students counted 85.33 and 84.78 per minute on average before making error in oral counting and one to one correspondence respectively which were relatively better results. On average children identified 25.81 number symbols within one minute which was printed in a grid ranging from single to three digit numbers. They also performed on average 14.35 and 10.92 addition and subtraction problems (where their sums less than or equal to 9) within one minute.



The zero scores of students across the subtasks, that is, the number of students who did not respond to a single item correctly for each subtask was shown in the figure below. Some percentage of students with zero scores were noted on every EGMA subtask, most markedly in the missing number (7.1%), addition level 2 (7.1%), subtraction level 1 (8.7%), and subtraction level 2 (12.3%) subtasks. Tasks which require simple mathematics skills received less percentage of students scored zero than the other subtasks which require advanced knowledge of mathematics. For instance, the percentage of students who scored zero increases from addition level 1 to subtraction level 2 as the difficulty of items increases.



In conclusion, an overall result of EGMA showed that students performed well on each subtasks and their level of performances are promising to the education sector. That means, the students are learning at least basic skills and procedures in each subtask. However, it has been revealed that a significant number of students were struggling with some subtasks such as missing number and subtraction level 2 (accuracy subtasks); and number identification, addition level 1 and subtraction level 1 (fluency subtasks). These tasks could be the focus areas of future intervention for the Ministry of Education.

What are the characteristics of students, teachers and school principals that have an impact on the performance of students?

A student questionnaire was administered to see to the factors that account for the variance in performance of students. The variables analyzed in the study were teacher feedbacks and follow ups, parental support, availability of text book, home language, student absenteeism, school shift,

homework and preschool. Accordingly, the performance of students attending with positive teacher feedback and follow up, parental support, available text book, same home and instructional language, full day schooling, homework, and preschool education were significantly higher than those attending with the absence of these variables. Moreover, variables such as teacher feedback, text book, home language, homework, parental support and availability of text book had positive and significant correlation with their performance on EGMA overall mean score. But, student absenteeism had significant negative correlation with EGMA overall mean score implying that as absenteeism increases performance decreases and vice versa.

The findings from teacher related variables also indicated that some of the variables such as teacher characteristics (age, qualification and experience), teacher training (in service and methodology training) and teachers' time spent on tasks had significant positive correlations with students' achievement.

Similarly, the findings from school principal related variables showed that some of the variables such as qualification, experience, training in school management and proportion of text book to student had positive significant correlations with student performance. However, variables like student absenteeism (like that of students' response) and principals teaching a class had negative correlations with students' performance.

In general, a step wise regression analysis showed that student variables (student absenteeism, text book, home language, teacher role and attending preschool), teacher variables (teacher characteristic, the time teacher spent on teaching mathematics, usage of instructional material and teacher interaction to others) and principal related variables (student absenteeism, principal training, principal support and leadership and mathematics text book ratio) explains the variance of students overall performance by 8 %, 10.5%, 2.9% respectively.

Finally based on the findings of the study, closing the performance gap of students' between male and female, urban and rural, and between regions using different affirmative actions of instructional provisions was recommended. The students in both grade 2 and 3 had great difficulty with the missing number and subtraction level 2 tasks compared to other tasks. Competency in this area could be improved by providing opportunities for students to practice counting in steps other than in ones (counting by twos, fives, and tens, counting backwards, etc.),

and by ensuring children develop different counting strategies. It was also recommended that school shifts to be full day, expanding preschool, schools to use mother tongue as a medium of instruction, and improve school facilities and instructional materials that have an impact on students' performance.

Introduction

1.1 Back ground

Ethiopia has a long term vision "to become a country where democratic rule, good governance and social justice reigns, up on the involvement of and free will of its people and once extricating itself from poverty and becomes a middle income economy" (MoFED, 2010). To attain this vision, a growth and transformation plan designed to be implemented within five years. One of the major objectives of the plan is to provide equitable access of quality educations to citizens. The GTP (2011-2015) document alleged that, with regard to the formal education, the existing endeavor to ensure equitable access to quality primary education (EFA) will be continued and strengthened. The plan gives priority to improve and ensure the quality and efficiency of education at all levels.

The education system of Ethiopia made a significant progress in achieving universal primary education for all. In ESDP IV (2011-2015), it is stated that Ethiopia has made considerable swift progress in access to education at all levels of the system with a sharp increase in the number of teachers, schools and institutions. According to the 2012/2013 MOE statistics, the gross enrollment rate of primary education reached to 95.3% and there has been a 2.9% average annual increase in primary education enrolment. It also designated that there is a decrease in repetition rate for grade 1 to 8 as of 8.5% to 7.9%, dropout rate for grade 1-8 as of 16.3% to 16.1% in the year between 2010 and 2011.Furthermore, the Ministry of education exerts considerable efforts for the quality of education at all levels. There were important improvements in the availability of trained teachers and some other inputs which are indispensable for a high quality education system.

The best way to monitor quality of education system is conducting assessment and giving feedback to all stakeholders since it is a key to know whether an education system is producing the desired outcomes for students, the economy, and society at large (Clarke, 2012). The Dakar Framework for Action (2000) of Goal 6 also commits to improve all aspects of education quality 'so that recognized and measurable learning outcomes are achieved by all, especially in literacy, numeracy and essential life skills'. Being equipped with this information, various stakeholders

determine where to target their energy and resources for the greatest improvement of learning outcomes. Thus, effective assessment is vital to inform policy makers, help teachers improve their teaching practices, and empower parents with information about how well their children are being taught (World Bank, 2011).

Recognizing the importance of assessments, the current Ethiopian Education and Training Policy and the General Education Quality Improvement Program (GEQIP) give emphasis on the importance of assessment for quality of education (TGE, 1994 & MoE, 2008). Moreover, according to GTP (2011-2015), the learning outcomes of students will be monitored and evaluated at regular scheme through national learning assessment (MoE, 2010).

To this regard, the Ministry started to conduct national learning assessments since 2000 to monitor its system, where at Grade 4 and 8 in 2000 the baseline national learning assessment (EBNLA) was undertaken, in 2004 the second national learning assessment (ESNLA), in 2008 the third national learning assessment (ETNLA) and in 2012 the fourth national learning assessment (EFNLA) was occurred. Similarly, at Grade 10 and 12 in 2010 the baseline national learning assessment and in 2013the second national learning assessment was implemented. Besides, Ethiopia conducted the base line early grade reading assessment (EGRA) by 2010 to monitor foundational skills of children in literacy.

However, quality of education as indicated in successive national learning assessments is still a crucial challenge for the nation. The national learning assessment conducted since 2000 in four rounds on grade 4 and 8, confirmed the mean score of students achievement in the assessed subjects was beneath 50%. This was underneath the minimum score expected by the Ethiopian education and training policy. Besides, in a study of the reading skills (EGRA) conducted in 8 regions of Ethiopia, showed that a significant number of children that were in grade 2 and 3 couldn’t read a single word and understood a story at all(USAID, 2010). This can be strong evidence for children in lower grades are not acquiring the proper knowledge and skills. If children at early stage do not get the right education, it will be difficult in future to make them competent.

To alleviate these problems of quality of education at early stages and government's great interest in science and mathematics education encouraged assessment to be conducted in Early Grade Mathematics Assessment (EGMA) for early intervention purpose.

Hence, this report presents the findings of a baseline Early Grade Mathematics Assessment (EGMA) study in Ethiopia that allows policy makers and stake holders to inform the achievement levels of foundational mathematics skills, how to alleviate the variety of impediments to early grade numeracy acquisition and to the development of interventions to improve the quality of early numeracy teaching and learning.

1.2 Objectives of EGMA

Ethiopia strongly commits to the development of continued expansion and equitable access to high quality general education with promising foundations in science and mathematics. She thought that education with science and mathematics as its major components determines the level of prosperity and welfare of the people and the nation. Mathematics is widely recognized as an important mechanism for individuals to further their education and enter the job market. Societies as a whole recognize the benefits and returns from the problem-solving skills and the flexibility that develop through mathematics education.

EGMA was designed to measure the extent to which school children in the early primary grades are learning mathematics and, more specifically, number and operations, and geometry skills. It provides information about basic competencies—those competencies which should typically be mastered in the very early grades, and without which students will struggle, or potentially drop out. Those competencies were drawn from extensive research on early mathematics learning and assessment and were constructed by a panel of experts on mathematics education and cognition. These abilities and skills are key in the progression toward the ability to solve more advanced problems and the acquisition of more advanced mathematics skills.

Therefore, the general objective of EGMA is to inform the system on how:

- ☞ Children are doing in mathematics, and

- ☞ To give feedback as to where improvements need to be made. Results from EGMA would also be informative at the teacher level for the implementation of the curriculum at the classroom.
- ☞ To gain insight into both student characteristics with foundational skills and to better understand characteristics of schools associated with students' performance.
- ☞ To serve as a base for future study on early numeracy.

1.2.1 Specific Objectives and Research Questions

The specific objectives of the study and associated research questions stated as follows:

Objective 1:

Generate baseline data in early grade mathematics assessment to measure children's foundational skills of mathematics at early grades (grade 2 and 3) in Ethiopia.

Research question:

1. To what extent do students perform in learning mathematics at early grades?

Objective 2:

To analyze variation in students' achievements by grade, region, gender, location and age

Research question:

2. To what extent students' achievements significantly vary by grade, region, gender, location and age?

Objective 3:

To identify factors those are associated with students' performance.

Research question:

3. What are the characteristics of students that have an impact on the performance of early grade mathematics achievement?
4. What features of teacher and principal characteristics account for children's early grade mathematics achievement?

Objective 4:

To give feedback as to where improvements need to be made.

Research question:

5. What are the areas of competency that needs improvement?

1.3 Scope of the Study

The scope of this early grade mathematics assessment study over the period 2013/2014 is defined by the outcomes of government schools in all regions of Ethiopia. Moreover, the study was delimited on:

a. Learners' achievement profiles to provide information on the performance of learners, aggregating in regions, gender, location and different age groups at early grades (grade 2 and 3).
b. Learners' background profile to provide information in which children's formal learning takes place.
c. Teacher profile to provide information in which teachers' instruction takes place.
d. Principal profile to provide information in which formal learning takes place in school.

1.4 Rationale – Why EGMA?

Mathematics as described by Patton, Cronon, Bassett & Koppel (1997) cited in Feldmann (2012) and Fuson (2004), National Center for Education Statistics (2008) cited in RTI (2009) is widely recognized as essential for every citizen to function successfully in their work, profession, and everyday life. It contributes to the development of the human capital needed for economic growth. Schacht (2005) cited in Feldmann (2012) further described that advancements in science, technology, engineering and mathematics (STEM) are responsible for up to one-half of the economic growth in the United States. Moreover, Duncan et al. (2007) and Geary (1994) cited in Purpura and Lonigan (2013) found that mathematics skills are foundational academic abilities for other academic skills, where individuals who are successful in mathematics are likely to experience later success in other areas as well. Thus, the education system of a country should give much emphasis to the development of mathematics skills especially starting from early stages.

Research findings support that mathematical skills in the early years are a building blocks for later success in mathematics. A strong foundation in mathematical skills during the early grades is the key to later success in mathematics (Malloy (2008), Nunes & Bryant(1996), Steen(2001), and U.S. Department of Education(2008) cited in RTI (2014); Denton & West (2002) cited in Sarama & Clements (2009); Duncan et al. (2007), Geary (1994) cited in Purpura &

Lonigan(2013); Lock and Gurganus (2004) cited in Early Childhood Learning Division (2011) and Doig et al. (2003)). The Mathematics Learning Study Committee (2001), cited in German Federal Ministry for Economic Cooperation and Development (BMZ) (2012) also quoted that,

> *"Citizens who cannot reason mathematically are cut off from whole realms of human endeavor. Innumeracy deprives them not only of opportunity but also of competence in everyday tasks. All children must learn to think mathematically, and they must think mathematically to learn."*

They further describe that helping students get started in developing conceptual understanding, mastery, and fluency with numeracy in the early grades is essential to ensuring that they will have the opportunity to successfully complete more advanced mathematics courses. The numeracy that children develop in the primary grades forms the foundation of the knowledge and skills needed for success in secondary school and beyond.

Moreover, RTI international (2009) explains that a review of more than 16,000 research publications and policy reports emphasized the importance of a strong foundation in the earliest grades for future academic success. In addition, recent meta-analyses studies by Duncan et al. (2007) and Romano et al. (2010) cited in RTI (2014) suggest that early mathematics skills predict not only mathematics but also later reading skills just as much as early reading skills. Longitudinal studies from six large-scale data by Duncan, Dowsett, Claessens, Magnuson, Huston, and Klebanov (2007) found that school-entry math, reading, and attention skills are the strongest predictors of later achievement. However, further analysis of this study result indicated that early mathematics skills had the greatest predictive power, followed by reading and attention skills. Hence, mathematical skill gaps at early elementary stage is predictive of delays in later mathematical success ((Jordan, Kaplan, Locuniak & Ramineni (2007), Mazzocco & Thompson (2005), Delazer, Girelli, Grana & Domahs (2003)) cited in Feldmann (2012); Clarke and Shinn (2004); Clements & Sarama (2000) cited in PEARSON (2005)). Tuill et al. (2001) cited in Doig et al. (2003), Lee et al. (2007) further described that early intervention in academic areas plays a prominent role in preventing students from later victims of academic failure.

The results of several large international studies on mathematics achievement revealed that, American students are lagging behind their international peers in mathematics skills (Gonzales et al. (2000); Mullis, Martin, Gonzalez, & Chrostowski (2004) cited in Purpura & Lonigan, 2013).

As further described by Stevenson, Lee, Chen, & Lummis (1990) cited in Purpura & Lonigan (2013), these performance disparities are evident as early as the beginning of preschool. These findings indicate that students' poor performance at the higher grades is due the gap at early development of mathematics skills. Thus, the development of mathematics skills could start from early stages of education in order to forestall fundamental deficits in later learning ((Campbell & Ramey (1994) and Vellutino et al. (1996) cited in Lee et al. (2007); National Center for Education Statistics (2004); Denton & West (2002) cited in Sarama and Clements (2009)).

Because of these importances's of early achievement in mathematics and increased global competition in this area, mathematics learning, and the associated areas of instruction, assessment, and intervention has increasingly come to the attention of educators and policy makers (Feldmann, 2012). Particularly speaking, there has been an increased emphasis on the use of appropriate assessments that are helpful in improving student performance. There is a growing recognition among policy makers, donors, and educators, of the importance of making evidence-based policy and programming decisions. An increased concern about mathematics performance, over the decades, has led to the creation of national assessments such as the National Assessment of Educational Progress (NAEP), Trends in International Mathematics and Science Study (TIMSS), National Council of Teachers of Mathematics, and the National Research Council (RTI, 2009). However, Ministries of Education in developing countries and donor organizations are challenged by a lack of solid information about student learning outcomes in mathematics, particularly in the early grades (RTI, 2014).

Hence Early Grade Mathematics Assessment (EGMA), an orally administered assessment of mathematical competencies at early grades, was developed by RTI international in response to countries and donor organizations demand of early information for early intervention (RTI, 2014). Because, it is important to conduct early screening and identification of students who appear to be struggling with mathematics (Lee et al., 2007).

EGMA is a tool that allows careful investigation of mathematics difficulties in early elementary school which may lead to later mathematics deficits, the measures utilized should entail basic mathematical concepts and skills. EGMA was designed to identify gaps in the mathematics education that children are receiving at an early age (RTI, 2014). The measurement tools that

provide diagnostic feedback to teachers and schools (Foegen, Jiban, & Deno, 2007) focus on the early years of mathematics learning; that is, mathematics learning with an emphasis on numbers and operations and on geometry through second grade or, in developing countries, perhaps through third grade (RTI, 2009). These are the years in which a young child builds a foundation or base that will be necessary for learning in the years that follow.

To this regard, Ethiopia has played a great effort to improve the quality of the learning that occurs through assessment. In addition to teacher made assessments at class room level, public examinations and large scale assessments (early grade reading, grade 4, 8, 10 and 12 national learning assessments) were implemented to assure quality. The Ethiopian Ministry of Education's great interest in ensuring the quality of primary education across regions/districts also demanded the quality of early grade mathematics learning to be assessed.

Hence, the rationale behind the use of EGMA is that a strong foundation in mathematics established during the early grades is crucial for success in mathematics, science, technology, and engineering in the later years (Duncan et al., 2007; Romano et al., 2010 cited in RTI (2014)).

1.5 Minimum Learning Competencies and EGMA

EGMA was designed to assess how well students are learning the foundational skills of mathematics at the early years of schooling (Reubens & Kline, 2009). A review of more than 16,000 research publications and policy reports by RTI international also emphasized that a strong start at the earliest grades in mathematics is a foundation for later success. The recommendations of these findings were that the curriculum for prekindergarten through eighth grade should be more streamlined, and that the goals should be to ensure that students understand key concepts in mathematics and acquire accurate and automatic execution in solving problems (RTI, 2009). Thus, the design of EGMA reflects these recommendations. There is also a great deal of convergence in its components and objectives across countries as well as the national and international assessment organizations.

Hence, it is useful to determine whether EGMA relates to the Ethiopian curriculum to the given grade level or not. EGMA does not test whether children have learned an appropriate amount of the curriculum, but rather assess the basic skills required for a particular level. However, it is fair

to evaluate whether EGMA is in line with the curricular goals of Ethiopia. To this end, a close analysis of the Minimum Learning Competencies (MLCs) document, allows an analysis of whether and how the EGMA is aligned with the expected tasks/outcomes for a particular grade level. Accordingly, the portion of the MLC document related to number and operation, and geometry in Grades 1-3 was referenced, with particular attention to counting, number identification, quantity discrimination, missing number identification, word problems, addition and subtraction, pattern extension and shape recognition . Table 1 makes clear that the EGMA tasks fits well with the expected learning competencies of Grade 2 and 3. In fact, EGMA appears to be targeted slightly below level for grade 3 students in some tasks (oral counting, one to one correspondence, number identification, quantity discrimination, missing number, pattern extension and shape recognition, addition level 1 and subtraction level 1) and for grade 2 students in some tasks (oral counting, one to one correspondence and shape recognition). In general, each EGMA task finds its match in an MLC document.

Table 1: Minimum learning competencies and associated EGMA tasks

Minimum learning competencies	Grade	Content	EGMA Tasks	EGMA Competencies Measured
• Count, read and write up to 100 • Order and compare whole numbers up to 100 • Solve problems of addition and subtraction • Divide a concrete objects in to two and for equal parts	1	Number and operation	• Oral counting • One to one correspondence • Number identification • Quantity Discrimination • Word problems • Addition and subtraction	• Children's ability to produce numbers fluently • The child's ability to understand that the last number-word counted in a group of objects signifies the value of the group. • The ability to identify written number symbols • The ability to make judgments about differences by comparing quantities, represented by numbers. • The ability to interpret a situation (presented orally to the pupil), make a plan and solve the problem. • Basic knowledge of addition and subtraction. It is expected that students should develop some level of automaticity/fluency and conceptual understanding (accuracy).
• Read and write whole numbers up to 1000 • Perform the four fundamental operations on whole number up to 1000 • Solve simple word problems • Use fractions of ½, 1/3, ¼ and ¾ on concrete objects	2			
• Read, write and order whole numbers up to 10,000 • Perform the four fundamental operations on whole numbers up to 10,000 • Describe and use fractions of ½, 1/3, ¼, ---1/10 on concrete Objects	3			
• Use pictures to record and read simple data • Continue and produce simple patterns of shapes, colors and numbers	1	Data handling and pattern	• Missing number identification • Pattern extension	• The ability to discern and complete number patterns. • Children's ability to identify objects making up the pattern and make predictions on how the pattern continues
• Collect and tabulate simple data • Complete and compile simple patterns of shapes and numbers.	2			
• Construct and interpret simple picture graphs and bar graphs	3			
• Recognize shapes by size, shape and name (□ΔO) • Draw triangular, rectangular and circular shapes	1	Geometry	• Shape recognition	• Ability to recognize geometric shapes
• Draw and name lines of five length • Mark points above, below and on a given line • Draw rectangle, square, triangle and circles	2			
• Identify and sketch intersecting, parallel and perpendicular lines • Construct parallel and perpendicular lines • Identify and drew rectangles, squares, parallelogram and trapezium with their properties	3			

2. Research Design and Methodology

2.1. Instrument Development and Adaptation

In response to the increased focus on mathematics, EGMA instruments was first developed by Research Triangle Institute (RTI) through funding provided by the United States Agency for International Development. The development of the EGMA began with a purpose to measure the extent to which school children in the early primary grades are learning mathematics and, more specifically, number and operations, and geometry skills (Reubens & Kline, 2009). The instrument was to be a simple one that teachers and/or local officials could apply to determine a child's understanding of essential foundational mathematics skills. To ensure the EGMA as a reliable and valid instrument in telling how children in these early years were doing in mathematics, a pilot application took place in Malindi, Kenya in early July 2009 (Reubens & Kline, 2009). After piloting the EGMA has demonstrated its ability to provide feedback on how children are doing at the class-level as well as the system-level.

This EGMA instruments were first adapted from the original EGMA developed by RTI international (RTI, 2009) to the Ethiopian context by a group of mathematics experts (curriculum experts, experienced teachers from teachers training colleges and primary school). Following the instrument adaptation, the EGMA was validated, and revised by validation workshops where experts from the regional and federal levels were involved.

EGMA is a one-on-one oral assessment designed to measure a student's foundational skills in mathematics in the early grades. The subtasks in the EGMA instrument were developed according to several criteria, in order to support the goal of ministries of education with the information essential to making informed decisions with regard to student learning, teacher education and training, curriculum development and implementation (RTI, 2014; Ghana, 2013). These include the expectation that the tasks:

- reflect those skills that are most predictive of future performance, according to available research and scientific advice;
- represent skills that to the curricula to be acquired in early grades;
- represent a progression of skills that lead toward proficiency in mathematics;

- target both conceptual and computational skills.
- represent skills and tasks that can be improved through instruction.

Thus, the EGMA Ethiopia tasks include the following:

1. **Oral counting fluency:** The assessment of oral counting fluency targets children's ability to produce numbers fluently. In this task children are asked to count by rote as far as they can. The score is based on the last correct number the child says previous to making an error or at the end of a minute. This is a timed subtask, since its purpose is to elicit a fluency measure. First, it will help make children comfortable with the EGMA; second, it will give us an opportunity to learn what the children know about number names.

2. **Counting one-to-one correspondence:** One-to-one correspondence refers to counting objects. This task targets children's ability to recognize the items they need to count and to mentally tag those items that they have already counted. Once children have counted the items, you will ask them a follow-up question as to how many items there are. This follow-up question will tell us of children's understanding that the last number-word counted for the group of objects signifies the value of the group. This is a timed task, since the purpose is to elicit a fluency measure. For this task, the children were presented with a stimulus sheet with 60 circles, presented as 6 columns, with 10 circles in each column.

3. **Number identification:** assesses the student's knowledge and ability to identify written symbols. Here, the stimulus sheet consisted of 30 one- to three-digit number symbols presented in a grid. Students were asked to orally identify the printed number symbols presented in one minute.

4. **Quantity discrimination:** assesses the student's ability to make judgments about differences by comparing quantities, represented by numbers. Each item presented to children consisted of two numbers. The children were asked to identify the larger number (e.g., "Which one is bigger?"). The number pairs used ranged from a pair of single- to-

three-digit numbers. Throughout the items the discriminating digit in the pairs was varied to ensure the pupils' understanding of place value.

5. **Missing number:** assesses the student's ability to discern and complete number patterns. The child was asked to name a missing number in a set or sequence of numbers. The items represented in the missing number task are based on number skills children should be learning in these early grades, such as counting forward and backward by ones, twos, fives, tens and hundreds.

6. **Word problems:** assesses the student's conceptual understanding of basic operations. Children were presented with an oral word problem, which is read to them, and asked to solve it. The children are provided with manipulative /strategies to assist in solving the problem. The word problems task will give children an opportunity to demonstrate several of the mathematics skills we have assessed up to this point. Here, children will have an opportunity to apply earlier mathematics concepts, informal and formal knowledge, and strategies in solving addition and subtraction word problems. Repeating the question is encouraged, but it must be repeated in its entirety, from beginning to end.

7. **Addition/Subtraction problems:** before even beginning formal schooling, children demonstrate a level of very basic addition and subtraction concepts. One example is with the size of groups of objects and how adding to a set of objects increases its size. For this task, we will learn of children's formal addition and subtraction knowledge and to an extent, the strategies they are using (e.g., fingers or counters). To learn of children's fluency and strategy use, the addition and subtraction sections for this task are broken down into two parts, level 1 and level 2.

   Addition: as children practice and become familiar with addition problems, they should begin to recall this information. To see if children are becoming familiar with simple addition problems, level 1 of the addition section will assess for fluency. These addition problems use addends 1 through 9 with sums less than or equal to 9. There is a total of 10 items to be timed for 60 seconds. Children will be instructed to tell the assessor the first answer that seems right to them. Counting on fingers will be discouraged as assessors will prompt the children to tell them the first answer that seems right. The time and

number correct will be recorded. As soon as level 1 is complete, the assessor will move on to level 2. Level 2 is timed for 2 minutes (120 seconds). We are not timing for fluency here; we are timing for efficiency. Here, children will be given the opportunity to use counters or their fingers to solve the addition problems. Children will be stopped from continuing if they get four consecutive errors or if they run out of time (lapse of 2 minutes). Assessors are to enter the number correct, and if the children use their fingers or the counters when solving the problems.

Subtraction: the format of the subtraction problem section of this task is identical to the format of the addition problems section (e.g., level 1, level 2). The subtraction problems for this section are the inverses of the addition problems. As children practice and become familiar with subtraction problems, they should begin to recall this information. The stop and timing rules for subtraction problems are identical to the addition problems.

8. **Shape recognition:** assesses the student's ability to recognize and distinguish geometrical attributes. For the shape recognition task, children will demonstrate their familiarity and proficiency with circles, squares, triangles, and rectangles. Familiarity with shapes in the early grades has been found to be a critical foundation for later mathematics skills.

9. **Pattern extension:** the pattern extension task will require children to review and identify (1) the number of objects making up a pattern and (2) the groups and replication of the objects making up the pattern. Based on this information, children will predict how these patterns will continue. This is a demonstration of the beginnings of algebraic thinking via order, cohesion, and prediction.

In addition to the EGMA assessment, students, teachers and principals questionnaires were developed to gather additional information about the school, their qualifications, their teaching practices, and other characteristics of the teaching and learning context. This information is used to obtain a more complete picture of the external factors that might affect learning.

2.2. Piloting

The EGMA instruments, after adapted from RTI international as to the Ethiopian contexts, they were reviewed by a group of mathematics experts such as mathematics curriculum experts, experienced teachers from teachers training colleges and primary schools. Following the instrument adaptation and review, they were piloted in randomly selected 720 students from 36 schools and 5 regions from June 17 – 30/2012 in order to test the reliability and validity of instruments. These pilot regions were Oromiya, SNNP, Tigray, Amhara, and Addis Ababa within 5 instructional languages such as Afan Oromo, Wolytigna, Sidamagna, Tigrigna and Amharic.

The pilot data were captured with the pre designed access-based data-entry template or software, and also properly cleaned and coded for analysis. Item analyses were made to examine the item quality such as its difficulty and discrimination /point biserial correlation. After pilot analysis these instruments were revised and validated by workshops where experts from the regional and federal levels were involved. Changes were made to improve each of the instruments before the full data collection and were included in the updated assessment versions. In nearly all cases, the changes made by the pilot results were simple modifications of somewhat cosmetics.

Hence, the instruments were surely aligned both to the contents of the curriculum and EGMA objectives of measuring foundational mathematical skills.

A reliability analysis was also conducted to determine the appropriateness of the subtasks in assessing grade 2 and 3 students in Ethiopia. The reliability estimates of Cronbach's alpha coefficient were calculated from the pilot test result scores. Hence, the reliability coefficient alpha of the entire test was found to be 0.77 which is generally considered acceptable. This result shows that the items are reliable so that the responses of students are consistent across each item and hence 77% of their answer was based on their knowledge on the problem not by chance/error.

The EGMA instruments were translated into 19 instructional languages based on sampled schools medium of instruction from all regions of the country. The languages were Amharic, Afan Oromo, Tigrigna, Agewegna, Hadiyisa, Kefinigna, Daworigna, Gamugna, Kembatigna,

Sidamigna, Silitigna, Wolaytigna, Gedeofa, Kontigna, Somaligna, Harari, Berta, Anywa and Nuer.

2.3. Population and Sampling

The population for the study includes all students of 2013/2014 academic year (2006 E.C.) at grade 2 and 3 levels who were attending government primary schools in all administrative regions of the country. The sampled primary schools to be included in the population of study were based on MoE2011/12 (2004 E.C.) EMIS data. Accordingly, there were 4,705,089 students attending in 27,394 schools in the desired target population. Of these, 3947 schools have less number of students than the cluster size (20 students in each grade level) and therefore their students were assigned to the excluded populations. Hence, 4,454,078 students in 23447 schools were the defined target populations.

The national samples of number of schools were proportionally allocated to regions as strata. The number of schools required for EGMA was governed by the requirement that final sample should have an effective sample size for the main criterion variables of at least 400 students. That is, the final sample was required to have sampling accuracy that was equivalent to, or better than, a simple random sample of 400 students Ross (1978) cited in UNESCO (2005). A two-stage cluster sample design with an effective sample size of 400 and the minimum cluster size of 40 (20 for each grade) were used. Taking the Fourth National Learning Assessment of 2012 of grades 4, average scores as dependent variable and the school as random factor, the variance component analysis resulted in an intra-class correlation commonly known as roh (a measure of the tendency of student characteristics to be more homogeneous within schools than would be the case if students were assigned to schools at random) were 0.42. Hence, using the coefficient of intraclass correlation (roh) 0.42 and cluster size 40 (20 in each grade) from the sample design tables with an effective sample size of 400, it was necessary to select a sample of 180 schools – which resulted in an expected total 7,184 sample students.

However, those regions that have small number of schools were under represented by this proportional allocation of schools. As the findings of by Ross (1978) and Borg and Gall (1979) cited in Cohen, Manion and Morrison (2007), the minimum effective sample size for a survey research of large population with 95 percent confidence level is 400 and is no fewer than 100 for

the subgroups or strata. Borg and Gall (1979) also advise that sample size has to begin with an estimation of the smallest number of cases in the smallest subgroup of the sample, and 'work up' from that, rather than vice versa. Thus, in order to have optimal samples for better representation of the regions, a fixed 20 schools were added to each region by considering the smallest allocation. The summary of the sampling process is given in table 2.

Table 2: Allocation of schools across region

Region	Total schools			Sample schools			Sample schools by location		Sample students				
	Total	Urban	Rural	Proportion	Fixed	Total	Urban	Rural	Planned	Achieved	% Achieved	% Achieved by gender	
												Female	Male
Tigray	1919	110	1809	13	20	33	2	31	1320	1317	99.77	50.6	49.4
Afar	453	42	412	3	20	23	2	21	920	917	99.67	53.9	46.1
Amhara	7200	473	6727	47	20	67	4	63	2680	2674	99.78	51.1	48.9
Oromiya	11030	717	10309	72	20	92	6	86	3680	3677	99.92	49.9	50.1
Somali	917	380	537	6	20	26	11	15	1040	1036	99.62	47.1	52.9
Benishangul-Gumuz	436	38	398	3	20	23	2	21	920	917	99.67	47.9	52.1
SNNP	5020	255	4764	33	20	53	3	50	2120	2110	99.53	49.1	50.9
Gambella	217	18	199	2	20	22	2	20	880	880	100.00	46.8	53.2
Harari	48	20	28	0	20	20	8	12	800	800	100.00	47.9	52.1
Addis Ababa	118	119	4	1	20	21	21	0	840	840	100.00	50.5	49.5
Dire Dawa	67	27	40	0	20	20	8	12	800	794	99.25	47.7	52.3
National	**27425**	**2199**	**25227**	180	220	400	69	331	16000	15962	99.76	49.6	50.4

Note that, the sample across region, school and location was achieved 100% as planned.

To obtain a random sample of grade 2 and grade 3 students, a two-stage cluster sampling was followed by selecting: schools and then students from schools/class rooms using simple random sampling technique. Once the effective sample size of schools in each region is determined, the sample schools within strata were selected randomly from the list of schools at EMIS data of Ministry of Education 2011/2012 (2004 E.C.) by using IBM/SPSS version 20 software. In each school, one class was randomly selected from each grade levels. Similarly, students were selected randomly with equal probability from each class. All students present on the day of assessment were stratified by gender. Ten boys and ten girls - a total of 20 from grade 2 and also ten boys and ten girls- a total of 20 from grade 3 - with a sum total of 40 students were to be randomly selected from each school. If there were fewer than ten girls at any given school, all of the girls were automatically selected and more boys were sampled to obtain a total of 20 students (the same procedure was followed if there were fewer than ten boys) in each grade.

In addition to sampling students for the EGMA, 386 (96.5% achieved) principals (or representatives if principals were not available) and 757 (94.63% achieved) teachers (one mathematics teacher from each grade level per school) completed questionnaires to provide background information's associated with students' performance.

2.4. Data Collection

Data collection took place in all 9 regions and 2 city administrations between May 7- 22/ 2014. Across these regions in the country data were collected from randomly selected 400 schools and 15962 students, 386 principals and 757 teachers. In the data collection process 9 national coordinators, 67 zonal and regional coordinators, 175 supervisors, 350 assessors were participated. Supervisors and assessors were grouped in to 175 teams of three each includes 1 supervisor and 2 assessors.

A five day intensive hands on training for trainers (TOT) were given for 63 data collectors from April26-29/214. The trainers in turn provided five day training for assessors and supervisors selected across the country in 63 cluster centers from May 3-6/2014. The TOT was given by the experts of National Educational Assessment and Examinations Agency (NEAEA) based on the EGMA assessors and supervisors manual. The supervisors, zonal and regional coordinators were

also required to work closely with the NEAEA staff, who were coordinating the data collection procedure.

The data collectors especially assessors and supervisors were selected from regions who were teaching mathematics, and fluent/native speaker with the instructional language of the selected sample schools.

2.5 Data Analysis Technique

After the data were collected both the quantitative and the qualitative methods were used to analyze the data. The statistical package for social science (SPSS) version 20 was used to undertake the analyses of the quantitative data. With the help of SPSS simple descriptive statistics such as percentage, mean scores, and standard deviations and the inferential statistics like t-test, one way ANOVA, correlation and regression and variance partitioning were used. Qualitative descriptions were also employed for analysis and interpretation of the data obtained through questionnaires.

3. Country Experiences in Early Grade Mathematics Assessment

A strong foundation in mathematics during the early grades is the key to future success in mathematics (Malloy, 2008; Nunes & Bryant, 1996; Steen, 2001; U.S. Department of Education, 2008 cited in RTI, 2014). Similarly, a review of more than 16,000 research publications and policy reports by RTI (2009) emphasized the advantages of a strong start in mathematics latter learning.

To this end, the demands for countries, policy makers, donors and educators for EGMA and EGRA were increased. It is due to their interest in making evidence-based policy and programming decisions. Hence, as to RTI (2014) EGRA and EGMA were implemented to date in more than 50 and 14 countries around the world respectively.

The EGMA instruments were developed in 2008 by RTI international and piloted in Kenya Malandi in 2009 (Reubens & Kline, 2009). This time onward many countries assessed their children to make informed decision with regard to students learning in mathematics. It helps them to provide diagnostic feedback for the development of further interventions to their

education system. Therefore the table 3 below summarizes the EGMA findings/performances of some countries to see the trend across the world.

Table 3: Countries performance on EGMA subtasks

EGMA Tasks		Countries performance																
		Malawi (2010)		DRC (2011)		Morocco (2012)		Iraq (2012)		Jordan (2012)		Rwanda (2012)		Nigeria (2012)	Kenya (2012)	Zambia (2012)	Ghana (2014)	Tanzania (2014)
		Standard 2	Standard 4	Grade 2	Grade 4	Grade 2	Grade 3	Grade 2	Grade 3	Grade 2	Grade 3	P4	P6	Overall	Overall	Overall	Overall	Overall
	Percent Mean Scores (Accuracy)																	
1	Number identification	20.5	74.1	39.4	61.4	71.2	87.7	85.4	92.6	88.6	92.6	83	69	12.6		69.3	71.7	
2	Quantity discrimination	48.7	81.8	60	65.3	69.6	85.1	66.4	75.1	70.9	77.5			19.4	39.5	58.5	64.9	61.8
3	Missing number	11.1	39.1	15.8	29	47.3	62.9	40	47.5	56.6	64.8			11.2	22.4	36.4	26.2	26.1
4	Word problem	20.6	60.5	37.6	47.5			28.4	47.8	39.2	52.2			30			40	38.7
5	Addition level 1	25.4	85.4			56.2	74	76.5	85.6	83.6	81.6			13.9	25.4		63.3	71.8
6	Addition level 2	8.5	35.6					41.5	56.8	52.7	54.8			7.9	12.2		21.4	26.1
7	Subtraction level 1	19.5	76.2			33.3	54.7	69	82.9	79.4	75.9			10.9			48.7	61.1
8	Subtraction level 2	6.6	36.3					19.9	31.2	32	35.3			7.1			11.8	19.0
	Mean Scores per Minute (Fluency)																	
1	Oral counting	37.1	70.95	42	45.6													
2	One to one correspondence	38.08	75.15	25.4	47.2										51.8			
3	Number identification			7.8	7.3	20.2	34.2	28.1	35.5	32.1	37.8	18.9	10.8	2.17	14.4	19.16	18.3	
4	Addition level 1							9.1	13.7	13.6	14.6			1.72	6.4		8.9	7.6
5	Subtraction level 1							7.5	9.8	11.4	12.1			1.37	2.8		6.1	5.5

4. EGMA Results and Findings

This section presents the results of descriptive and inferential analyses of EGMA, first with overall summaries and then by subtask that are disaggregated by grade level, region, gender location and age where appropriate. In addition, it presents background factors that are related to the achievement of students. The results were analyzed based on data obtained from 15,962 (49.6% females) grade 2 and 3 students, 757 teachers and 386 principals from 400 sampled primary schools.

4.1 Summary of EGMA Descriptive Results

This section presents summary statistics of EGMA scores of students' performance in accuracy (the number of items that students respond to correctly) and fluency (the number of items that students respond to correctly per minute) for all subtasks as shown in Table 4. It shows the average percentage of the number of items that students answered correctly out of the total number of items and the number of items that students answered correctly per minute for each subtask.

The overall average EGMA percent mean score (accuracy) was 71.92% with standard deviation 19.33 where the minimum score was48.15% at missing number identification and maximum 89.17% for one to one correspondence. The percent mean score results of the subtasks in number identification, missing number, addition level 2 , subtraction level 2 and pattern extension were below EGMA overall result. The median was above the mean for all the subtasks indicating that at least 50% of the students scored above the mean. Similarly, the distributions of the percent mean scores in all subtasks except missing number identification were negatively skewed indicating that most of the students achieved the highest scores.

Figure 1 and Table 4 further illustrates that as the items cognitive demand increases from addition level 1 to addition level 2 and subtraction level 1 to subtraction level 2, the performance of students' decreases from 82.9% to 71.03% and 72.22% to 58.64% respectively. Similarly, as we goes from the task Addition level 1 to subtraction level 1 and addition level 2 to subtraction level 2, the score of the students decreases from 82.9% to 72.22% and 71.03 % to 58.64% respectively. The result of the students obtained in pattern extension (62.14 %) was less than the

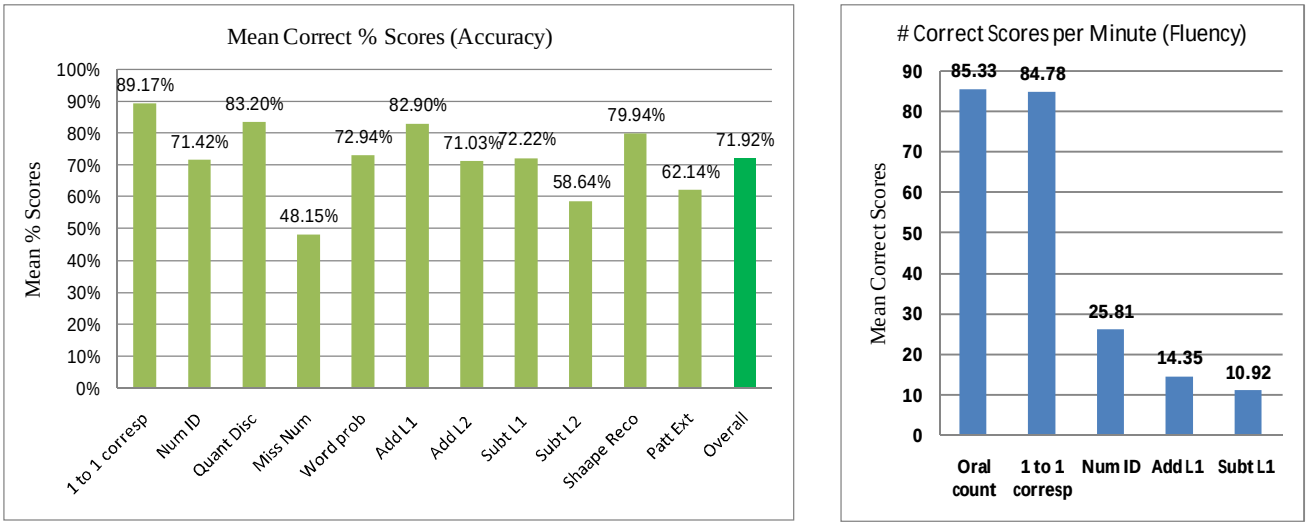
score in addition, subtraction and word problem except to subtraction level 2 subtasks. Shape recognition receives better score (79.94%) than number identification (71.42%), missing number (48.15%), word problem (72.94%), addition level 2 (71.03%), subtraction level 1 (72.22%), subtraction level 2 (58.64%) and pattern extension (62.14%).

Table 4: EGMA percent mean scores and fluency descriptive statistics by subtasks

EGMA Tasks	N	Mean	Median	SD	Skewness
1. Percent Mean Scores (Accuracy)					
One to one correspondence	15588	89.17	100.00	22.41	-2.22
Number identification	15919	71.42	80.00	29.86	-0.80
Quantity discrimination	15901	83.20	90.00	20.38	-1.64
Missing number	15888	48.15	50.00	31.41	0.14
Word problem	15837	72.94	75.00	28.47	-0.91
Addition level 1	15770	82.90	100.00	27.43	-1.77
Addition level 2	15772	71.03	80.00	31.43	-1.02
Subtraction level 1	15786	72.22	90.00	33.42	-1.03
Subtraction level 2	15761	58.64	70.00	34.24	-0.45
Shape recognition	15547	79.94	91.67	24.93	-1.34
Pattern extension	15887	62.14	75.00	28.51	-0.39
EGMA Overall Percent Score	15961	71.92	76.06	19.33	-0.82
2. Mean Scores per Minute (Fluency)					
Oral counting	14975	85.33	89.00	27.93	-0.75
One to one correspondence	8763	84.78	87.80	21.61	-0.69
Number identification	15873	25.81	25.00	14.36	0.67
Addition level 1	15560	14.35	12.50	9.25	1.53
Subtraction level 1	15534	10.92	10.00	8.05	1.78

Similarly, Table 4 and Figure 1 shows that students counted 85.33 and 84.78 per minute on average before making error in oral counting and one to one correspondence respectively which were relatively better results. The median was below the mean score per minute for number identification, addition level 1 and subtraction level 1 items implying that at least 50% of the students fluency score was below the mean. Similarly, the distribution of number identification, addition level 1 and subtraction level 1 were positively skewed indicating most of the students achieved the lower scores.

Figure 1: EGMA Percent Mean Scores and Fluency by Subtasks



Furthermore, the Pearson correlation coefficients computed between each subtasks also revealed that there was a significant positive correlations among the subtasks as shown in table 5. This indicated that as the performance of students' increased in one subtask, there was also an increment in the other subtasks.

Table 5: Pearson correlations between subtasks percent mean scores

	One to one corresp	Number identification	Quantity discrimination	Missing number	Word problem	Addition level1	Addition level 2	Subtraction level1	Subtraction level2	Shape recognition	Pattern extension	EGMA overall mean
One to one correspondence	1	.172**	.319**	.150**	.245**	.302**	.278**	.234**	.200**	.177**	.135**	.405**
Number identification		1	.302**	.250**	.245**	.282**	.311**	.287**	.276**	.195**	.178**	.477**
Quantity discrimination			1	.433**	.461**	.538**	.548**	.495**	.475**	.350**	.310**	.686**
Missing number				1	.486**	.444**	.536**	.535**	.600**	.289**	.399**	.711**
Wordproblem					1	.545**	.573**	.559**	.555**	.318**	.343**	.727**
Addition level1						1	.773**	.668**	.581**	.313**	.298**	.780**
Addition level 2							1	.708**	.708**	.321**	.338**	.839**
Subtraction level1								1	.785**	.328**	.348**	.826**
Subtraction level2									1	.304**	.366**	.819**
Shape recognition										1	.327**	.517**
Pattern extension											1	.551**
EGMA Overall mean score												1

**. Correlation is significant at the 0.01 level (2-tailed).

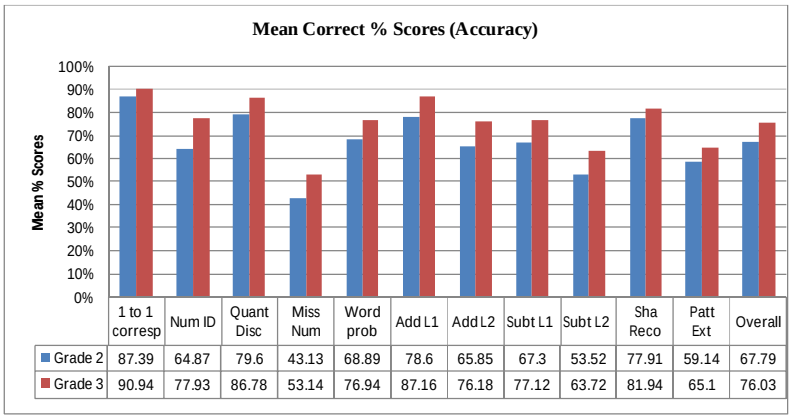
In general, an overall result of EGMA showed that students performed well on each subtasks and their level of performances are promising to the education sector. That means, the students are learning at least basic skills and procedures in each subtask. However, it has been revealed that a significant number of students were struggling with some subtasks such as missing number and subtraction level 2 (accuracy subtasks); and number identification, addition level 1 and subtraction level 1 (fluency subtasks).

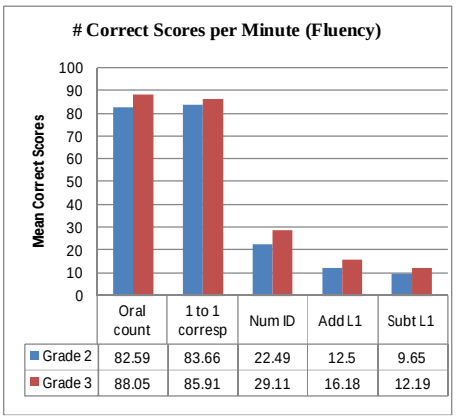
4.1.1 EGMA Summary Results by Subtask and Grade

Table 6 and figure 2 shows the average percentage of tasks answered correctly for each subtasks (accuracy) and the mean scores correct per minute (fluency) by grade. In all the subtasks asked for students' accuracy score, there is a positive progression from grade 2 to grade 3, where an 8.23% increase on EGMA overall with 95% confidence interval for the estimated population mean difference was between 7.64 and 8.81. An independent samples *t*-test result revealed that the EGMA overall percent mean score result of grade 3 was significantly higher than grade 2 at (t = -27.503, df = 15727.71, p < .001(2-tailed)).

Similarly, Grade 3 students scored higher in all timed fluency subtasks than Grade 2 students. As the cognitive level of the task increases from counting subtasks (oral counting and rational counting) to subtraction level 1, performance of students decreased in both grade levels. Besides, a 2-tailed *t*-test shows the mean difference between the two grades in fluency of each tasks was significant at p < .001.

Figure 2: EGMA percent mean scores and fluency by subtask and grade





*All the differences were statistically significant at p < .001 level

Table 6: EGMA summary percent mean scores and fluency by grade and gender

Subtasks	Grade 2			Grade 3		
	Female	Male	Total	Female	Male	Total
1. Percent Mean Scores (Accuracy)						
One to one correspondence	86.74	88.03	87.39	90.45	91.42	90.94
Number identification	63.75	65.97	64.87	76.68	79.18	77.93
Quantity discrimination	77.28	81.88	79.60	85.13	88.41	86.78
Missing number	39.84	46.34	43.13	48.77	57.49	53.14
Word problem	66.43	71.29	68.89	74.46	79.40	76.94
Addition level1	75.95	81.20	78.60	85.13	89.19	87.16
Addition level 2	62.69	68.93	65.85	72.99	79.36	76.18
Subtraction level1	64.12	70.40	67.30	72.81	81.41	77.12
Subtraction level 2	50.49	56.49	53.52	58.60	68.79	63.72
Shape recognition	76.16	79.62	77.91	80.46	83.41	81.94
Pattern extension	57.81	60.45	59.14	63.31	66.87	65.10
EGMA Overall Percent Score	65.53	70.00	67.79	73.46	78.57	76.03
2. Mean Scores per Minute (Fluency)						
Oral counting	81.32	83.84	82.59	86.78	89.33	88.05
One to one correspondence	82.83	84.50	83.66	85.90	85.92	85.91
Number identification	22.05	22.91	22.49	28.47	29.75	29.11
Addition level 1	11.72	13.25	12.50	15.14	17.22	16.18
Subtraction level 1	8.89	10.39	9.65	10.90	13.47	12.19

In general, as depicted in table 6 and figure 2, the performance of students in missing number was minimal in both grades. Specifically, grade 2 students perform 43.13% in this task which was far less than other tasks.

3.1.2 EGMA Results by Gender

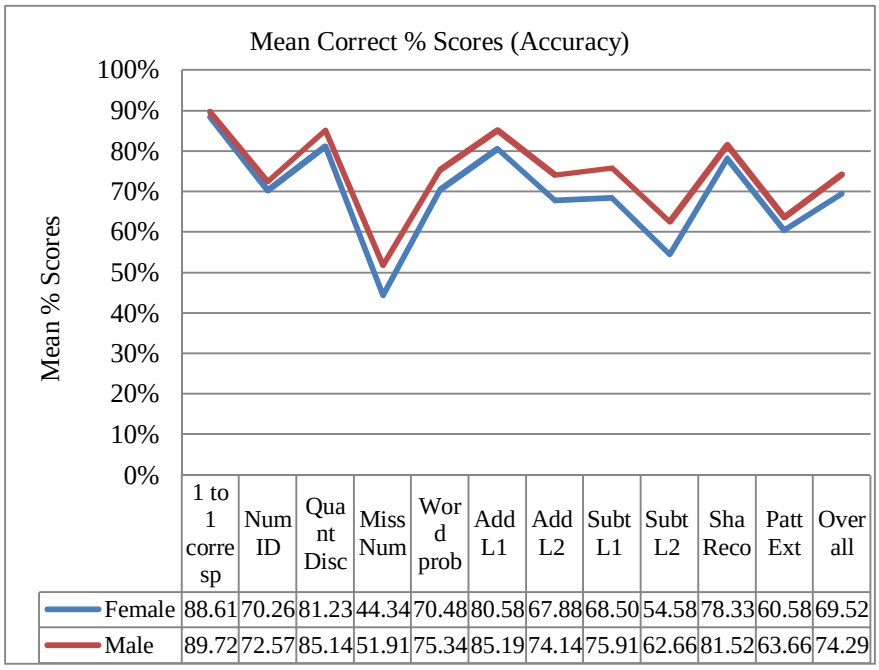
When the performance is disaggregated by gender as shown in table 6 and figure3, there is a difference in the performance accuracy subtasks where boys outperform than girls. The mean difference between female and male on EGMA overall is 4.77% and the independent *t*-test showed that the difference was significant (t = 15.67, df = 15852.65, p < .001, 2-tailed). The disparity is maximum in subtraction level 2 (8.08 %) and minimum in one to one correspondence (1.11%). Female achieved below their EGMA overall score in pattern extension, subtraction

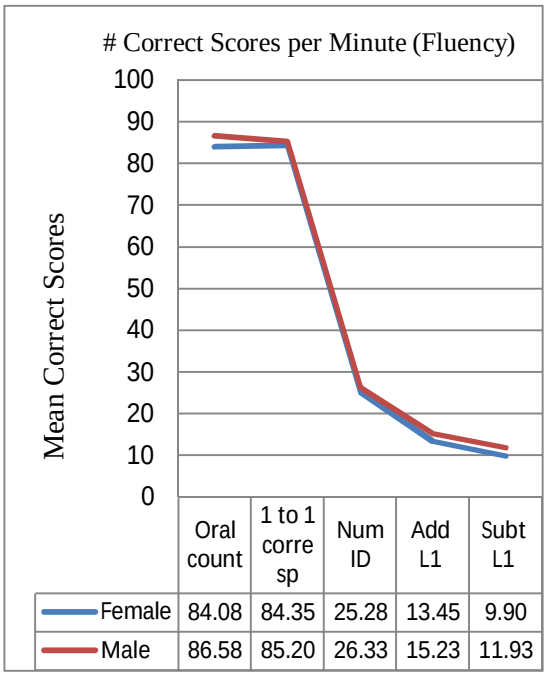
level 2, subtraction level 1, addition level 2 and missing number. Whereas, male scores below their EGMA overall score the same to female except in subtraction level 1 and number identification.

Moreover as table 6 above, the mean difference between gender with in grade level, boys perform better than girls ranging from a mean percent score of 1.29% (in one to one correspondence) to 6.5% (in missing number) in grade 2 and from 0.97% (in one to one correspondence) to 10.19% (in subtraction level 2) in grade 3.

In all timed tasks (fluency), male performed better than females. Figure 3 shows both groups performed least in subtraction level 1. It also illustrates the performance of male students declined from oral counting to subtraction level 1 as the cognitive difficulty of tasks increases. However, females scores drops from number identification to subtraction level 1. The gap between the groups is high in oral counting 1.25 and low in one to one correspondence 0.42. A 2-tailed *t*-test at p < .001 showed all the difference was significant except in one to one correspondence.

Figure 3: EGMA percent mean scores and fluency by subtask and gender



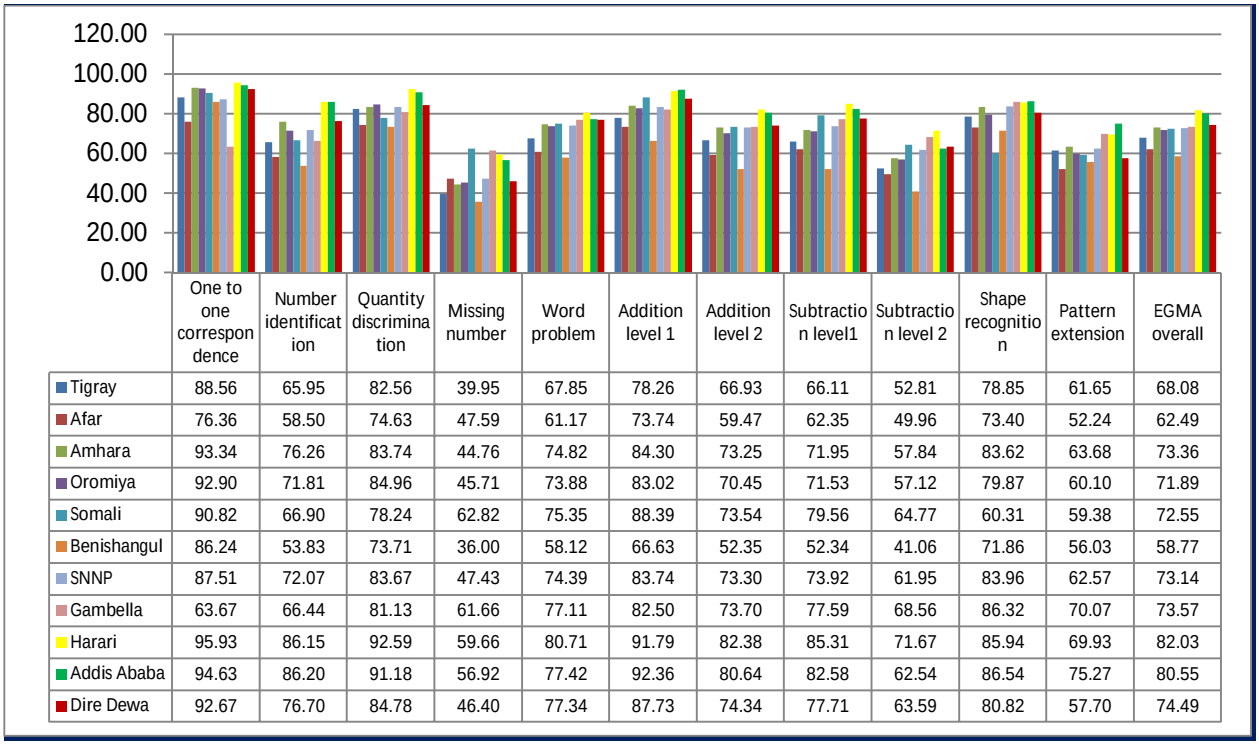


*All the differences were statistically significant at $p < 0.001$ level except one to one correspondence fluency subtask

4.1.3 EGMA Results by Region

Figure 4 and figure 5 illustrate the average performance of accuracy subtasks across regions. The overall percent mean score result of EGMA across regions was promisingly better ranging from 58.77% (Benishangul Gumuz) to 82.03% (Harrari).

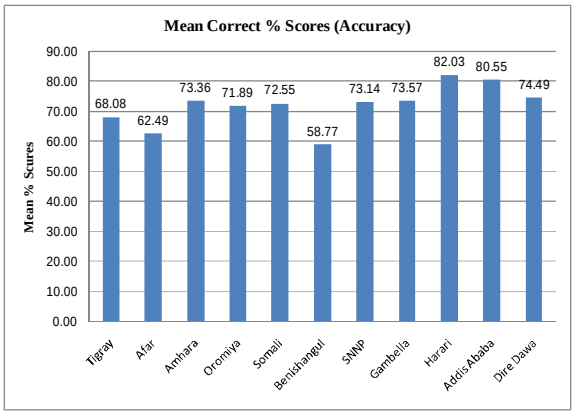
Figure 4: EGMA Mean Scores by Subtask and Region

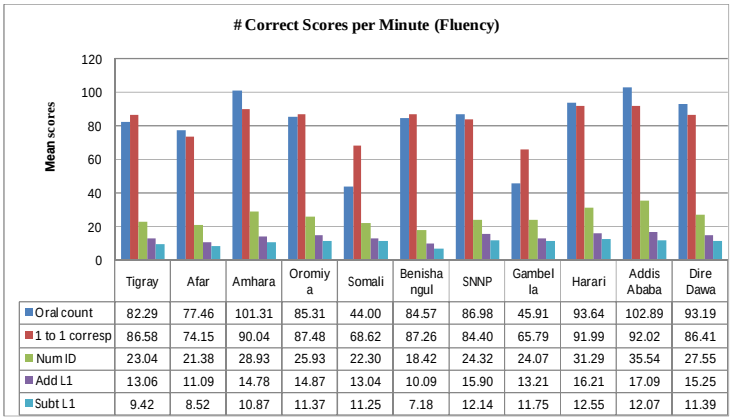


	One to one correspondence	Number identification	Quantity discrimination	Missing number	Word problem	Addition level 1	Addition level 2	Subtraction level1	Subtraction level 2	Shape recognition	Pattern extension	EGMA overall
Tigray	88.56	65.95	82.56	39.95	67.85	78.26	66.93	66.11	52.81	78.85	61.65	68.08
Afar	76.36	58.50	74.63	47.59	61.17	73.74	59.47	62.35	49.96	73.40	52.24	62.49
Amhara	93.34	76.26	83.74	44.76	74.82	84.30	73.25	71.95	57.84	83.62	63.68	73.36
Oromiya	92.90	71.81	84.96	45.71	73.88	83.02	70.45	71.53	57.12	79.87	60.10	71.89
Somali	90.82	66.90	78.24	62.82	75.35	88.39	73.54	79.56	64.77	60.31	59.38	72.55
Benishangul	86.24	53.83	73.71	36.00	58.12	66.63	52.35	52.34	41.06	71.86	56.03	58.77
SNNP	87.51	72.07	83.67	47.43	74.39	83.74	73.30	73.92	61.95	83.96	62.57	73.14
Gambella	63.67	66.44	81.13	61.66	77.11	82.50	73.70	77.59	68.56	86.32	70.07	73.57
Harari	95.93	86.15	92.59	59.66	80.71	91.79	82.38	85.31	71.67	85.94	69.93	82.03
Addis Ababa	94.63	86.20	91.18	56.92	77.42	92.36	80.64	82.58	62.54	86.54	75.27	80.55
Dire Dewa	92.67	76.70	84.78	46.40	77.34	87.73	74.34	77.71	63.59	80.82	57.70	74.49

Among all subtasks the achievement of regions in missing number identification was minimal, where the minimum score registered in this task was 36.00% by Benishangul Gumuz and the maximum was by Somali 62.82%. In most of the subtasks as shown in figure 4 Benshangul Gumuz region scored the lowest; and Harari and Addis Ababa achieved highest. Besides, with in the subtasks Harari's 95.93% in one to one correspondence and Benishangul Gumuz's 36% in missing number were the highest and lowest scores respectively.

Figure 5: EGMA percent mean scores and fluency by subtask and region





	Tigray	Afar	Amhara	Oromiya	Somali	Benishangul	SNNP	Gambella	Harari	Addis Ababa	Dire Dawa
Oral count	82.29	77.46	101.31	85.31	44.00	84.57	86.98	45.91	93.64	102.89	93.19
1 to 1 corresp	86.58	74.15	90.04	87.48	68.62	87.26	84.40	65.79	91.99	92.02	86.41
Num ID	23.04	21.38	28.93	25.93	22.30	18.42	24.32	24.07	31.29	35.54	27.55
Add L1	13.06	11.09	14.78	14.87	13.04	10.09	15.90	13.21	16.21	17.09	15.25
Subt L1	9.42	8.52	10.87	11.37	11.25	7.18	12.14	11.75	12.55	12.07	11.39

*All the differences were statistically significant at $p < .001$ level

The One Way ANOVA result shown in table 7 revealed that there was significant mean difference among regions in EGMA overall percent mean score at $F_{(10,15950)} = 121.12$, $p < 0.001$).

Table 7: EGMA overall percent mean score comparison by region using One Way ANOVA

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	420870.204	10	42087.020	121.120	.000
Within Groups	5542352.229	15950	347.483		
Total	5963222.433	15960			

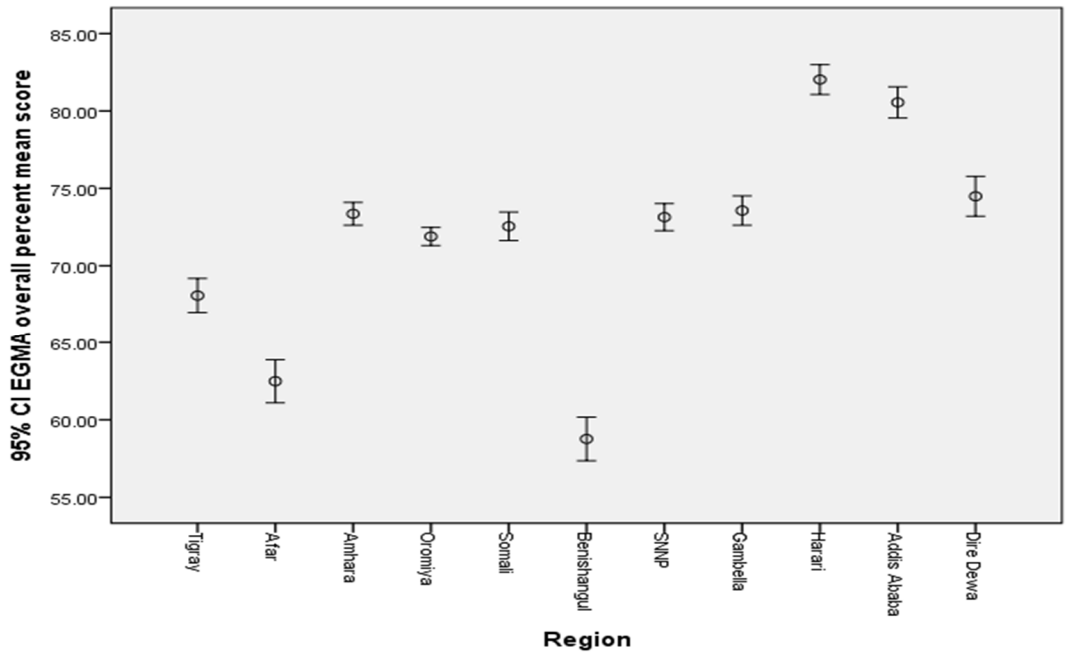
To see the individual differences a Post Hoc Tests of ANOVA using Tukey HSD method were executed from the overall percent mean score results of EGMA as shown in table 8. The result showed that the regions were classified in to six categories of homogeneity subset groupings. Children from Harari (82.03%) and Addis Ababa (80.55%) performed the highest mean score, whereas Benishangul Gumuz (58.77%) performed the least mean score as compared to the others. Their mean differences were also significantly different from the rest of the regions. In group 4 and group 5 there was more overlap of mean and the difference in the same homogeneous groups were not significant.

Table 8: Homogenous subset groupings of EGMA overall percent mean scores by regions using One Way ANOVA (Tukey HSD method)

Region	N	Subset for alpha = 0.05					
		1	2	3	4	5	6
Benishangul Gumuz	917	58.77					
Afar	917		62.49				
Tigray	1317			68.08			
Oromiya	3677				71.89		
Somali	1035				72.55	72.55	
SNNP	2110				73.14	73.14	
Amhara	2674				73.36	73.36	
Gambella	880				73.57	73.57	
Dire Dewa	794					74.49	
Addis Ababa	840						80.55
Harari	800						82.03
Sig.		1	1	1	0.559	0.331	0.736

Figure 6 also supports the existence of mean differences between regions at 95% confidence interval. It points out Harari and Addis Ababa was the highest and Benishangul Gumuz was the lowest achiever. It also displays the existence of an overlap of bars for means of some regions.

Figure 6: 95 % CI EGMA overall percent mean score

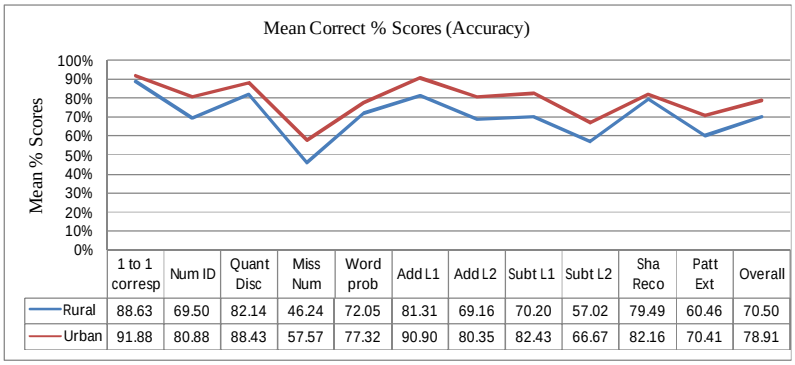


4.1.4 EGMA Results by Location

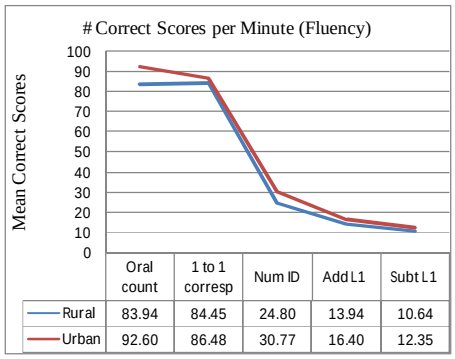
The overall percent mean score results of EGMA disaggregated in location as described in figure 7 also reveals that urban children perform significantly (t = -25. 12, df = 4854.51, p < .001, 2-tailed) better than rural. The disparity was maximum in subtraction level 1 (12.23%) and minimum in shape recognition (2.67%) in favor of urban students. The figure also noted the gap was increasing from word problem to subtraction level 1.

The mean score per minute also shows urban students achieved higher fluency than rural students in all timed sub tasks. Both groups achieved least fluency result in subtraction level 1. The fluency of urban students dropped from oral counting to subtraction level 1 as the difficulty of the task increases. While, fluency of rural students declined from number identification to subtraction level 1. The disparity is higher in oral counting (8.66%) and lower in subtraction level 1 (1.71%). A 2-tailed t-test at p < .001 showed the mean difference was statistically significant for all timed tasks in favor of urban students.

Figure 7: EGMA Percent Mean Scores and Fluency by subtask and location



	1 to 1 corresp	Num ID	Quant Disc	Miss Num	Word prob	Add L1	Add L2	Subt L1	Subt L2	Sha Reco	Patt Ext	Overall
Rural	88.63	69.50	82.14	46.24	72.05	81.31	69.16	70.20	57.02	79.49	60.46	70.50
Urban	91.88	80.88	88.43	57.57	77.32	90.90	80.35	82.43	66.67	82.16	70.41	78.91



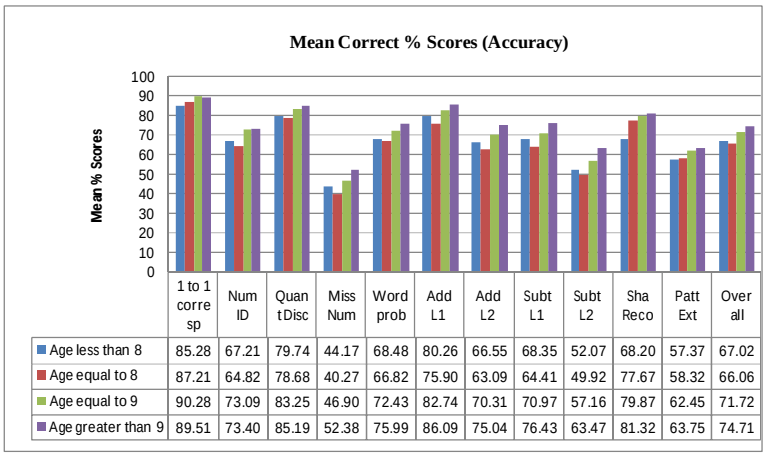
	Oral count	1 to 1 corresp	Num ID	Add L1	Subt L1
Rural	83.94	84.45	24.80	13.94	10.64
Urban	92.60	86.48	30.77	16.40	12.35

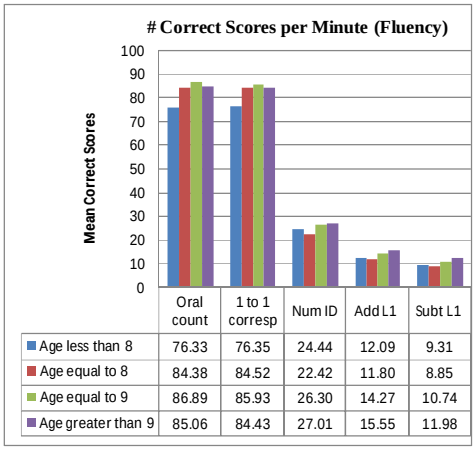
*All the differences were statistically significant at p < .001 level

4.1.5 EGMA Results by Age

The mean score comparison of students' performance across age was computed for each task as shown in figure 8. At all age levels included in the study scored maximum in one to one correspondence and minimum in missing number. From all age groups, age equal to 8 obtained 40.27% in missing number was the lowest score and age equal to 9 scored 90.28% in one to one correspondence was the highest of all. Besides, age equal to 8 scores lowest (66.06%) and age greater than 9 scores (74.71%) highest in EGMA overall.

Figure 8: EGMA percent mean scores and fluency by subtask and age





*All the differences were statistically significant at p <.001 level

The overall percent mean difference across age category as shown one way ANOVA (table 9) were significant($F_{(3,15895)}$ = 168.046, p < .001).

Table 9: EGMA overall percent mean score comparison by age using One Way ANOVA

		Sum of Squares	Df	Mean Square	F	Sig.
EGMA overall percent mean score	Between Groups	182718.899	3	60906.300	168.046	.000
	Within Groups	5760948.145	15895	362.438		
	Total	5943667.044	15898			

The mean differences were checked using Tukey's HSD method of ANOVA analysis from the overall percent mean score results of EGMA as shown in table 10. It revealed that the EGMA results were classified in to three age categories of homogeneity subset groupings. Children with age greater than 9 (74.71%) performed the highest mean score, whereas age equal to 8 (66.06%) and age less than 8 (67.02%) performed the least mean score as compared to others.

Table 10: Homogenous subset groupings of EGMA overall percent mean scores by ages using One Way ANOVA (Tukey HSD method)

Age	N	Subset for alpha = 0.05		
		1	2	3
Age equal to 8	3381	66.06		
Age less than 8	235	67.02		
Age equal to 9	4470		71.72	
Age greater than 9	7813			74.71
Sig.		.742	1.000	1.000

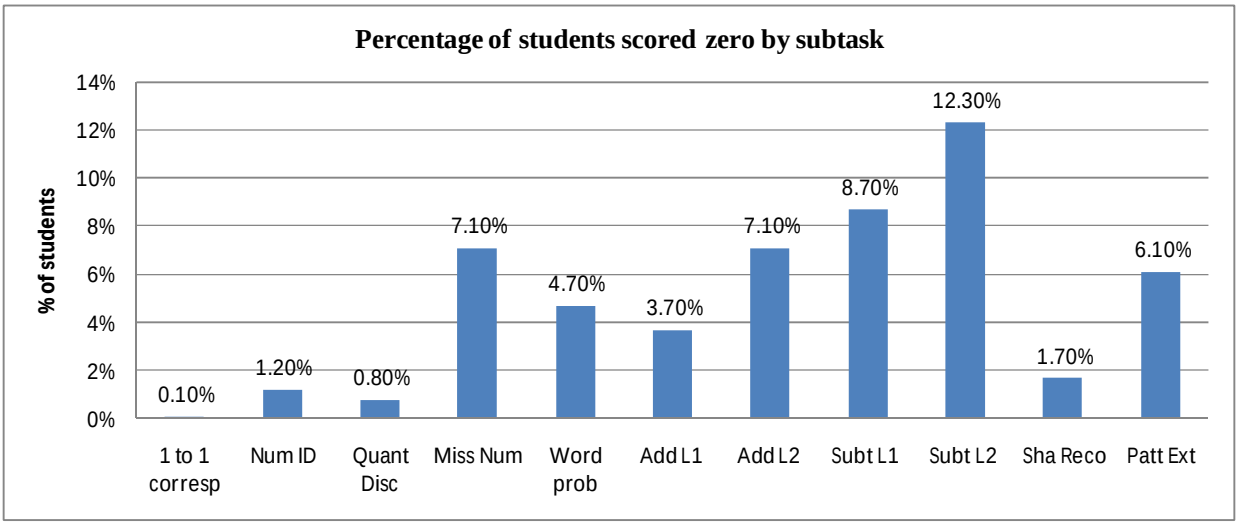
The fluency scores of EGMA by age category as illustrated in figure 8 and one way ANOVA revealed that there was a significant mean difference between ages at $p < .001$. Age equal to 9 and greater than 9 students' fluency score were decreased from oral counting to subtraction level 1 as the difficulty of the tasks increased. While, age less than 8 and equal to eight fluency kept decreasing from number identification to subtraction level 1.

4.2. EGMA Zero Scores

4.2.1 EGMA Zero Scores by Subtasks

Figure 9 illustrates the zero scores of students across the subtasks, that is, the number of students who did not respond to a single item correctly for each subtask. Across the EGMA overall, some percentage of students with zero scores were noted on every EGMA subtask, most markedly in the missing number (7.1%), addition level 2 (7.1%), subtraction level 1 (8.7%), and subtraction level 2 (12.3%) subtasks. A zero score trend across subtasks is evident that—students had fewer zero scores on those subtasks where they performed best, namely on one to one correspondence, number identification, quantity discrimination and shape recognition subtasks. Tasks which require simple mathematics skills received less percentage of students scored zero than the other subtasks which require advanced knowledge of mathematics. For instance, the percentage of students who scored zero increases from addition level 1 to subtraction level 2 as the difficulty of items increases.

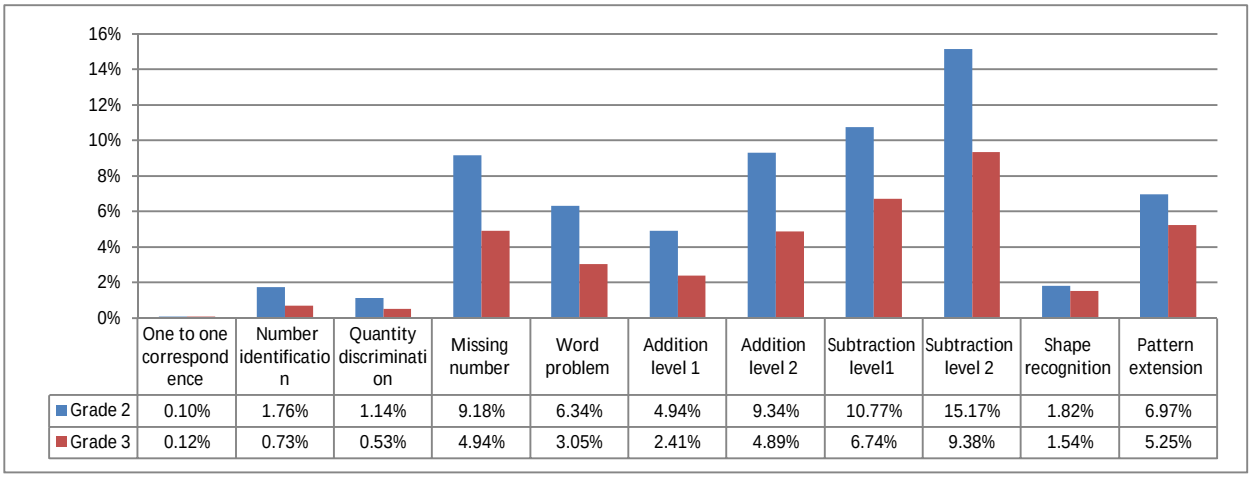
Figure 9: EGMA percentage of students scored zero by subtask



4.2.2 EGMA Zero Scores by Grade

The percentage of students scored zero by grade in each subtask as shown in figure 10revealed that significantly more number of grade 2 students scored zero than grade 3 students except in one to one correspondence subtask. Relatively, in some of the tasks such as missing number (9.20%), addition level 2 (9.30%), subtraction level 1 (10.8%) and subtraction level 2 (15.2%) more percentage of grade 2 students were not able to answer a single problem correctly. The tasks children scores zero were items that require simple mathematical knowledge such as "identifying number 4 ", "identifying the missing number pattern of 2, __, 6 ,8 ", "2 + 2 = " and "4 – 2 = ". Moreover, the highest differences in percentage of students scored zero between grade levels was in subtraction level 2 (5.8%) and the lowest was 0.01% in one to one correspondence.

Figure 10: EGMA percentage of students scored zero by subtask and grade

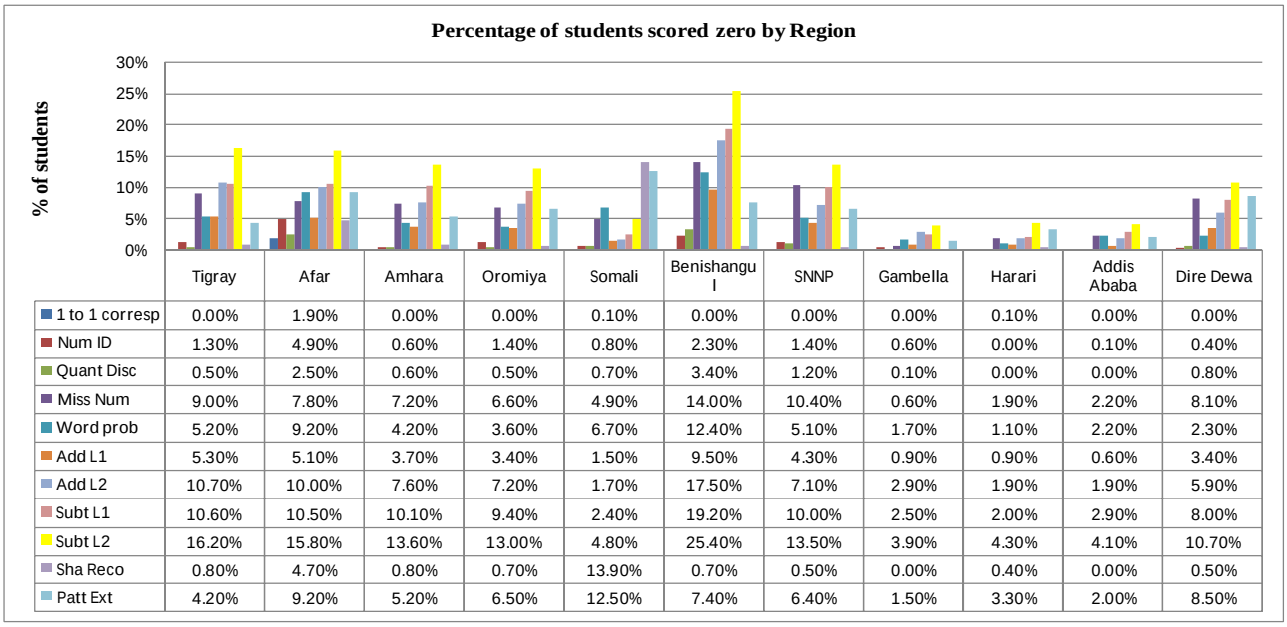


	One to one correspondence	Number identification	Quantity discrimination	Missing number	Word problem	Addition level 1	Addition level 2	Subtraction level1	Subtraction level 2	Shape recognition	Pattern extension
Grade 2	0.10%	1.76%	1.14%	9.18%	6.34%	4.94%	9.34%	10.77%	15.17%	1.82%	6.97%
Grade 3	0.12%	0.73%	0.53%	4.94%	3.05%	2.41%	4.89%	6.74%	9.38%	1.54%	5.25%

4.2.3 EGMA Zero Scores by Region

The percentage of students scored zero in EGMA subtasks also disaggregated by regions as shown in figure 11 describe that most of the regions registered high zero scores were at subtraction, addition and missing number problems. More specifically at missing number, 14%; addition level 2, 17.5%; subtraction level 1, 19.2%; and subtraction level 2,25.40% were found high zero score results in Benishangul Gumuz region. In all the regions more percentage of students unable to perform a single item was depicted in subtraction level 2 except Somali region. However, Somali region got more percentage of students zero in shape recognition. Relatively, among regions Addis Ababa had no zero scores in more number of tasks such as one to one correspondence, quantity discrimination and shape recognition.

Figure 11: EGMA percentage of students scored zero by region

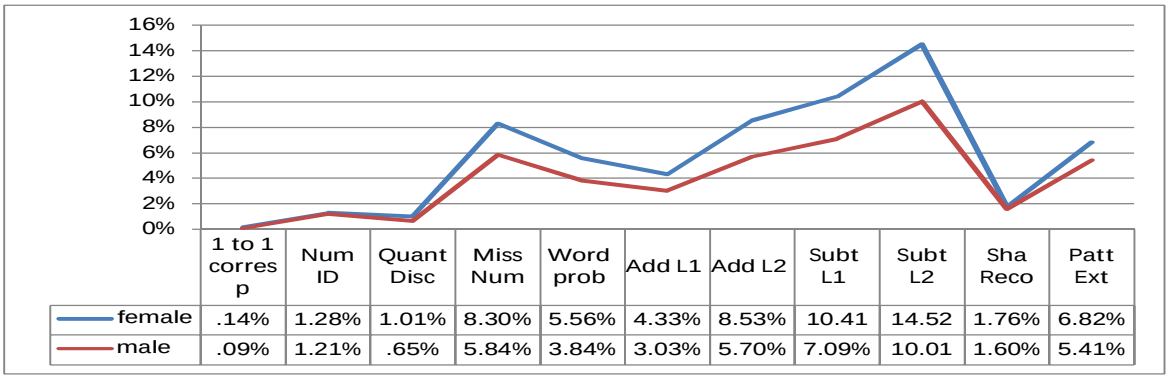


	Tigray	Afar	Amhara	Oromiya	Somali	Benishangul	SNNP	Gambella	Harari	Addis Ababa	Dire Dewa
1 to 1 corresp	0.00%	1.90%	0.00%	0.00%	0.10%	0.00%	0.00%	0.00%	0.10%	0.00%	0.00%
Num ID	1.30%	4.90%	0.60%	1.40%	0.80%	2.30%	1.40%	0.60%	0.00%	0.10%	0.40%
Quant Disc	0.50%	2.50%	0.60%	0.50%	0.70%	3.40%	1.20%	0.10%	0.00%	0.00%	0.80%
Miss Num	9.00%	7.80%	7.20%	6.60%	4.90%	14.00%	10.40%	0.60%	1.90%	2.20%	8.10%
Word prob	5.20%	9.20%	4.20%	3.60%	6.70%	12.40%	5.10%	1.70%	1.10%	2.20%	2.30%
Add L1	5.30%	5.10%	3.70%	3.40%	1.50%	9.50%	4.30%	0.90%	0.90%	0.60%	3.40%
Add L2	10.70%	10.00%	7.60%	7.20%	1.70%	17.50%	7.10%	2.90%	1.90%	1.90%	5.90%
Subt L1	10.60%	10.50%	10.10%	9.40%	2.40%	19.20%	10.00%	2.50%	2.00%	2.90%	8.00%
Subt L2	16.20%	15.80%	13.60%	13.00%	4.80%	25.40%	13.50%	3.90%	4.30%	4.10%	10.70%
Sha Reco	0.80%	4.70%	0.80%	0.70%	13.90%	0.70%	0.50%	0.00%	0.40%	0.00%	0.50%
Patt Ext	4.20%	9.20%	5.20%	6.50%	12.50%	7.40%	6.40%	1.50%	3.30%	2.00%	8.50%

4.2.4 EGMA Zero Scores by Gender

The percentage of female students scored zero were higher than boys in all subtasks as shown in figure 12. It further showed that more girls were not able to answer a single problem in some of the subtasks like missing number (8.30%), addition level 2 (8.53%), subtraction level 1 (10.41%) and subtraction level 2 (14.52%). Both males and females had higher percentage of students with zero score in subtraction level 2. Similarly, the percentage of students scored zero kept increasing from addition level 1 to subtraction level 2 as the items increased its cognitive difficulty. The percentage difference is highest in subtraction level 2 (4.51%) and lowest in one to one correspondence (0.05%).

Figure 12: EGMA percentage of students scored zero by gender

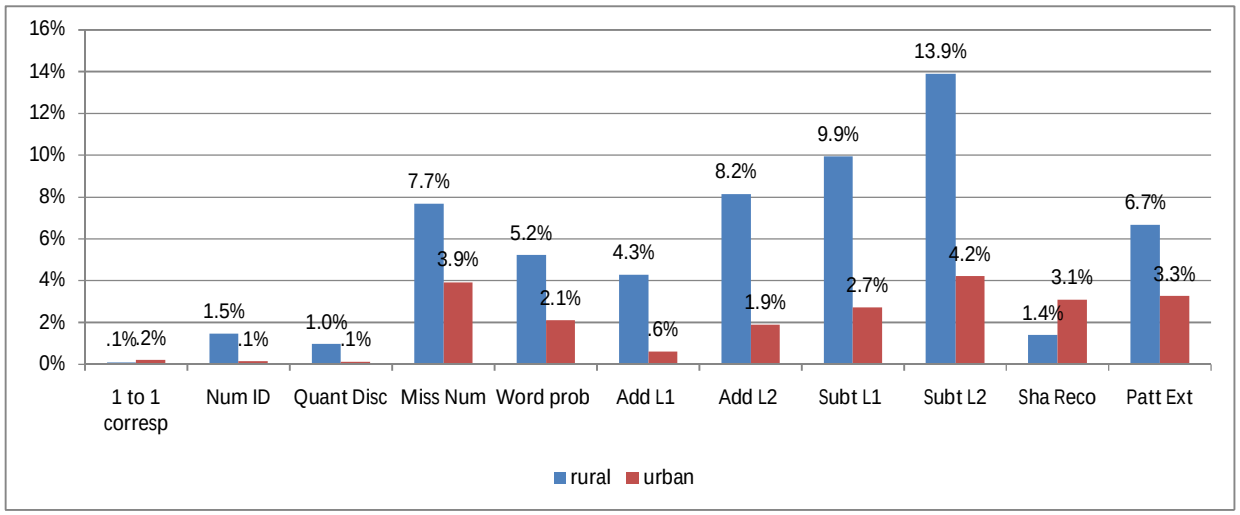


	1 to 1 corresp	Num ID	Quant Disc	Miss Num	Word prob	Add L1	Add L2	Subt L1	Subt L2	Sha Reco	Patt Ext
female	.14%	1.28%	1.01%	8.30%	5.56%	4.33%	8.53%	10.41	14.52	1.76%	6.82%
male	.09%	1.21%	.65%	5.84%	3.84%	3.03%	5.70%	7.09%	10.01	1.60%	5.41%

4.2.5 EGMA Zero Scores by Location

The percentage of zero scores in rural areas as depicted in figure 13 were slightly higher than urban students in all the given subtasks except in one to one correspondence and shape recognition. The difference in percentage of students scored zero between rural and urban in some tasks like missing number (3.8%), word problem (3.1%), addition level 1 (3.7%), addition level 2 (6.3%), subtraction level 1 (7.2%) and subtraction level 2 (9.7%) and pattern extension (3.4%) were more higher than other subtasks in favor of urban students. Subtraction level 2 had maximum percentage of students who got zero than the other subtasks in both groups. Similar to grade level and gender, the percentage of student who got zero kept increasing from addition level 1 to addition level 2.

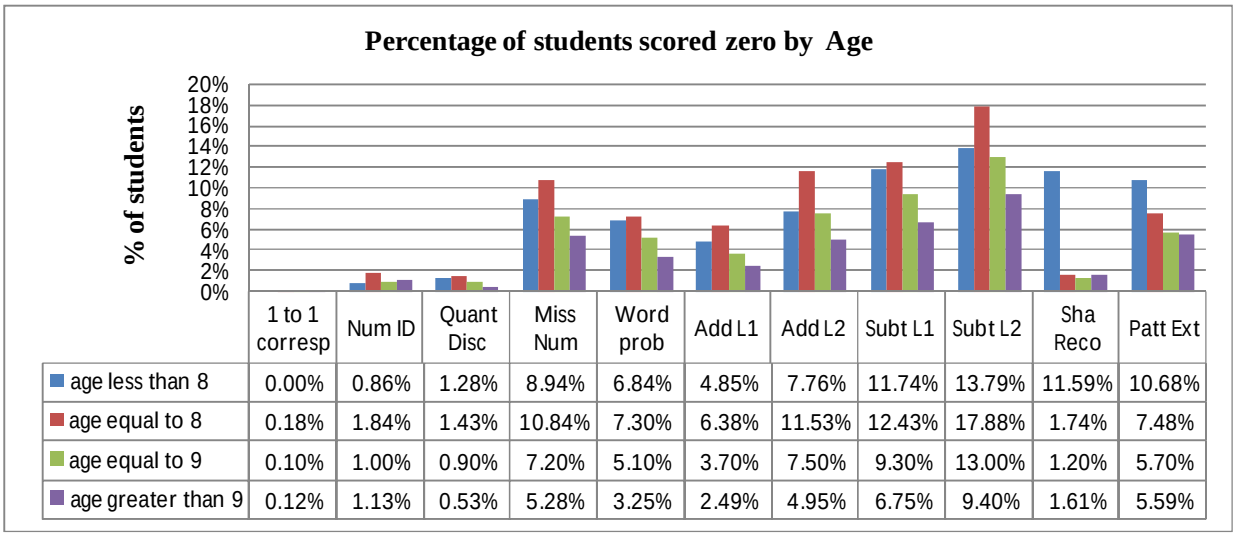
Figure 13: EGMA percentage of students scored zero by location



4.2.6 EGMA Zero Scores by Age

EGMA zero score across age category is presented in figure 14 and it revealed the same trend as grade and gender where all age groups had high percentage of students in missing number, word problem, addition and subtraction relative to other subtasks. Among the age categories in most of the subtasks age less than 8 and age equal to 8 obtained more percentage of zero scores. Specifically, among the subtasks subtraction level 2 had more percentage of students' scored zero in all age categories. Besides, all age groups percentage of zero scores kept increasing from addition level 1 to addition level 2.

Figure 14: EGMA percentage of students scored zero by subtask and age



	1 to 1 corresp	Num ID	Quant Disc	Miss Num	Word prob	Add L1	Add L2	Subt L1	Subt L2	Sha Reco	Patt Ext
age less than 8	0.00%	0.86%	1.28%	8.94%	6.84%	4.85%	7.76%	11.74%	13.79%	11.59%	10.68%
age equal to 8	0.18%	1.84%	1.43%	10.84%	7.30%	6.38%	11.53%	12.43%	17.88%	1.74%	7.48%
age equal to 9	0.10%	1.00%	0.90%	7.20%	5.10%	3.70%	7.50%	9.30%	13.00%	1.20%	5.70%
age greater than 9	0.12%	1.13%	0.53%	5.28%	3.25%	2.49%	4.95%	6.75%	9.40%	1.61%	5.59%

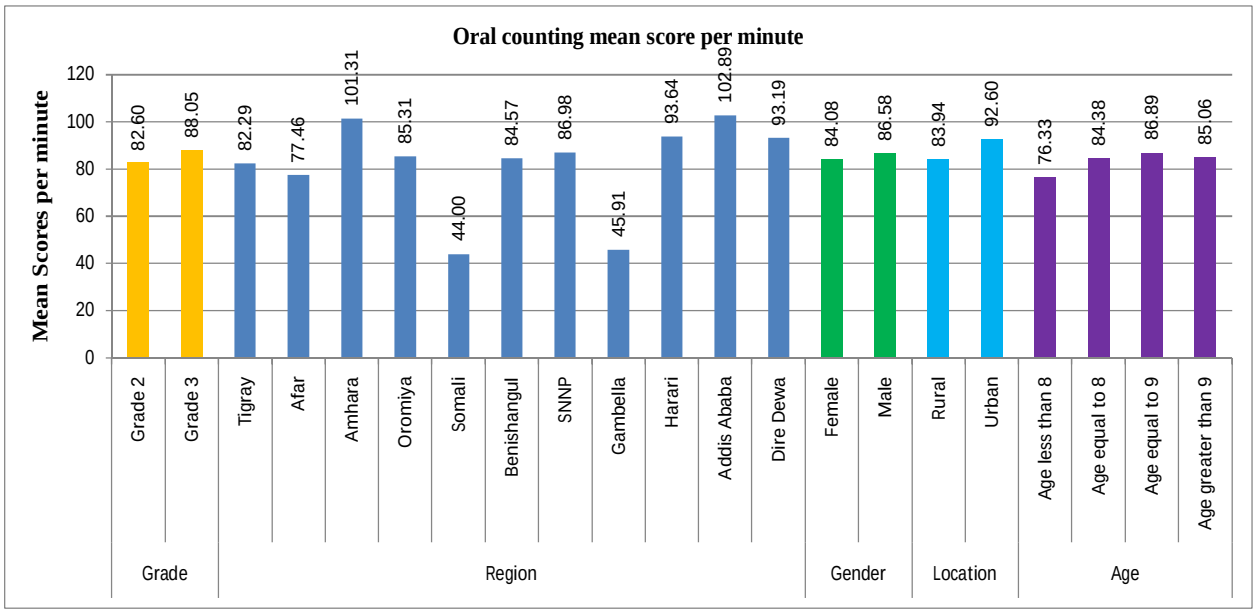
4.3. EGMA Results by Subtasks

4.3.1 Oral Counting (fluency)

The assessment of oral counting fluency targets children's ability to produce numbers fluently. In this task children were asked to rote count as far as they can (i.e., starting from one and counting up). The score was based on the last correct number the child says previous to making an error or at the end of a minute. This is a timed task, since the purpose is to elicit a fluency measure. As shown in table 4 above, the overall mean score result per minute for oral counting fluency task were 85.33 with a standard deviation 27.93 and skewness -.75 and the median 89 which was above the mean.

The results of the oral counting fluency subtask in figure 15 showed that, on average, students were counting to around 82 in grade 2 and 88 in grade 3. Although according to the Ethiopian curriculum students should master numbers up to 1000 by the end of grade 2 and 10,000 by the end of grade 3, the oral counting result was a better achievement compared to other tasks. It could be true that students would be able to reach this or higher numbers if they were given more time, indicating that many were not able to count fluently (with speed and precision).

Figure 15: Oral counting fluency mean scores by grade, region, gender, location and age



*All the differences were statistically significant at $p < .001$ level

The oral counting fluency score, which was disaggregated by regions as shown figure 15 and table 11 (Tukey HSD), revealed that Somali (44.00) and Gambella (45.91) scored the least whereas Amhara (101.31) and Addis Ababa (102.89) were the higher achievers. The variance between regions in one way ANOVA were found significant at $F_{(10, 1496)} = 634.826$ and $p < .001$. Students almost in all the regions except Somali and Gambella were counting around 77 and above in one minute which was a better and promising result in enhancing automaticity and mathematical skill of children's future learning in mathematics and science.

By comparing oral counting fluency scores with gender; boys perform better than girls and by the same trend in location urban were better than rural students. There mean difference 2.5 and 8.66 were in favor of male and urban students respectively. The 2-tailed *t*-test both in gender and

location showed the difference was statistically significant. In terms of age, the minimum score were counting around 76 in ages less than 8 and the rest were nearly similar, that were counting between 84 and 86. A One Way ANOVA indicated that there were variances in student achievement between age groups.

Table 11: Homogenous subset groupings of oral counting fluency mean scores by regions using One Way ANOVA (Tukey HSD method)

Region	N	Subset for alpha = 0.05					
		1	2	3	4	5	6
Somali	638	44.00					
Gambella	844	45.91					
Afar	863		77.46				
Tigray	1292			82.29			
BenishangulGumuz	912			84.57	84.57		
Oromiya	3537			85.31	85.31		
SNNP	1938				86.98		
Dire Dewa	784					93.19	
Harari	795					93.64	
Amhara	2559						101.31
Addis Ababa	813						102.89
Sig.		.754	1.000	.118	.411	1.000	.913

In general, there were statistically significant differences found in the mean scores of oral counting fluency between all the strata described above such as grades, regions, gender, location and age.

4.3.2 One to One Correspondence

Similar to oral counting, one-to-one correspondence (sometimes named as rational counting) is one of the most basic mathematical skills. Children were requested to recognize the items that they need to count, and also recognize those items that they have already counted to know children's understanding that the last number-word counted for the group of objects signifies the value of the group. They were asked to count 60 circles that had been printed on a sheet of paper, arranged in rows and columns within one minute. The score is based on the last correct number the child says previous to making an error or at the end of a minute. This is a timed task, since

the purpose is to elicit a fluency measure. Both the fluency (counting correct per minute and accuracy (percent of counting total correct) scores of children were analyzed for this task.

The summary result of students' counting one to one correspondence in table 4 showed that the average number of objects counted by the assessed students per minute was 84.78 with a standard error of .23. Similarly, the percent mean score was 89.17 with a standard error of .18. It was a better achievement like that of oral (rote) counting, where students have the basic foundational skill of cardinality associating numbers with objects.

The results of one to one correspondence subtask were also disaggregated by grade, region, gender, location and age as shown in figure 13. The result showed that, students mean percent score of counting objects (circles) was around 87% in grade 2 and 90% in grade 3. Percent mean score performance across regions as shown in table 12 and figure 16 also revealed that Gambella (63.67%) scored the least whereas Amhara (93.34%), Addis Ababa (94.63%) and Harari (95.93%) were the higher achievers.

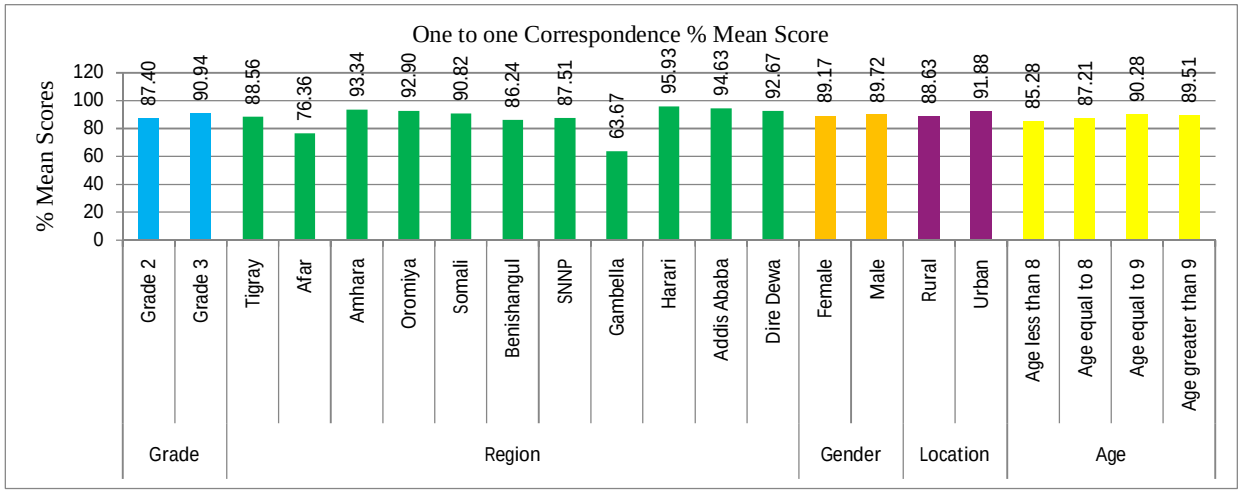
Table 12: Homogenous subset groupings of one to one correspondence (rational counting) percent mean score by regions using One Way ANOVA (Tukey HSD method)

		Subset for alpha = 0.05						
Region	N	1	2	3	4	5	6	7
Gambella	830	63.67						
Afar	834		76.36					
BenishangulGumuz	908			86.24				
SNNP	2064			87.51				
Tigray	1283			88.56	88.56			
Somali	999				90.82	90.82		
Dire Dewa	780					92.67	92.67	
Oromiya	3639					92.90	92.90	
Amhara	2649					93.34	93.34	93.34
Addis Ababa	824						94.63	94.63
Harari	778							95.93
Sig.		1.000	1.000	.279	.314	.175	.539	.140

Similarly, the comparison of one to one correspondence percent mean sores with gender; boys perform better than girls and by the same trend in location urban were better than rural students

and in terms of age the minimum percent mean score were counting around 85% in ages less than 8 and the maximum was 90% at age greater than 9.

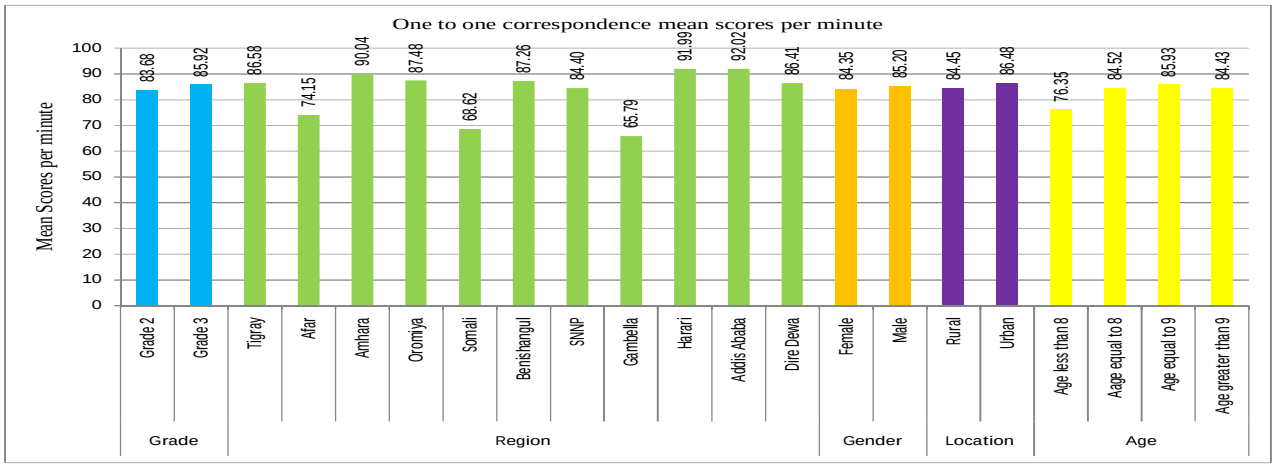
Figure 16: One to one correspondence (rational counting) percent mean score by grade, region, gender, location and age



*All the differences were statistically significant at $p < .001$ level

One to one correspondence mean score per minute result across grade, gender and location as shown in figure 17 revealed that students' performance in counting objects per minute were higher in grade 3 male and urban students than grade 2 female and rural students respectively. By the same trend, Gambella (65.79) and Somali (68.62) regions was the lower scorer whereas Amhara (90.04), Harari(91.99) and Addis Ababa (92.02) were the higher achiever regions. And also by age the minimum score were counting around 76 in ages less than 8 and the rest were nearly similar, that were counting between 84 and 85.

Figure 17: One to one correspondence (rational counting) mean score per minute (fluency) by grade, region, gender, location and age



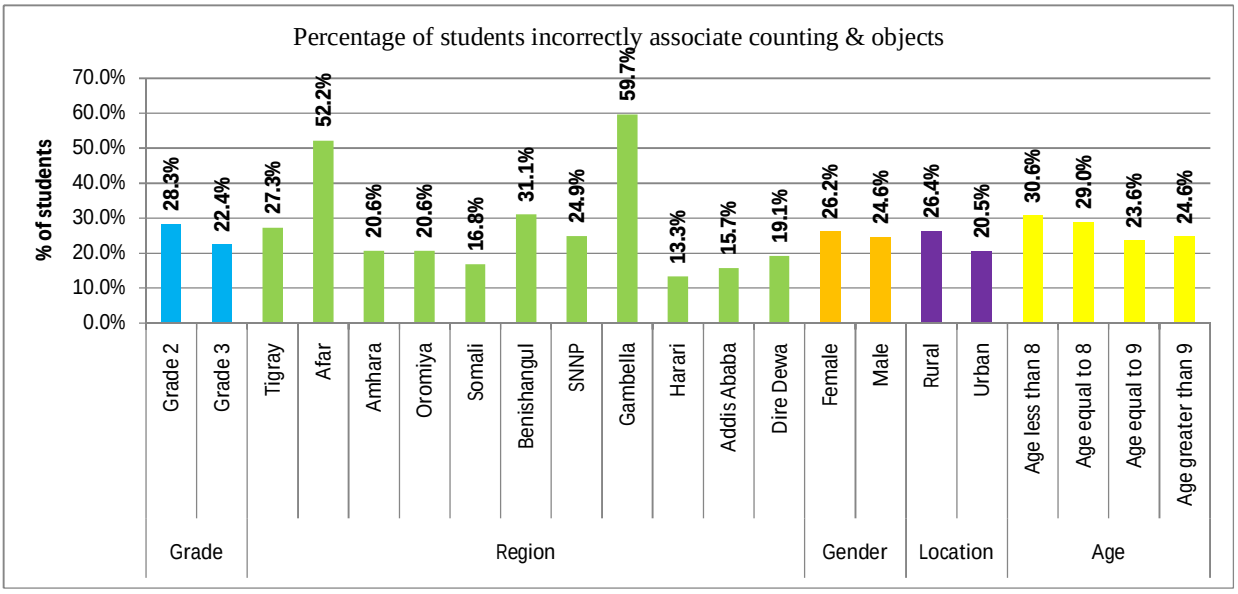
*All the differences were statistically significant at $p < .001$ level except gender

In general, there were statistically significant differences found both in the percent mean scores and fluency scores of one to one correspondence tasks between all the strata described above such as grades, regions, gender, location and age except the fluency score in gender.

Figure 18 reveals the percentage of students incorrectly associate counting of objects (circles) and their understanding that the last number-word counted for the group of objects signifies the value of the group which is called cardinality. The overall result showed that 25.4% of students were not able to correctly associate with the group of objects they count and the number value that represent the objects. In other words, only 74.6% of the students were fulfilled the objectives of one to one correspondence or cardinality.

The percentages of incorrect association of rational counting were aggregated by grade, region, gender, location and age as shown figure 18. More incorrect association were observed in grade 2 (28.3%) than grade 3 (22.4%) and from regions Gambella (59.7%) and Afar (52.2%) more than half of their students didn't understand cardinality. Harari had the lowest 13.3% of students who couldn't associate numbers correctly. Similarly, more percentage of female students (26.2%) and rural students (26.4%) incorrectly associate counting of objects and the last number that signifies than male (24.6%) and urban 20.5% students respectively.

Figure 18: Percentage of students incorrectly associate counting objects and the total number of objects (cardinality)



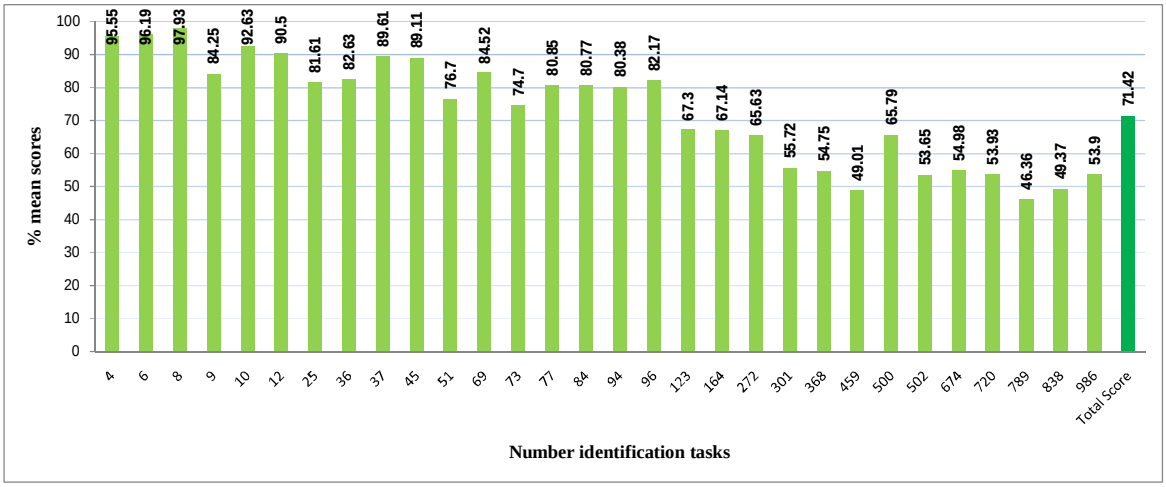
4.3.3 Number Identification

The number identification subtask was targeted to the student's knowledge and identification of written symbols. It assessed a student's recognition and understanding that each of the numbers is a constant with one number-word associated with it, and that the student knows the number-word(s) associated with the number symbol. If children's cannot identify numbers, they cannot engage effectively in all aspects of mathematics. Students were asked 30 number symbols to identify orally printed in a grid ranging from single to three digit numbers. This task was timed and children were asked to identify the numbers within one minute. Both the fluency (number correct per minute and accuracy (percent total correct) scores of children were analyzed for this task.

The overall percent mean score result of students for number identification subtask as shown in figure 19 was 71.42%. The result shows that the minimum percent mean score were found in identifying number (item) 838 (46.36%) and maximum at number (item) 8 (97.93%). In general the trend shows that the result decreases as it proceeds from single digit to three digit number. Those three digit number identification results were below the overall number identification

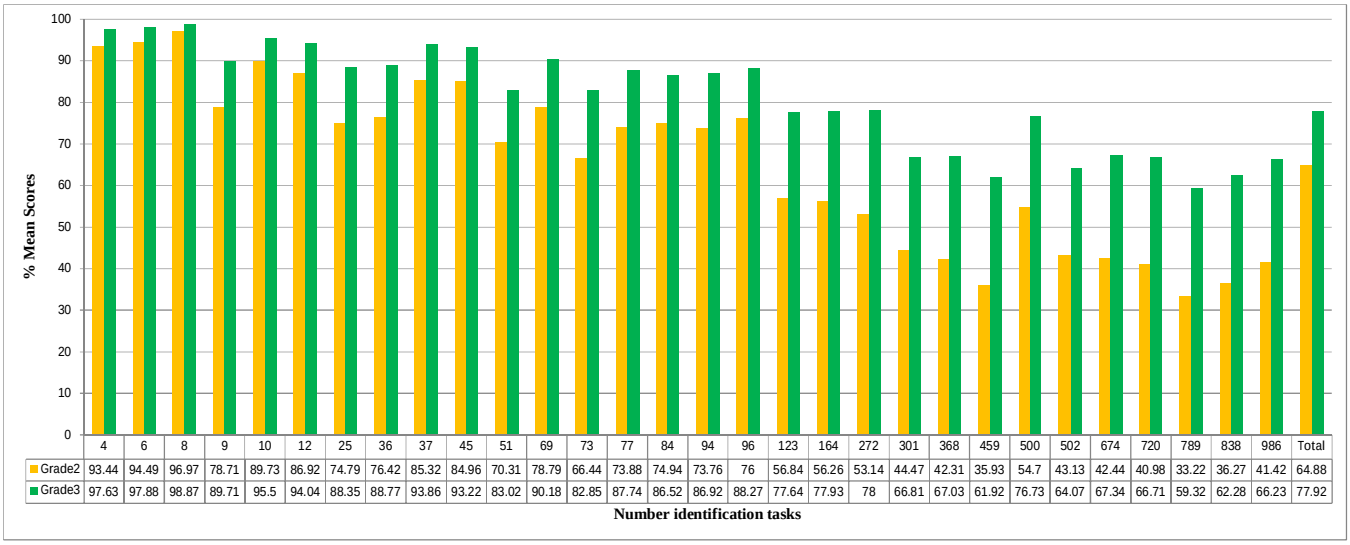
mean score. But students scored relatively better in identifying the number 500 (65.79%) among three digit numbers.

Figure 19: Number identification percent mean scores by tasks



The percent mean score result of each number identifications task shown in figure 20 revealed that in all the 30 items grade 3 performs better than grade 2 and the mean difference was larger as they proceed from single digit to three digit numbers. In both grades, item 789 was difficult to identify and 8 was easy to identify. Similarly, the gap is high for the number 789 with mean difference of 26.10% and low for number 8 with the mean difference of 1.91% in favor of grade 3 students.

Figure 20: Number identification percent mean scores by subtask and grade

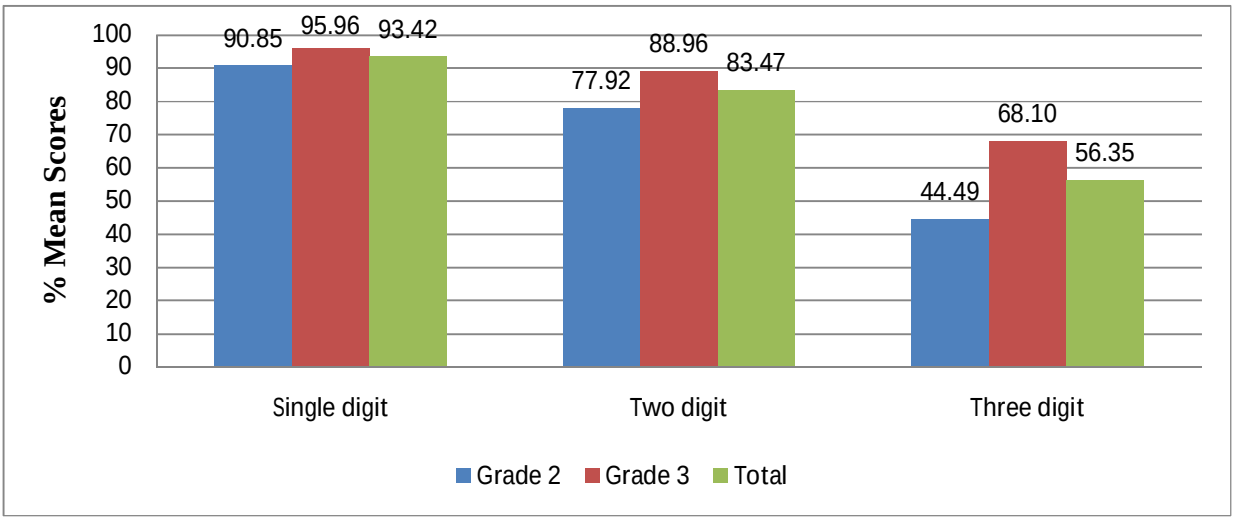


	4	6	8	9	10	12	25	36	37	45	51	69	73	77	84	94	96	123	164	272	301	368	459	500	502	674	720	789	838	986	Total
Grade2	93.44	94.49	96.97	78.71	89.73	86.92	74.79	76.42	85.32	84.96	70.31	78.79	66.44	73.88	74.94	73.76	76	56.84	56.26	53.14	44.47	42.31	35.93	54.7	43.13	42.44	40.98	33.22	36.27	41.42	64.88
Grade3	97.63	97.88	98.87	89.71	95.5	94.04	88.35	88.77	93.86	93.22	83.02	90.18	82.85	87.74	86.52	86.92	88.27	77.64	77.93	78	66.81	67.03	61.92	76.73	64.07	67.34	66.71	59.32	62.28	66.23	77.92

The number identification percent mean scores results by subtask and grade presented in figure 22 revealed that the percent mean score (accuracy) result of students in grade 3(77.92%) significantly higher than grade 2 (64.88%). And also there was less number of zero scores (0.1%) both in grade 2 and 3 on this subtask.

The percent mean score results of number identification subtask by digit category and grade as shown in figure 21 also indicated that the result declines as it proceeds from single to three digit numbers. Especially grade 2 highly decline from 90.85% in single digit to 44.49% in three digit number identification. In other words, the gap was high in three digit numbers 23.61% and low in single digit number 5.11%.

Figure 21: Number identification total correct percent mean score by single, double and three digit number category and grade



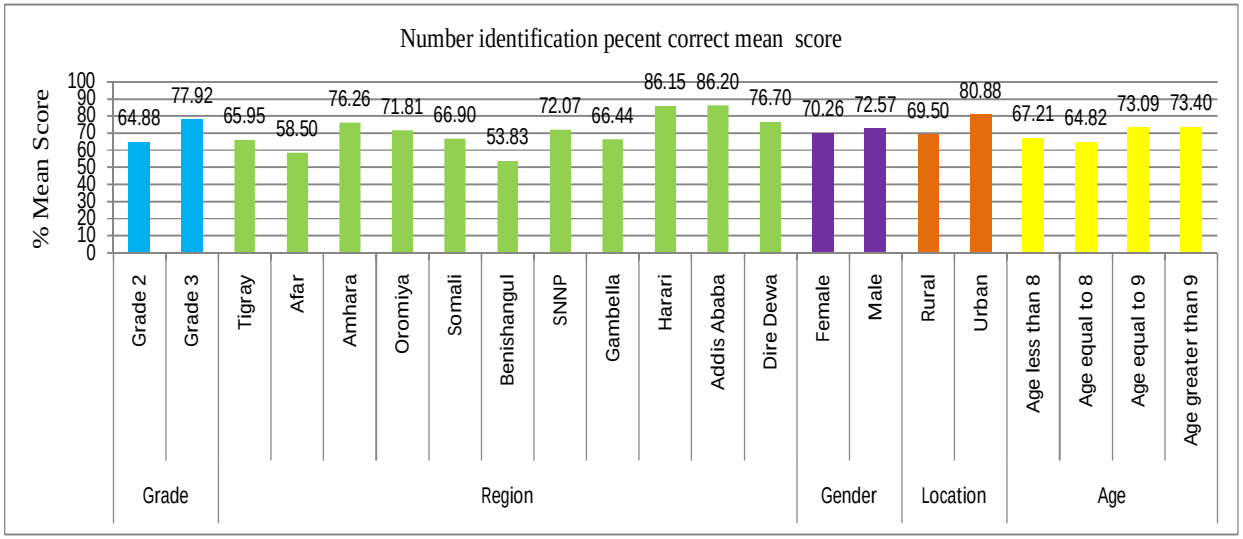
Similarly, there were a statistically significant differences found in the percent mean scores of this task across gender and location where males and urban children's perform significantly better than females and rural students respectively. Among regions the difference was significant (table 13) ranging from minimum result of Benishangul Gumuz (53.83%) and maximum Harari (86.15%) and Addis Ababa (86.20%).

Table 13: Homogenous subset groupings of number identification percent mean score by regions using One Way ANOVA (Tukey HSD method)

Region	N	Subset for alpha = 0.05					
		1	2	3	4	5	6
Benishangul Gumuz	915	53.83					
Afar	915		58.50				
Tigray	1316			65.95			
Gambella	879			66.44			
Somali	1024			66.90			
Oromiya	3662				71.81		
SNNP	2105				72.07		
Amhara	2672					76.26	
Dire Dewa	794					76.70	
Harari	799						86.15
Addis Ababa	838						86.20
Sig.		1.000	1.000	1.000	1.000	1.000	1.000

There were also significant differences by age category ranging from 64.82% in age equal to 8 to 73.40% in age greater than 9.

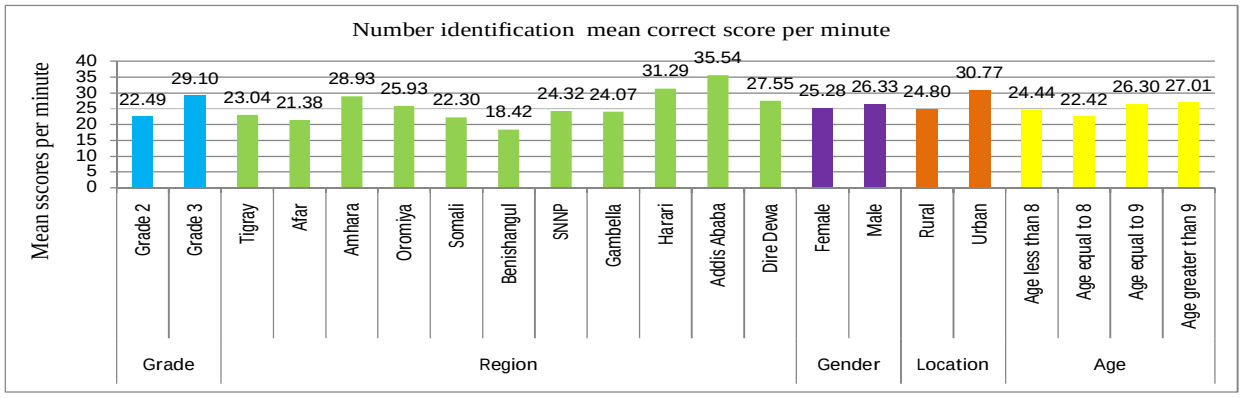
Figure 22: Number identification percent mean score by grade, region, gender, location and age



*All the differences were statistically significant at $p < .001$ level

The total average correct score per minute results for number identification subtask revealed that students correctly identify 25.81 numbers in one minute. The fluency score as aggregated by grade shown in figure 23 revealed that grade 2 students were able to correctly identify an average of 22.49 numbers in one minute, while grade 3 students were able to correctly identify 29.1 numbers in one minute. The mean score difference as shown in figure 23 were statistically significant across grade, region, gender, location and age.

Figure 23: Number identification correct mean score per minute (fluency) by grade, region, gender, location and age



*All the differences were statistically significant at $p < .001$ level

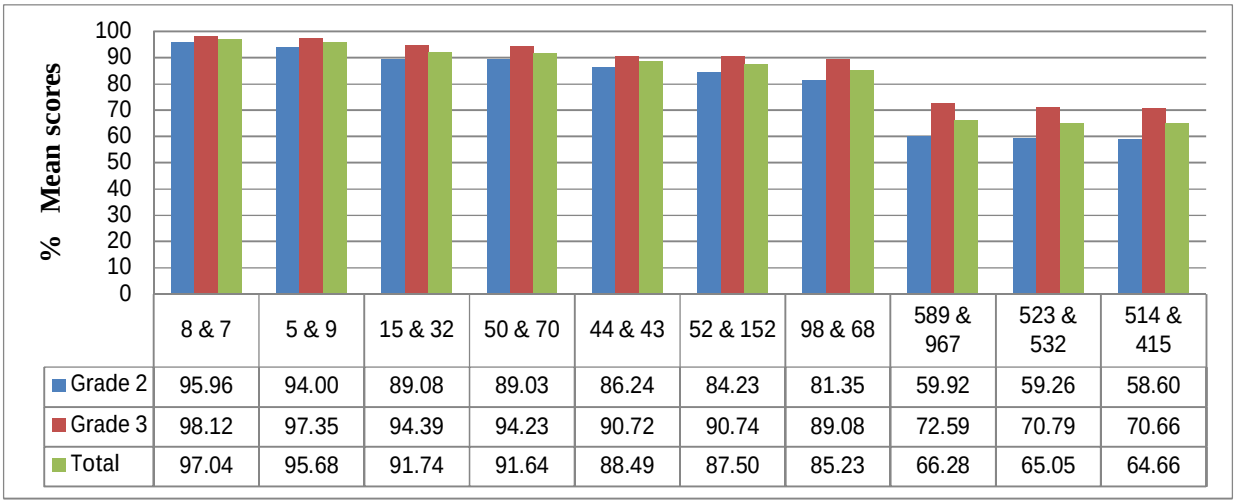
In conclusion, of the subtasks in the EGMA, this was the most basic, and the results indicate that students were able to identify numbers with pleasing levels of both fluency and accuracy.

4.3.4 Quantity Discrimination

Quantity discrimination subtasks measures students' ability to make judgments about differences by comparing quantities, represented by numbers. It measures their sense of magnitude in such a way that how big a number/quantity is by comparing two numbers/quantities. Being able to compare numbers/quantities is a foundational mathematical skill which is critical to effective and efficient problem-solving strategies. This subtask has 10 pairs of items/numbers ranging from single to three digit numbers in which students' were asked to identify the bigger number /quantity.

The percent mean score result of students by grade for quantity discrimination subtasks was shown in figure 24. It was easy for students to discriminate the quantity between 8 and 7 with mean score of 97.04 and was difficult between 514 and 415 with average score of 64.66 than the other items. The result indicates that in all the subtasks grade 3 students perform better than grade 2 and the overall trend showed that the result declines in both grades as the comparison proceeded from one to three digit numbers/quantity. Both grades performed best in 8 and 7 and lowest in 514 and 415.Similarly, the gap was high in 514 and 415 and low in 8 and 7.

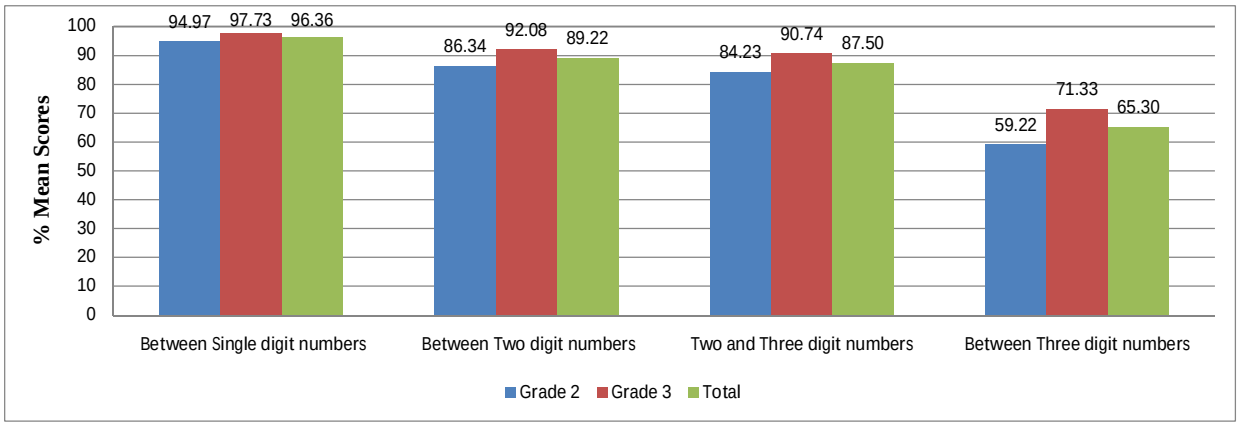
Figure 24: Quantity discrimination percent mean score by subtask and grade



	8 & 7	5 & 9	15 & 32	50 & 70	44 & 43	52 & 152	98 & 68	589 & 967	523 & 532	514 & 415
Grade 2	95.96	94.00	89.08	89.03	86.24	84.23	81.35	59.92	59.26	58.60
Grade 3	98.12	97.35	94.39	94.23	90.72	90.74	89.08	72.59	70.79	70.66
Total	97.04	95.68	91.74	91.64	88.49	87.50	85.23	66.28	65.05	64.66

Figure 25 clearly indicated that students performed best on the single-digit item and also performed better on the two-digit number items than on the three-digit number items. On the three-digit items, the items with which students had the most difficulty were those where the tens' and ones' digits were larger for the smallest number or quantity.

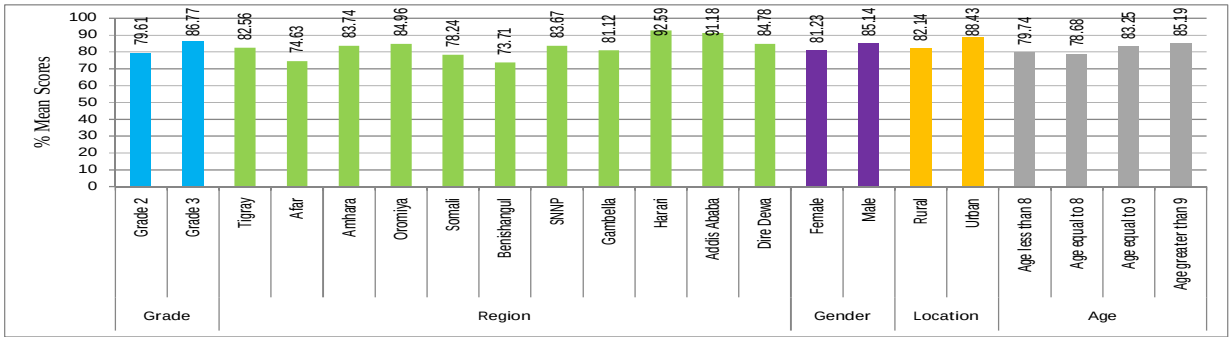
Figure 25: Quantity discrimination percent mean scores by single, double and three digit numbers



The percent mean score differences across grade, region, gender, location and age showed in figure 26 were significant at $p < .001$ (2-tailed). As with the oral counting, one to one correspondence and number identification subtasks, the quantity discrimination section showed positive growth from grade 2 to grade 3, with the average accuracy rising from 79.61% to 86.77%. Similarly the average performance of boys and urban students were higher than girls

and rural students respectively. There were also significant differences by age category ranging from 79.74% in to 85.19% in age greater than 9.

Figure 26: Quantity discrimination mean percent score by grade, region, gender, location and age



*All the differences were statistically significant at $p < .001$ level

Although all the regions performance was encouraging for this subtask, the ANOVA test in table 14 classify the regions in 5 homogeneity subsets where Benishangul Gumuz and Afar were from the lower group and Addis Ababa and Harari were from the higher achievers.

Table 14: Homogenous subset groupings of quantity discrimination percent mean score by regions using One Way ANOVA (Tukey HSD method)

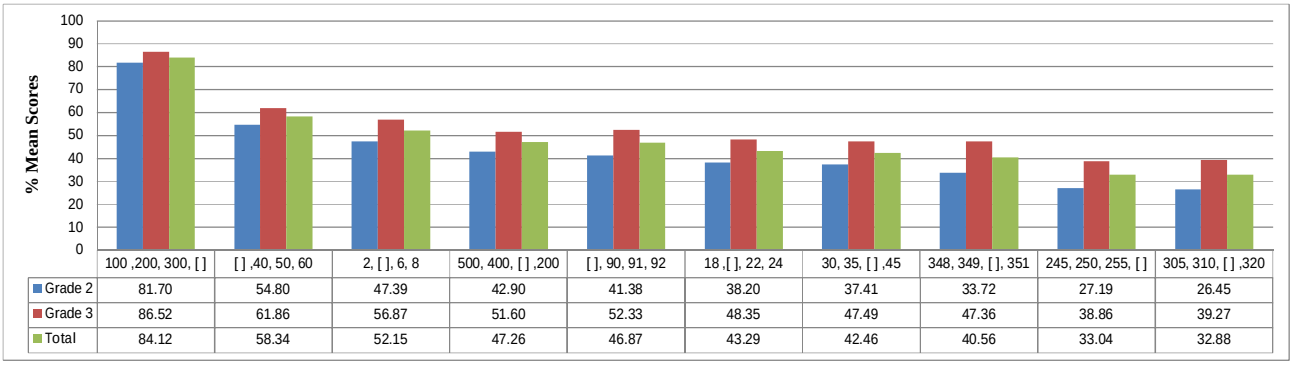
		Subset for alpha = 0.05				
Region	N	1	2	3	4	5
BenishangulGumuz	914	73.71				
Afar	916	74.63				
Somali	1023		78.24			
Gambella	880			81.13		
Tigray	1316			82.56	82.56	
SNNP	2099			83.67	83.67	
Amhara	2671			83.74	83.74	
Dire Dewa	791				84.78	
Oromiya	3657				84.96	
Addis Ababa	838					91.18
Harari	796					92.59
Sig.		.992	1.000	.072	.143	.853

4.3.5 Missing Number

Missing number identification is an important mathematical skill that involves pattern recognition and extension. Students ability to recognize number patterns, including counting patterns, such as by ones, tens, hundreds, fives and twos, etc. both forwards and backwards lays the foundation for other mathematical concepts, including multiplication and division and, later, algebra. Being able to identify patterns more generally enables students' problem solving skill.

Hence, students in this subtask were shown four placeholders with numbers in a sequence, and one placeholder was left blank for a next or missing number. The students were asked 10 items ranging from single to three digit numbers to determine and name the missing number. The percent mean score result of students' performance across the missing number items as shown in figure 27were weak compared to the previous subtasks. A relatively better result was achieved for the only one item "i.e. 100, 200, 300, [ ]", which was a total score result of 84.12% with an item of increasing and a large step size (100) pattern. And they performed least in a sequence 305, 310, ___, 320 a step size of 5 with average score of 32.88%. As with the trend across all subtasks, grade 3 students' perform higher than grade 2 in all the items. There was a noticeable drop-off in those items which are decreasing and backward number patterns.

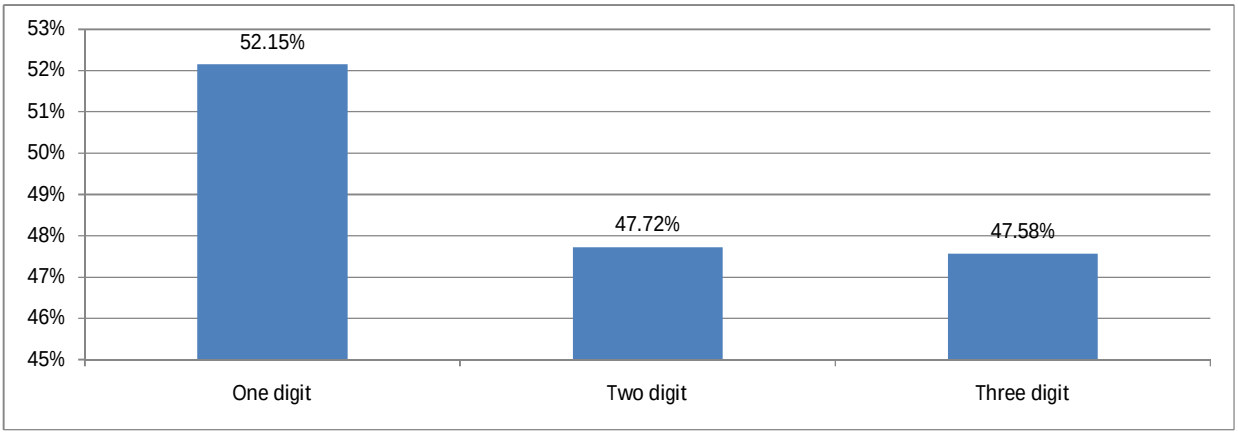
Figure 27: Missing number correct percent mean score result by each subtasks and grade



	100 ,200, 300, [ ]	[ ] ,40, 50, 60	2, [ ], 6, 8	500, 400, [ ] ,200	[ ], 90, 91, 92	18 ,[ ], 22, 24	30, 35, [ ] ,45	348, 349, [ ], 351	245, 250, 255, [ ]	305, 310, [ ] ,320
Grade 2	81.70	54.80	47.39	42.90	41.38	38.20	37.41	33.72	27.19	26.45
Grade 3	86.52	61.86	56.87	51.60	52.33	48.35	47.49	47.36	38.86	39.27
Total	84.12	58.34	52.15	47.26	46.87	43.29	42.46	40.56	33.04	32.88

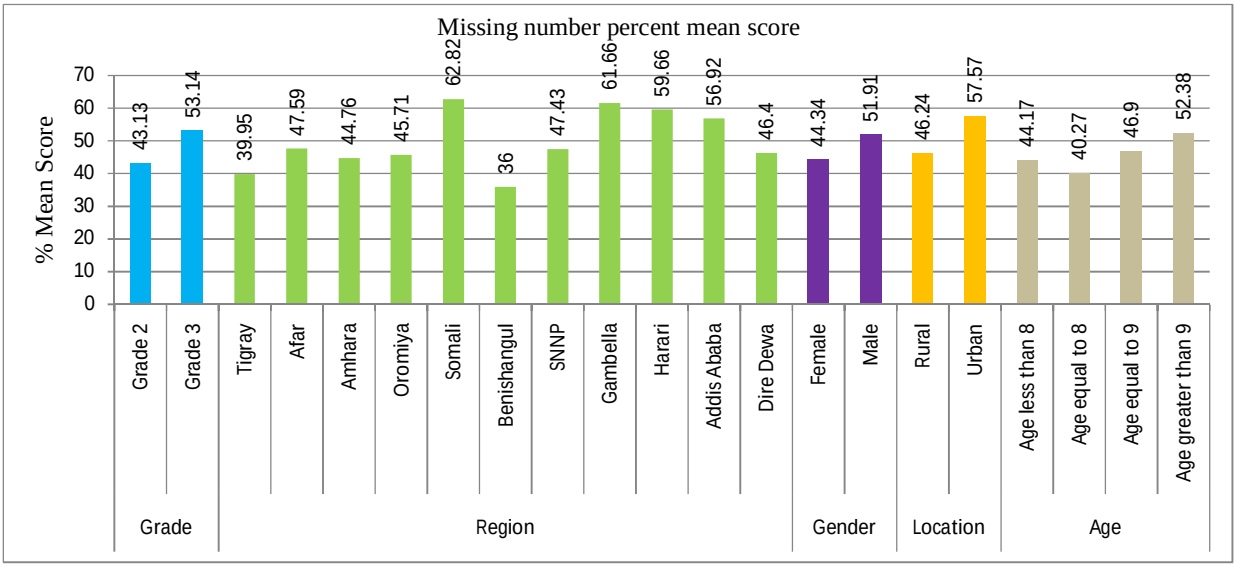
Similarly, as shown in figure 28 students' performance was higher on the single-digit number pattern than on the double-digit and three-digit number patterns. For two-digit and three-digit it was less than 50% achievement.

Figure 28: Missing number identification percent mean scores between single, double and three digit numbers



The overall percent mean score result of missing number pattern identification across grade, region, gender, location and age were presented in figure 29. The result shows that there was a significant mean difference across these strata at $p < .001$. As stated earlier, the overall result revealed that the performance was weak to the extent that female, rural, age less than or equal to 9 and grade 2 students scored below 50%.

Figure 29: Missing number percent mean score by grade, region, gender, location and age



*All the differences were statistically significant at $p < .001$ level

The results of EGMA mean score comparison across region as shown in table 15 revealed that the regions were grouped in to 4 homogeneous subset groups of which Benishangul Gumuzand Tigray were the least whereas Harari, Gambella and Somali were highest achievers of this subtask.

Table 15: Homogenous subset groupings of missing number percent mean score by regions using One Way ANOVA (Tukey HSD method)

Region	N	Subset for alpha = 0.05			
		1	2	3	4
Benishangul Gumuz	914	36.00			
Tigray	1315	39.95			
Amhara	2669		44.76		
Oromiya	3654		45.71		
Dire Dewa	792		46.40		
SNNP	2100		47.43		
Afar	916		47.59		
Addis Ababa	835			56.92	
Harari	797			59.66	59.66
Gambella	878				61.66
Somali	1018				62.82
Sig.		.082	.522	.570	.345

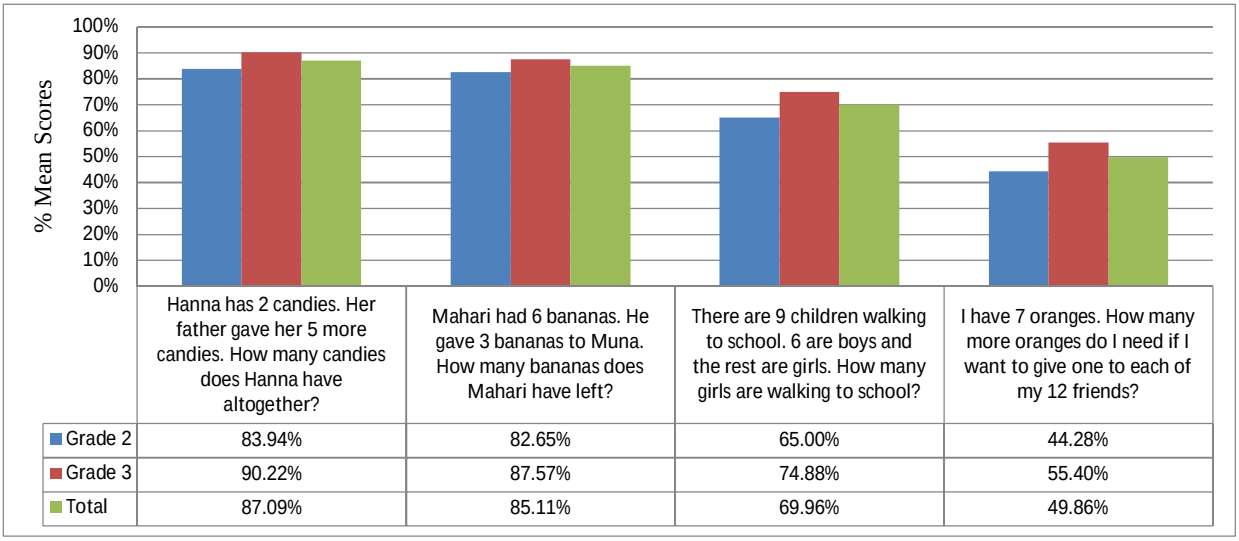
4.3.6 Word Problem

This subtask was used to assess the ability of students to interpret a situation (presented to them in words), make a plan, and solve the problem using the informal concepts of addition and subtraction. Because the focus was on assessing the students' ability to interpret a situation, make a plan, and solve a problem, the numerical values involved in the problem were deliberately small to allow for the targeted skills to be assessed without being confounded by problems with calculation skills that might otherwise impede performance. The word problems were designed to assess different mathematical operations (addition and subtraction) and problem structures: such as joining/separating, combining (part – part – whole) and comparison.

The overall percent mean score of this subtask as shown in table 4 was 72.94% which was markedly better than number identification (71.42%), missing number (48.15%), addition level 2 (71.03%), subtraction level 1 (72.22%), subtraction level 2 (58.64%) and pattern extension

(62.14%). The word problem subtask then has 4 sub items as shown in figure 30. Grade 3 children perform better in all the sub items than grade 2 and also among the sub items they score high total score in problem 1 (87.09%) with a mathematical structure of combining (part - part – whole) and least for problem 4 (49.86%) with sharing type of item. The rest two are comparing structure of items with moderately medium achievement was obtained.

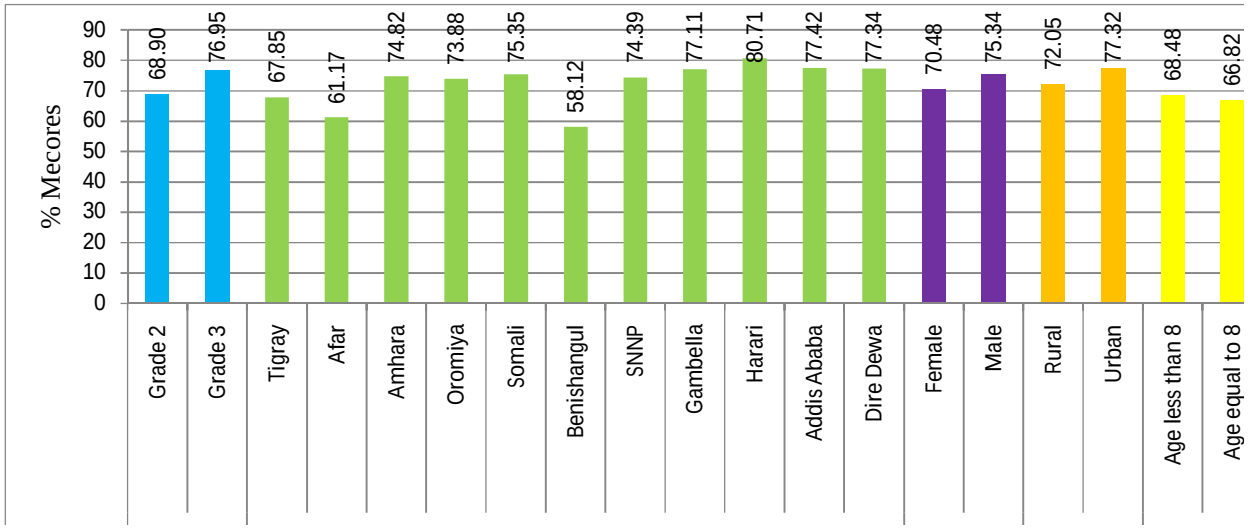
Figure 30: Word problem percent mean score by sub task



	Hanna has 2 candies. Her father gave her 5 more candies. How many candies does Hanna have altogether?	Mahari had 6 bananas. He gave 3 bananas to Muna. How many bananas does Mahari have left?	There are 9 children walking to school. 6 are boys and the rest are girls. How many girls are walking to school?	I have 7 oranges. How many more oranges do I need if I want to give one to each of my 12 friends?
Grade 2	83.94%	82.65%	65.00%	44.28%
Grade 3	90.22%	87.57%	74.88%	55.40%
Total	87.09%	85.11%	69.96%	49.86%

The percent mean score result in figure 31 revealed that there were significant mean differences across grade, region, gender, location and age at $p < .001$. This implied that grade 3 students mean score of 68.90% significantly higher than grade 2 students (76.95%). Similarly, boys (75.34%) and urban (77.32%) students outperform than girls (70.48%) and rural (72.05%) students respectively.

Figure 31: Word problem percent mean scores by grade, region, gender, location and age



*All the differences were statistically significant at $p < .001$ level

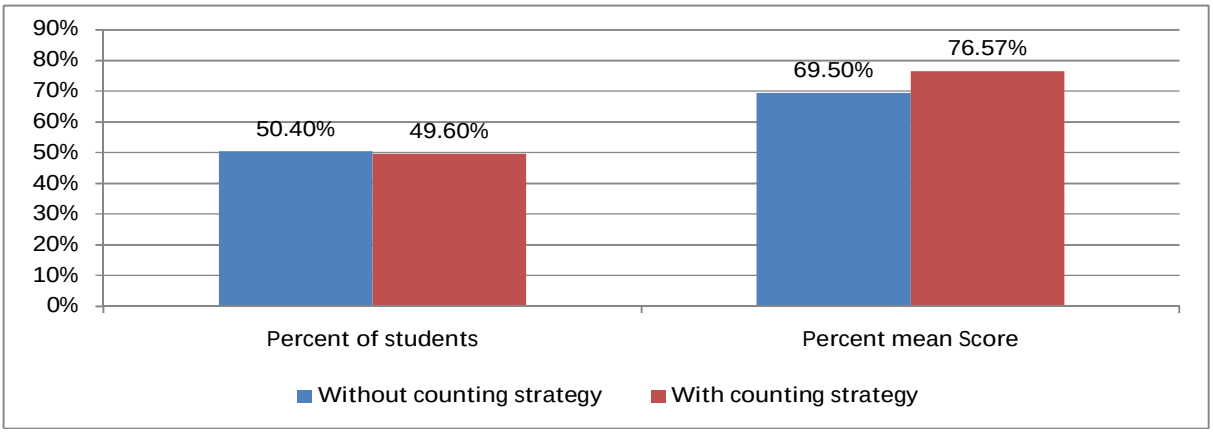
The regions in this subtask were grouped in to 4 homogeneity subsets as shown in table 16 of One Way ANOVA Tukey HSD comparison. These result indicated that Benishangule Gumuz (58.12%) and Afar (62.17%) performed the least whereas Gambella (77.11%), Diredawa (77.34%), Addis Ababa (77.42%) and Harari (80.71%) were highest performing regions in the homogeneity subset groupings.

Table 16: Homogenous subset groupings of word problem percent mean score by regions using One Way ANOVA (Tukey HSD method)

		Subset for alpha = 0.05			
Region	N	1	2	3	4
BenishangulGumuz	914	58.12			
Afar	915	61.17			
Tigray	1315		67.85		
Oromiya	3623			73.88	
SNNP	2091			74.39	
Amhara	2670			74.82	
Somali	1014			75.35	
Gambella	877			77.11	77.11
Dire Dewa	790			77.34	77.34
Addis Ababa	836			77.42	77.42
Harari	792				80.71
Sig.		.265	1.000	.099	.085

Moreover, in the word problem tasks children were given to use counters or figures or any other counting strategy. Then the results as shown in figure 31 revealed that more than half of the students (50.40%) did not used counting strategies. However, the word problem percent mean score result of students with counting strategies were 76.57%, which was significantly greater than those without counting strategy (69.50%) with t (14997) = 15.436, p < .001(2-tailed).

Figure 32: Word problem counting strategy



4.3.7 Addition and Subtraction

Addition and subtraction subtasks were presented to children with two categories which are addition and subtraction level 1 (their sums less than or equal to 9 or single digit numbers) and addition and subtraction level 2 (their sums were between 10 and 100 or two digit numbers).

The items on level 1task represent the foundational addition and subtraction "facts" that are at the heart of addition and subtraction with numbers in larger number ranges. Without achieving some level of automaticity on the range of addition and subtractions "facts" represented by these items, there is little expectation that students will be able to perform addition and subtraction in higher number ranges. These tasks are timed and children were asked to perform addition and subtraction within one minute.

The level 2 addition and subtraction tasks assessed students' conceptual understanding of addition and subtraction, as well as their ability to apply the procedural knowledge that had been

assessed in the level 1 subtasks to more complex tasks. Students were allowed to use counting strategies such as counters or fingers to help them solve these questions.

Hence, the mean score results of students in addition and subtraction both at level 1 and level 2 were presented as follows.

4.3.7.1 Addition

i. Addition level 1

The overall percent mean score and fluency score result of students for addition level 1 as shown in table 4 above were found to be 82.90% and 14.35 respectively. The accuracy result of this task third highest score next to one to one correspondence (89.17%) and quantity discrimination (83.20%) and also it was above the overall mean of EGMA (71.92%). In the overall fluency score at this task children's were able to perform around 14 items addition level 1 tasks in one minute. Grade 2 students on average were able to answer around 13 addition level 1 questions correctly in one minute, while the grade 3 students were able to answer 16 addition level 1 questions correctly in one minute.

The result across grade, region, gender, location and age was also shown in table 17. An independent sample t – test showed that grade 3, male and urban students' performance were significantly higher than grade 2, female and rural students respectively in both fluency and accuracy tasks. Similarly, a one way ANOVA indicated that there was a significant difference between the mean scores both in age and regions.

Table 17: Addition level 1total correct percent mean scores by grade, region, gender, location and age

Stratum		Addition level1 percent correct	Addition level 1 fluency
Grade	Grade 2	78.60	12.50
	Grade 3	87.16	16.18
Region	Tigray	78.26	13.06
	Afar	73.74	11.09
	Amhara	84.30	14.78
	Oromiya	83.02	14.87
	Somali	88.39	13.04
	Benishangul Gumuz	66.63	10.09
	SNNP	83.74	15.90
	Gambella	82.50	13.21
	Harari	91.79	16.21
	Addis Ababa	92.36	17.09
	Dire Dawa	87.73	15.25
Gender	Female	80.58	13.45
	Male	85.19	15.23
Location	Rural	81.31	13.94
	Urban	90.90	16.40
Age	Age less than 8	80.26	12.09
	Age equal to 8	75.90	11.80
	Age equal to 9	82.74	14.27
	Age greater than 9	86.09	15.55

*All the differences were statistically significant at $p < .001$ level

Table 18 shows homogeneity subset groupings of the regions using one way ANOVA Tukey HSD comparison. They were grouped in to 8 homogeneity subsets. These result indicated that Benishangule Gumuz (66.63%) was performed the least whereas Addis Ababa (92.36%) was highest performing region in the homogeneity subset groupings.

Table 18: Homogenous subset groupings of addition level 1 percent mean score by regions using One Way ANOVA (Tukey HSD method)

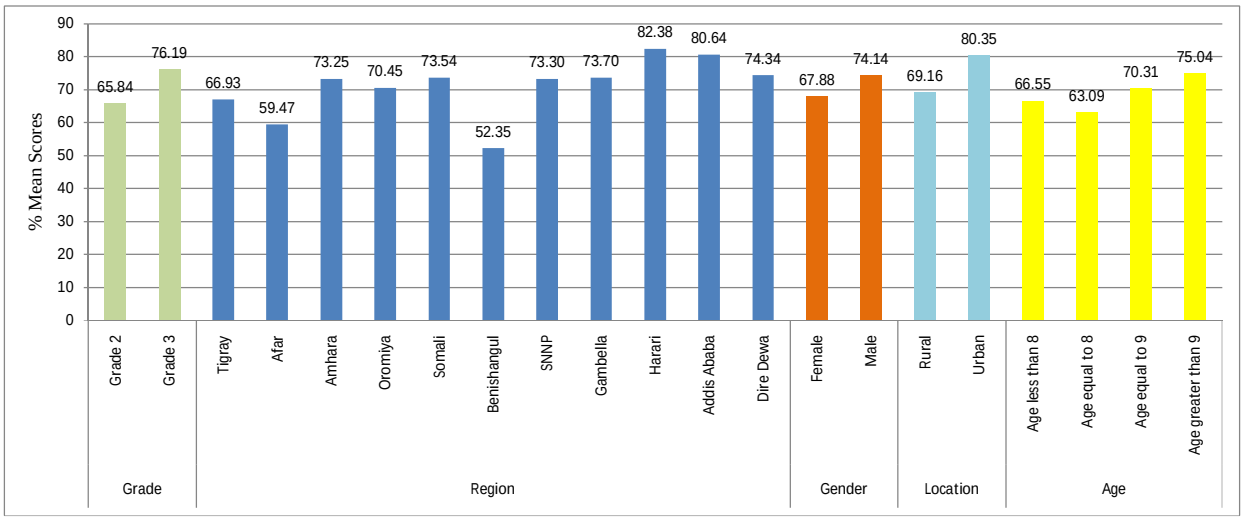
Region	N	Subset for alpha = 0.05							
		1	2	3	4	5	6	7	8
BenishangulGumuz	916	66.63							
Afar	914		73.74						
Tigray	1313			78.26					
Gambella	876				82.50				
Oromiya	3663				83.02				
SNNP	2100				83.74				
Amhara	2669				84.30	84.30			
Dire Dewa	793					87.73	87.73		
Somali	892						88.39	88.39	
Harari	798							91.79	91.79
Addis Ababa	836								92.36
Sig.		1.000	1.000	1.000	.893	.097	1.000	.101	1.000

ii. Addition level 2

The overall percent mean score for addition level 2 as shown in table 4 above were found to be 71.03%. Although the result was still encouraging as addition level 1, a marked decline in performance were observed on the level 2 addition tasks when compared with the level 1 tasks.

The percent mean score result across grade, region, gender, location and age was shown in figure 33. The percent mean score result of grade 3, male and urban students were significantly ($p < .001$) higher than grade 2, female and rural students respectively. Similarly, a one way ANOVA indicated that there was a significant difference between the mean scores both in age and regions.

Figure 33: Addition level 2 percent mean scores by grade, region, gender, location and age



*All the differences were statistically significant at $p < .001$ level

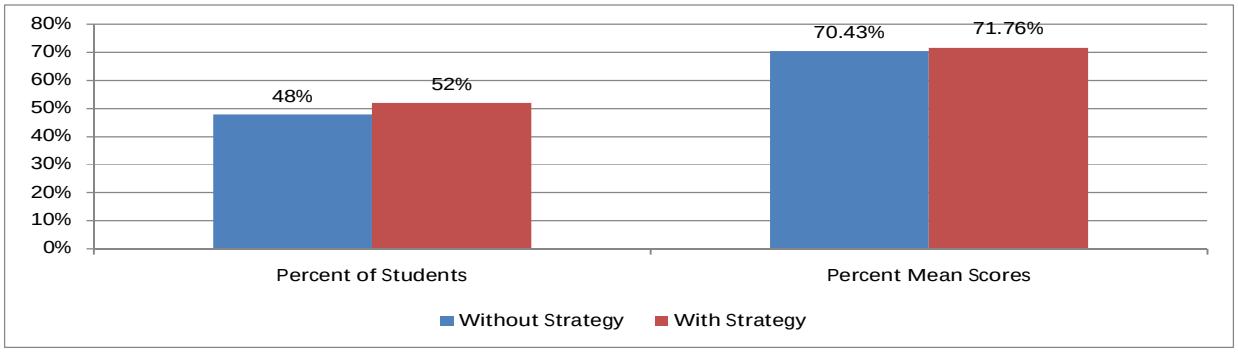
The homogeneity subset groupings of the regions grouped them in to 8 homogeneity subsets using One Way ANOVA Tukey HSD comparison shown in table 19. These result indicated that Benishangule Gumuz (52.35%) was performed the least, whereas Addis Ababa (80.64%) and Harari (82.38%) were highest performing region in the homogeneity subset groupings.

Table 19: Homogenous subset groupings of Addition level 2 percent mean score by regions using One Way ANOVA (Tukey HSD method)

Region	N	Subset for alpha = 0.05				
		1	2	3	4	5
Benishangul Gumuz	909	52.35				
Afar	906		59.47			
Tigray	1304			66.93		
Oromiya	3646			70.45	70.45	
Amhara	2652				73.25	
SNNP	2086				73.30	
Somali	1000				73.54	
Gambella	870				73.70	
Dire Dewa	786				74.34	
Addis Ababa	826					80.64
Harari	787					82.38
Sig.		1.000	1.000	.208	.103	.965

For the addition level 2 tasks children were given the opportunity to use counters or fingers or any other counting strategy. Then results as shown in figure 34 revealed that 52% of students used counting strategies. The addition level 2 percent mean score result of students with counting strategy were 71.76%, which was significantly greater than those without counting strategy (70.43%) with t (13623.774) = 2.531, p = .011(2-tailed).

Figure 34: Addition level 2 counting strategy



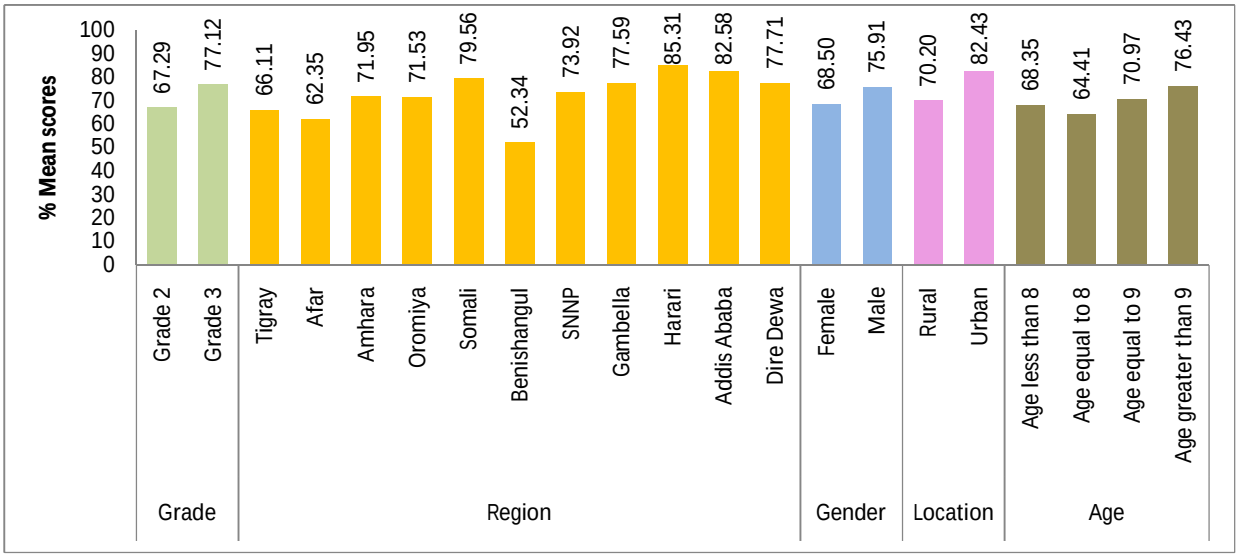
4.3.7.2 Subtraction

iii. Subtraction level 1

The overall percent mean score and fluency score result of students for subtraction level 1 as shown in table 3 above were found to be 72.22% and 10.92 respectively. The accuracy result of this task was above the overall mean of EGMA (71.92%). In the overall fluency score result at this task indicated that children's were able to perform 10.92 items of subtraction level 1 tasks in one minute.

The percent mean score result across grade, region, gender, location and age in figure 35 and 36 showed that grade 3, male and urban students' performance were significantly higher than grade 2, female and rural students respectively in both fluency and accuracy tasks. Similarly, as indicated in a One Way ANOVA there was a significant difference between the mean scores between regions and ages.

Figure 35: Subtraction level 1 percent mean scores by grade, region, gender, location and age



*All the differences were statistically significant at $p < .001$ level

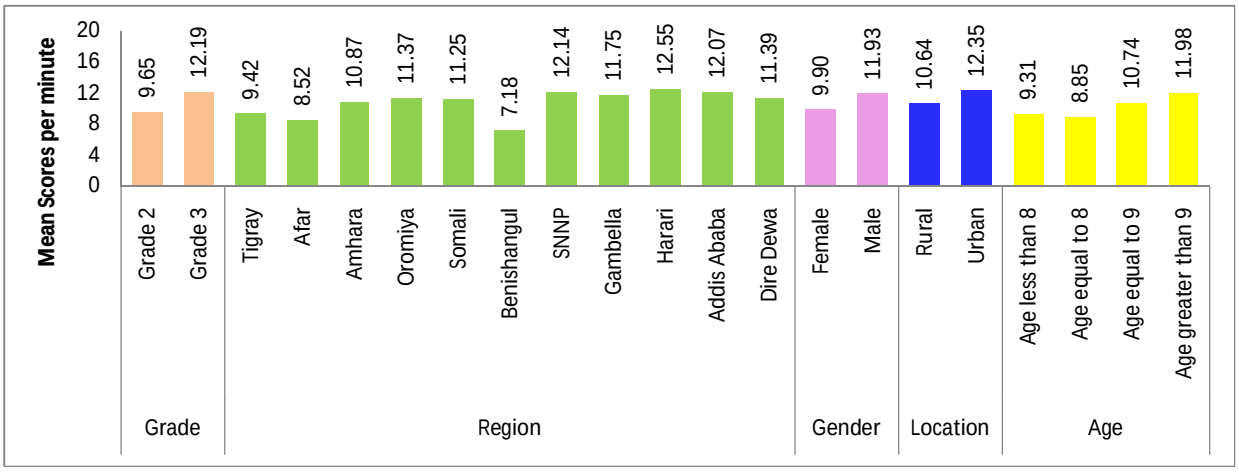
The one way ANOVA Tukey HSD homogeneity subset groupings of the regions shown in table 20 revealed that regions were grouped in to 7 homogeneity subsets. These result indicated that Benishangule Gumuz (52.34%) was performed the least, whereas Addis Ababa (82.58%) and Harari (85.31%) were highest performing region in the homogeneity subset groupings.

Table 20: Homogenous subset groupings of subtraction level 1 percent mean score by regions using One Way ANOVA (Tukey HSD method)

Region	N	Subset for alpha = 0.05						
		1	2	3	4	5	6	7
Benishangul Gumuz	915	52.34						
Afar	914		62.35					
Tigray	1312		66.11					
Oromiya	3657			71.53				
Amhara	2669			71.95				
SNNP	2096			73.92	73.92			
Gambella	870				77.59	77.59		
Dire Dewa	792				77.71	77.71		
Somali	926					79.56	79.56	
Addis Ababa	836						82.58	82.58
Harari	799							85.31
Sig.		1.000	.202	.826	.189	.945	.524	.680

Figure 36 also indicates that grade 2 students on average were able to answer 9.65 subtraction level 1 questions correctly in one minute, while the grade 3 students were able to answer 12.19subtraction level 1 questions correctly in one minute. By the same trend, urban (12.35) and male (11.93) students were able to answer questions significantly higher than rural (10.64) and female (9.90) students respectively. With regard to regions, students from Benishangul Gumuz score the lowest (7.18) whereas Gambella (11.75), Addis Ababa (12.07), SNNP (12.14) and Harari (12.55) were the highest score homogeneity subset groups.

Figure 36: Subtraction level 1 correct mean scores per minute (fluency) by grade, region, gender, location and age



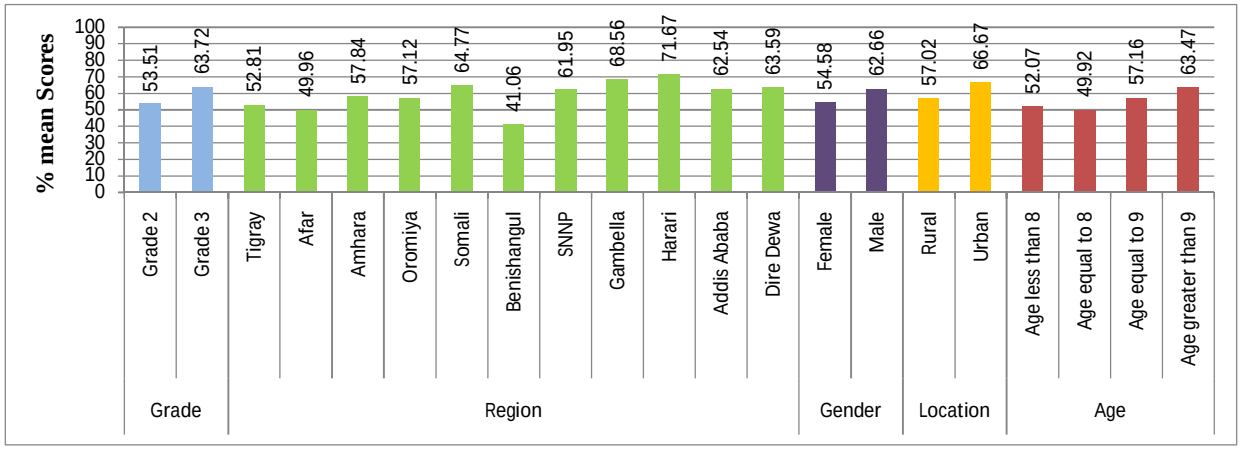
*All the differences were statistically significant at $p < .001$ level

iv. Subtraction level 2

The overall percent mean score for subtraction level 2 shown in table 4 above were found to be 58.64%. A marked decline in performance was observed on this task when compared with the addition level 1, addition level 2 and subtraction level 1 tasks.

The percent mean score result of this task across grade, region, gender, location and age was shown in figure 37. The percent mean score result of grade 3, male and urban students were significantly ($p < .001$) higher than grade 2, female and rural students respectively. Similarly, a One Way ANOVA indicated that there was a significant difference between the percent mean scores both in age and regions.

Figure 37: Subtraction level 2 percent mean scores by grade, region, gender, location and age



*All the differences were statistically significant at $p < .001$ level

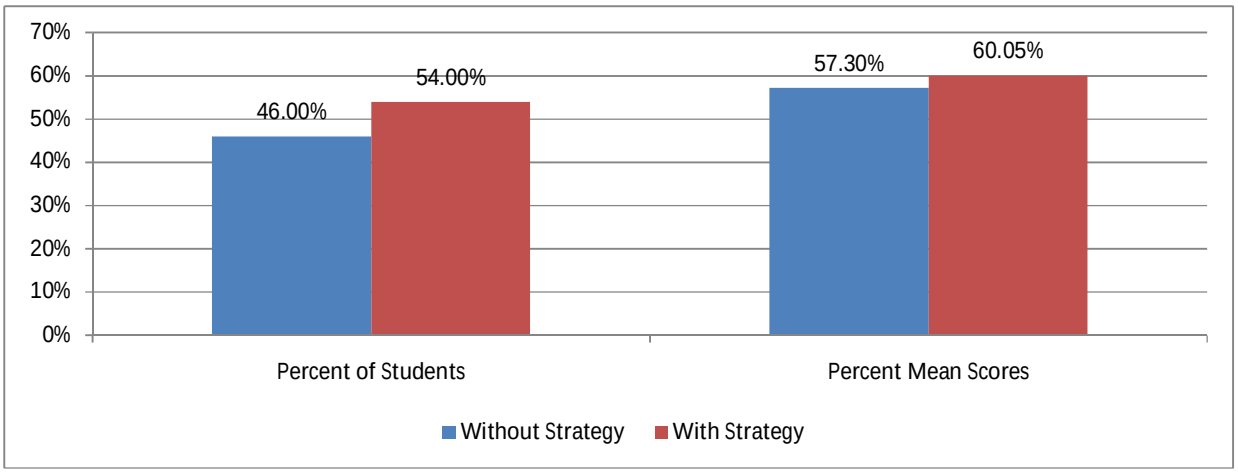
The homogeneity subset groupings of the regions shown in table 21 classify regions in to 8 homogeneity subsets using One Way ANOVA Tukey HSD method. These result indicated that Benishangul Gumuz (41.06%) was performed the least, whereas Gambella (68.56%) and Harari (71.67%) were highest performing region in the homogeneity subset groupings.

Table 21: Homogenous subset groupings of subtraction level 2 percent mean score by regions using One Way ANOVA (Tukey HSD method)

Region	N	Subset for alpha = 0.05							
		1	2	3	4	5	6	7	8
Benishangul Gumuz	905	41.06							
Afar	900		49.96						
Tigray	1311		52.81	52.81					
Oromiya	3640			57.12	57.12				
Amhara	2649				57.84	57.84			
SNNP	2068					61.95	61.95		
Addis Ababa	824						62.54		
Dire Dewa	788						63.59		
Somali	1020						64.77	64.77	
Gambella	870							68.56	68.56
Harari	786								71.67
Sig.		1.000	.655	.091	1.000	.132	.668	.225	.528

Like that of addition level 2, students in subtraction level 2 subtasks were given the opportunity to use counters or fingers or any other counting strategy. Then the results as shown in figure 38 revealed that 54% of students used counting strategies. The percent mean score result of students with counting strategy were 60.05%, which was significantly greater than those without counting strategy (57.30%) with t (13061.895) = 4.786, $p < .001$ (2-tailed).

Figure 38: Subtraction level 2 counting strategy



In conclusion, the analysis of student performance on the addition and subtraction tasks indicate that performance markedly declines as the items increased in complexity from level 1 to level 2 items. Moreover, performance on the subtraction items was well below that of the performance on the addition items.

4.3.8 Shape Recognition

The shape recognition subtask children were asked to identify the 4 types of shapes such as circle, triangle, rectangle and square which are mixed among other related shapes or figures. On average, students were able to correctly identify 79.94 percent of the shapes presented to them. While this average was much higher than for all the subtasks except one to one correspondence (89.17%), quantity discrimination (83.20%), addition level 1 (82.90%), it should be noted that the items in this subtask were supposed to have been mastered at an earlier grade level.

The percent mean score result of students for each shape recognition tasks was shown in figure 39 revealed that the maximum achievement scored were circle identification (88.50%) and

minimum in identifying square (69.71%) shapes. Relatively children perform better both in circle and triangle figures than the four side (rectangle and square) geometric shapes.

Figure 39: Percent mean score result by shapes

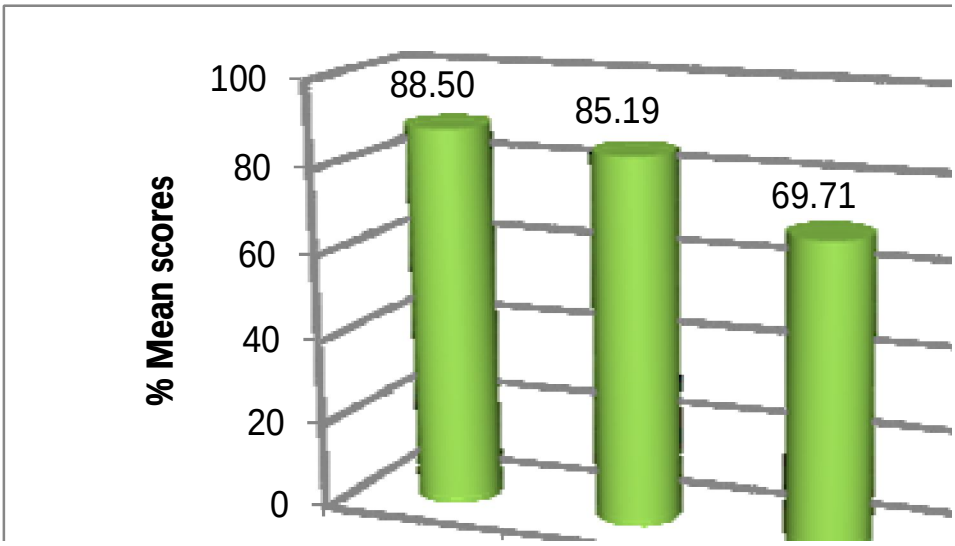
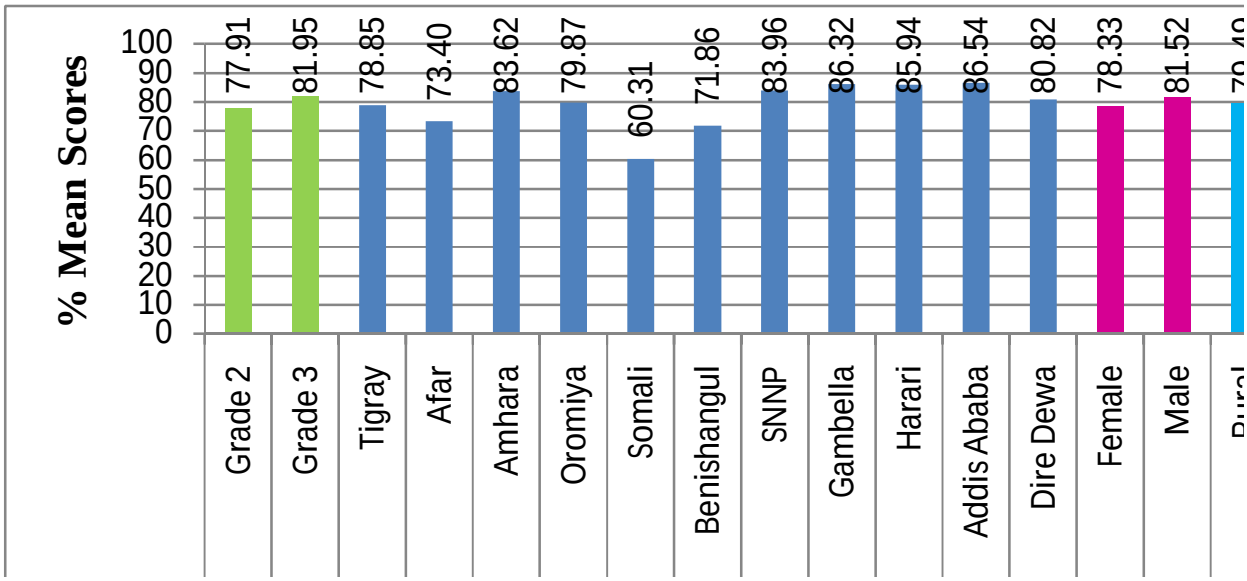


Figure 40 shows the overall percent mean score result across grade, region, gender, location and age in order to see whether achievement difference exists across each stratum's. There were statistically significant differences between all comparison groups. The percent mean score result of grade 3, male and urban students were significantly ($p < .001$) higher than grade 2, female and rural students respectively. And also a One Way ANOVA indicated that there was significant differences between the percent mean scores both in age and regions.

Figure 40: Shape recognition total correct percent mean scores by grade, region, gender, location and age



*All the differences were statistically significant at $p < .001$ level

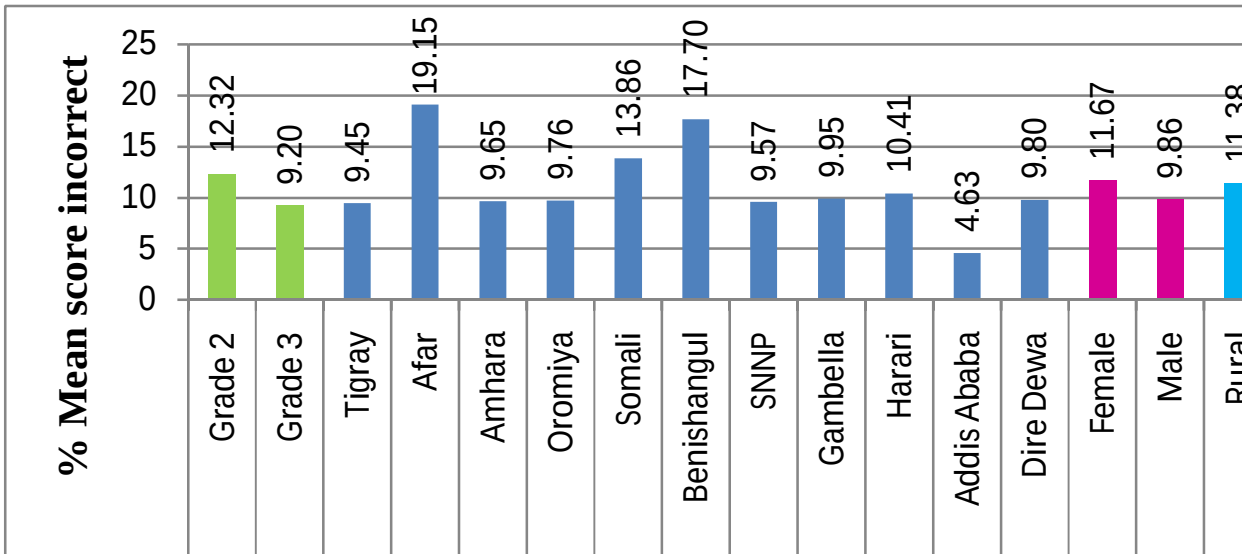
The homogeneity subset groupings of the regions shown in table 22 classify regions in to 8 homogeneity subsets using One Way ANOVA Tukey HSD method. These result indicated that Somali (60.31%) was performed the least; whereas Amhara (83.62%), SNNP (83.96%), Harari (85.94%), Gambella (86.32%) and Addis Ababa (86.54%) were highest performing regions in the homogeneity subset groupings. Comparatively all the regions perform better in this subtask next to quantity discrimination, addition level 1, number identification and word problem subtasks.

Table 22: Homogenous subset groupings of shape recognition percent mean score by regions using One Way ANOVA (Tukey HSD method)

Region	N	Subset for alpha = 0.05				
		1	2	3	4	5
Somali	1009	60.31				
Benishangul Gumuz	833		71.86			
Afar	903		73.40			
Tigray	1306			78.85		
Oromiya	3616			79.87		
Dire Dewa	760			80.82	80.82	
Amhara	2621				83.62	83.62
SNNP	2034				83.96	83.96
Harari	773					85.94
Gambella	867					86.32
Addis Ababa	825					86.54
Sig.		1.000	.925	.717	.087	.152

Moreover, children's were provided with other similar figures to identify the correct requested shape. The overall percent mean score result of incorrect shape recognition was 10.77. That means on average out of 100 alternative shapes given nearly 11 figures were incorrectly chosen. In other words, 10.77% of the shapes which are not circles, triangles, rectangles nor squares were chosen incorrectly as circle or triangle or rectangle or square. Figure 41 shows the incorrect shape recognition results across grade, region, gender, location and age.

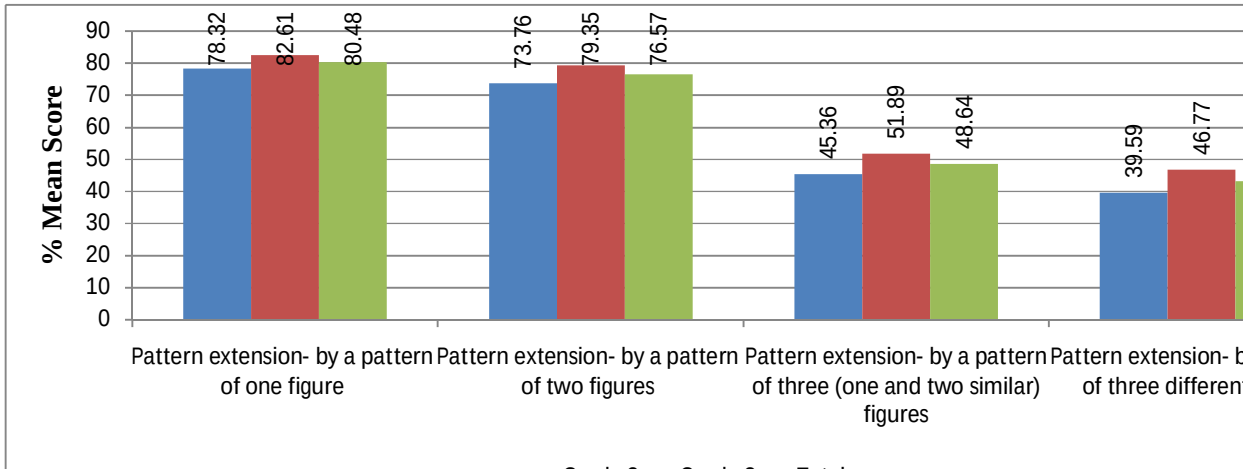
Figure 41: Shape recognition incorrect percent mean scores by grade, region, gender, location and age



4.3.9 Pattern Extension

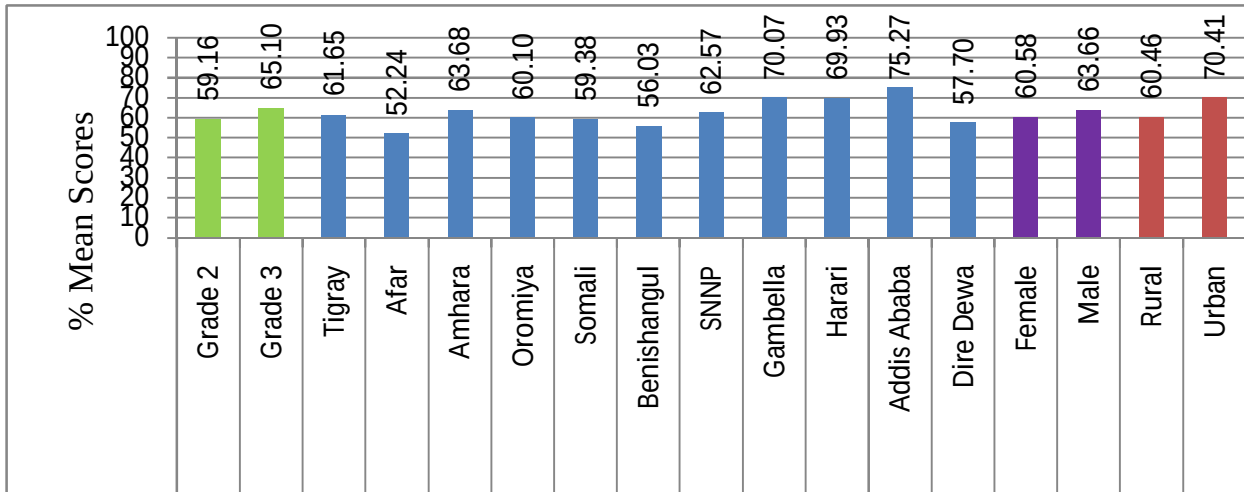
The pattern extension subtask has 4 items ranging from a pattern of single figure to three different figures. Students depending on the number of patterned figures were provided with two alternatives for a pattern of one figure, and three alternatives for a pattern of two and three figures. The percent mean score result of students by grade for each pattern extension task was shown in figure 42 showed that the performance markedly decreased as it goes from a pattern of one figure (80.48%) to a pattern of three different figures (43.19%). In all the pattern extension subtasks grade 3 perform better than grade 2.

Figure 42: Pattern extension percent mean score by item



The overall percent mean score result of pattern extension as presented in table 4 was 62.14%. These average percent mean score result as disaggregated by grade, region, gender; location and age shown in figure 43 revealed that the difference in all comparison groups were significant. The percent mean score result of grade 3, male and urban students were significantly ($p < .001$) higher than grade 2, female and rural students respectively. A One Way ANOVA also indicated that there were significant differences between the percent mean scores in age and regions.

Figure 43: Pattern extension percent mean score by grade, region, gender, location and age



*All the differences were statistically significant at $p < .001$ level

The homogeneity subset groupings of the regions shown in table 23 revealed that Afar (52.24%) and Benishangul Gumuz (56.03%) were the least performing regions; whereas Addis Ababa (75.27%) was the highest in the homogeneity subset groupings.

Table 23: Homogenous subset groupings of pattern extension percent mean score by regions using One Way ANOVA (Tukey HSD method)

Region	N	Subset for alpha = 0.05						
		1	2	3	4	5	6	7
Afar	916	52.24						
Benishangul Gumuz	916	56.03	56.03					
Dire Dewa	792		57.70	57.70				
Somali	1024		59.38	59.38	59.38			
Oromiya	3655			60.10	60.10	60.10		
Tigray	1316				61.65	61.65		
SNNP	2089				62.57	62.57		
Amhara	2670					63.68		
Harari	794						69.93	
Gambella	877						70.07	
Addis Ababa	838							75.27
Sig.		.055	.155	.637	.209	.093	1.000	1.000

4.4 Findings of Background variables

4.4.1 Student Related Variables

The study tried to identify different student related variables associated to their performance such as school shift, teacher feed backs and follow up, parental support, availability of text book, home language, preschool and student absenteeism. They are presented in detail as follows:

Time on assessment, School shift and Assessment order

It is researched EGMA tasks to be administered and accomplished with in 15 to 25 minutes for each individual. The result indicated both grade 2 and 3 students took 20 minutes on average to accomplish the task.

Besides, majority of them 85.7% ended the assessment task in the first round and the remaining in the second or third round. Table 24 shows the output of school shift and assessment order.

Table 24: Students assessment order

	Frequency	Valid Percent
1st test	13147	85.7
2nd test	1488	9.7
3rd test	699	4.6

Table 25 revealed that more percentage of students (88%) was attending school with shift or half day. The overall mean score result of full day students (77.23%) was significantly higher than school shifts/half day students (71.16) with t (5113.274) = -9.151, p< .001.

Table 25: School shift with EGMA overall mean score

	N	% of Total N	Mean	Median	Std. Deviation	Skewness
Schools with shift	13928	88.0%	71.16	75.27	19.52	-0.78
Schools with full day	1903	12.0%	77.23	81.67	17.13	-1.12
Total	15831	100.0%	71.89	76.00	19.35	-0.82

Students' related variables and EGMA overall percent mean score

The study posed nine questions to students focused on teacher feed backs and follow up, parental support, availability of text book, home language, preschool and student absenteeism. The responses of students to these variables together with the EGMA overall mean score were shown in figure 44. The students response on teachers ways of feedback when students perform well and unable to answer or incorrectly answer a question showed; 96.6% of them said their teacher provide positive feedback when they do well and 91.5 % of them responded their teacher continue without punishment when they unable to answer questions. This supports most teachers are in the right track in using feedbacks. When compared to EGMA overall percent mean score, students with positive feedback (72.34%) and continue without punishment (72.6%) scored higher mean than those with no feedback (61.23%) and continue with punishment (65.5%) respectively.

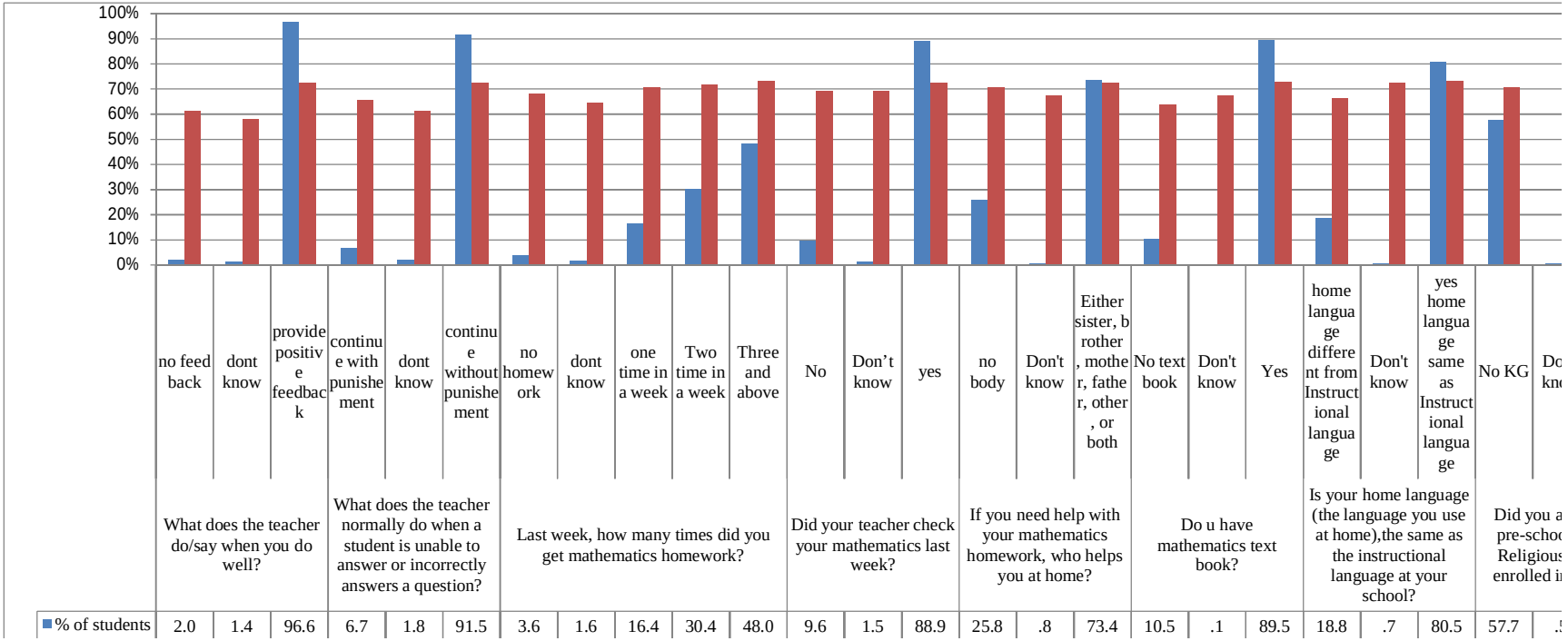
Related to homework, more percentage of students (48%) answered three and above to the frequency of homework's given last week than no home work (3.6%), don't know (1.6%),

onetime (16.4%) and two times in a week (30.4%). Similarly, high percentage of students (88.9%) answered 'yes' to the question whether their teacher check their homework last week or not. Students with their homework checked by teachers ('yes' respondents) also scored higher mean than the 'no' respondents. It is essential to follow up students work regularly to keep student progress continuous. Related to parental support, majority of the respondents (73.4%) reported that they had family support during their study. However, significant percentage of the respondents (25%) replied they had no family support. The EGMA percent mean score with family support (72.49 %) also showed they perform higher than the 'no' respondents (70.50 %). Parental supports during students study enhance their performance in school.

With regard to text book, students were asked whether they have mathematics text book or not and more percentage (89.5%) of them responded 'yes'. But still there were students (10%) who responded 'No'. Availability of mathematics text book is crucial for a child proper mathematics learning at their early stages of development. The EGMA overall percent mean score also revealed those with mathematics text book scored higher mean (72.49%) than the 'No' text book (63.7%) respondents. It is quite clear that availability of textbooks matter students learning and performance.

Moreover, students were also asked whether their home language and instructional language is similar or not. The study revealed large proportion of students (80.5%) answered their home language is similar to school instructional language. Likewise, the EGMA overall mean score of students with same home and instructional languages (73.26%) were significantly higher ($t(3907.682) = -16.264$, $p < .001$) than different home and instructional language (66.09%). Similarly, more percentage of students (55.7%) replied that they did not attend preschool. An independent sample test also indicated that the overall EGMA percent mean score result of preschool children (74.02%) were significantly higher ($t(14789.787) = -11.407$, $p < .001$) than those who didn't attend preschool (70.51%).

Figure 44: Students percentage response and EGMA overall mean score



Correlation between EGMA percent mean score and students related variables

Most of student related variables shown in table 26 had positive and significant correlation with their performance on EGMA overall mean score. Teacher feedback with r =.11, text book r = .15, and home language r =.14 showed relatively high positive significant correlation with student performance. But, student absenteeism had significant negative correlation r = -.17 with EGMA overall mean score implied that as absenteeism increases performance decreases and vice versa.

Table26: Correlation between EGMA overall mean score and students' related variables

Student Related Variables	Pearson Correlation	N	Sig. (2-tailed)
What does the teacher do/say when you do well?	.107**	15910	.000
What does the teacher normally do when a student is unable to answer or incorrectly answers a question?	.106**	15857	.000
Last week, how many times did you get mathematics homework?	.077**	15880	.000
Did your teacher check your mathematics last week?	.049**	14996	.000
If you need help with your mathematics homework, who helps you at home?	.046**	15720	.000
Do you have mathematics text book?	.146**	15676	.000
Is your home language (the language you use at home),the same as the instructional language at your school?	.144**	15534	.000
Did you attend any pre-school (KG or Religious) before enrolled in grade 1	.089**	15739	.000
For how many days were you absent from school Last week?	-.173**	15061	.000
Parental support and home environment	.091**	15526	.000
**. Correlation is significant at the 0.01 level (2-tailed).			

Multiple regression analysis of student related variables

To identify the contribution of student related variables on students' performance step wise regression was executed as shown in table 27. The final model showed that student absenteeism, text book, home language, teacher role and attending preschool explain 8 % of the variances on EGMA overall percent mean score.

Table 27: Multiple regression model summary based on variables related to students

Model Summary					
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**Change Statistics**
					R Square Change
1	.180[a]	.033	.033	19.03414	.033
2	.227[b]	.051	.051	18.84969	.019
3	.258[c]	.067	.067	18.69565	.016
4	.282[d]	.079	.079	18.56952	.013
5	.284[e]	.081	.080	18.55909	.001
a. Predictors: Student absenteeism					
b. Predictors: Student absenteeism, Text book					
c. Predictors: Student absenteeism, Text book, Home language					
d. Predictors: Student absenteeism, Text book, Home language, Teacher role					
e. Predictors: Student Absenteeism, Text book, Home language, Teacher role, Attending pre-school					

Looking at the first model which include only student absenteeism accounted 3.3% of the variance (Adjusted R square = .033). The inclusion of text book in to model 2 resulted in an additional 1.9% of the variance being explained (R^2change = .019). The final model which includes home language, teacher role and attending preschool resulted in an additional 2.9% of the variance explained and accounts a total of 8% the variance on EGMA overall mean score. Besides, Table 28 shows the model to explain the variance on EGMA over all was significant ($F_{(5,13351)} = 233.891$, $p < .001$).

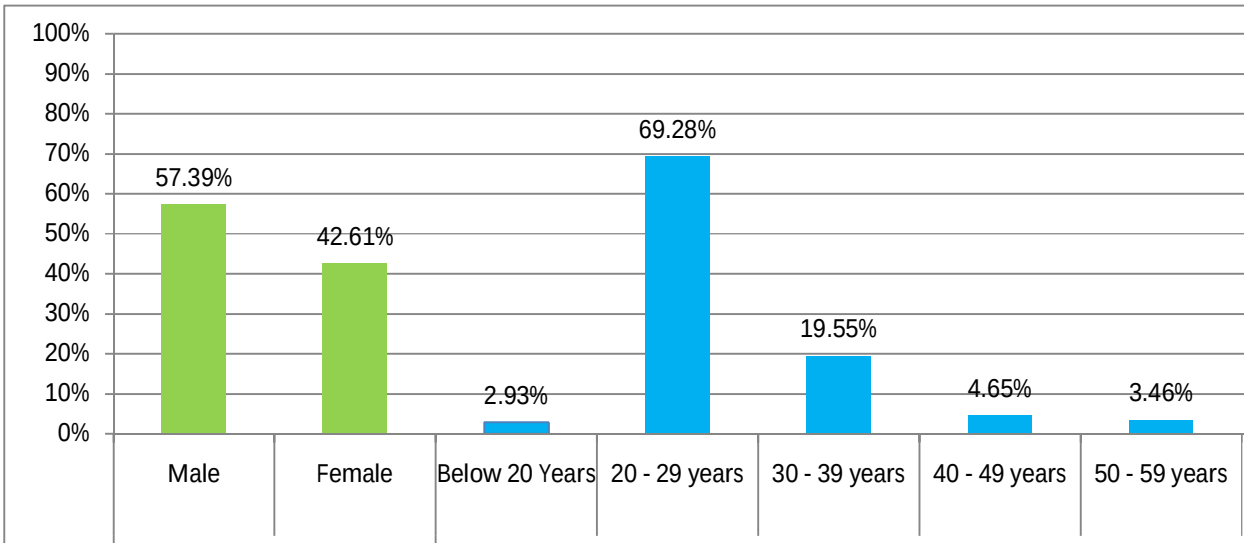
Table 28: Student variables model summary stepwise regression

ANOVA[a]						
Model		**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
	Regression	402806.350	5	80561.270	233.891	.000[f]
	Residual	4598613.844	13351	344.440		
	Total	5001420.193	13356			

4.4.2 Teacher Related Variables

To identify teacher related variable that have contribution to students' performance questionnaires were administered to 380 grade 2 and 377 grade 3 mathematics teachers. Figure 45 illustrates the background information of teachers participated in the study across gender and age range. It shows 57.4% and 42.6% of teachers were female and male respectively. More percentage of teachers (69.3%) was found in the age range 20 to 29 years.

Figure 45: Percentage of teachers' across gender and age range



Teacher responses to teacher related variables

Teachers were asked to respond to different kinds of factor related to them. Looking at figure 46, majority of the teachers 85 % participated in the study were teaching the class since the beginning of the school year.

Teacher qualification and training

Teacher qualification and training related questions were posed to teachers. The finding showed among the respondents most of the teacher 83% had trained teacher certificate. However, 14.8 % of them replied they had no teacher certificate. Similarly, more percentage of teachers (67.1%) and (55.9%) answered they received 'no' training to the question related to professional training in the year between 2004 E.C. and 2005 E.C. and mathematics teaching respectively.

Lesson plan

Preparing lesson plan is one of the pedagogy aspects of teaching learning process. Related to this factor, the record of teacher shows most of the teachers (96.6%) responded ‘yes’ to the question do they prepare mathematics lesson plan prior to class. But, still there were teachers (3.4%) who responded they do not prepare a lesson plan prior to class. Similarly, majority of the teachers (84.2%) prepare their mathematics lesson plan together with others.

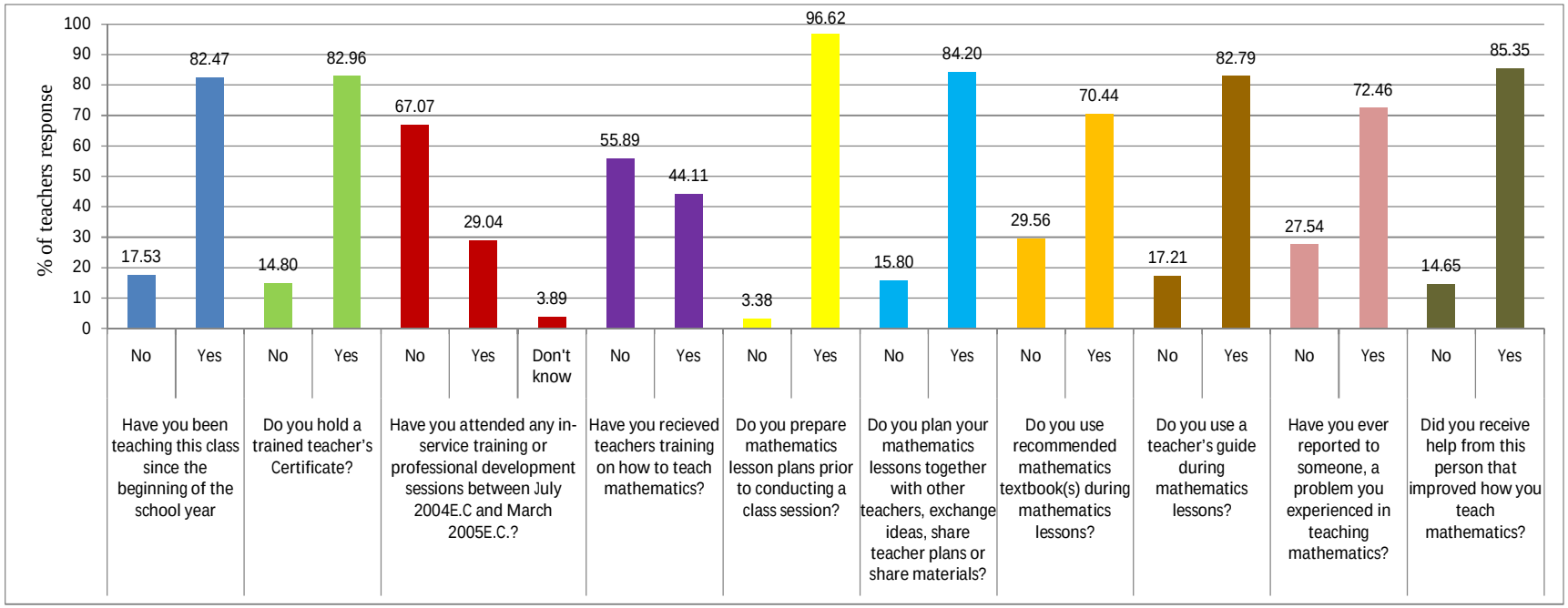
Instructional material

Teachers’ response related to usage of recommended mathematics books shows that majority of them (70.4%) and (82.8%) replied they were using recommended mathematics books and teachers guide during mathematics lesson respectively. However, there was also significant percentage of teacher (17.2%) who answered ‘no’ to the use of mathematics teachers’ guide.

Teacher interaction

The study identified most of the teachers (72.5%) had experience to share problem faced in teaching mathematics to someone else. Moreover, related to support from this person, majority of them (85.3 %) agree on ‘yes’ that they had got useful support from this person.

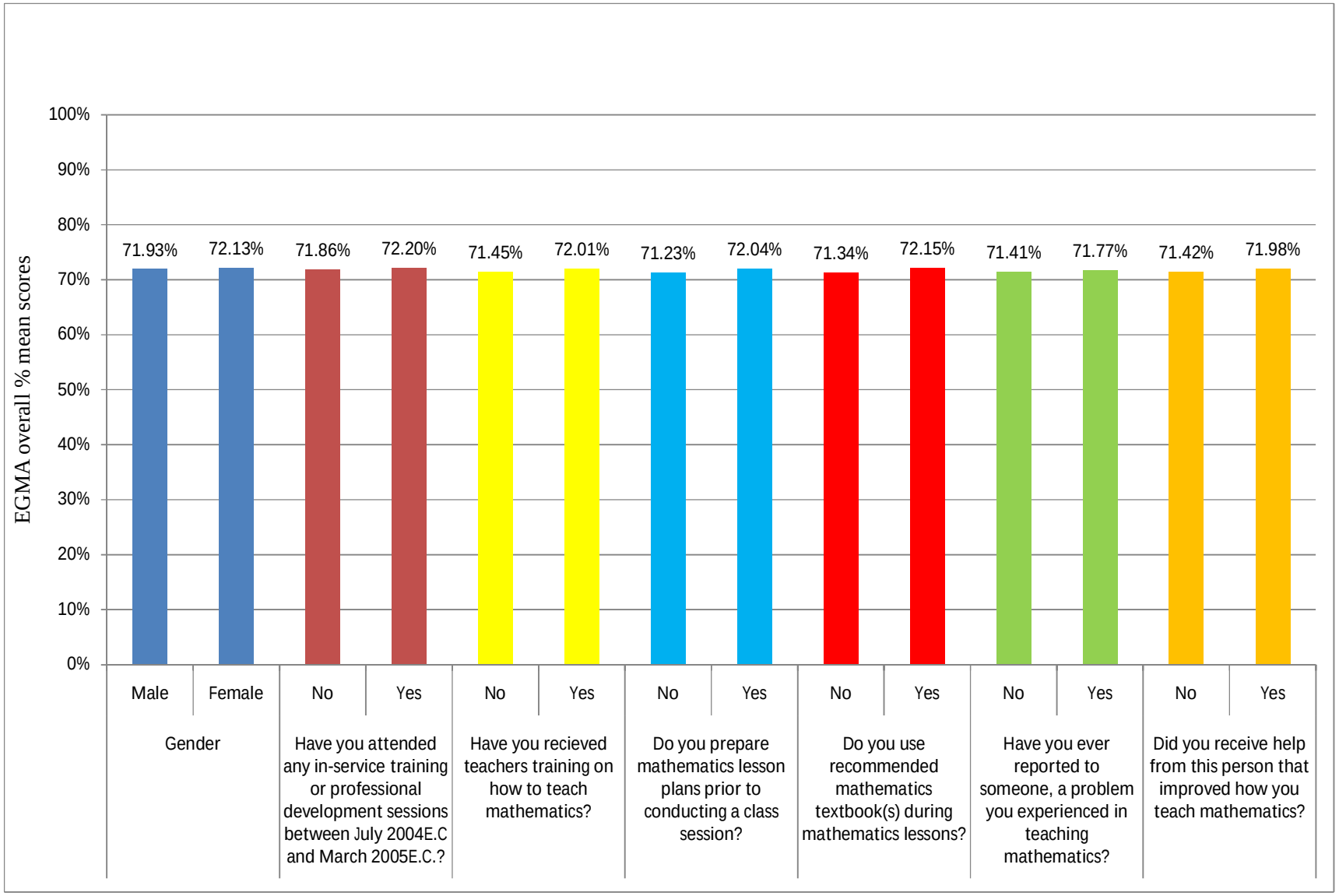
Figure 46: Percentages of responses on teacher related variables



Teachers response and student performance on EGMA overall

This section presents the comparison of student performance on EGMA overall with the different teacher variables as shown in figure 47. The overall percent mean score result of students who taught by female teachers (72.13%) was higher than those taught by male teachers (71.93%). Moreover, students who taught by teachers who received teacher training, prepare lesson plan prior to class, use recommended mathematics text book and teachers guide, and teacher who interact with others scored higher mean than the other students. However, all the differences are not significant except teachers' use of recommended mathematics text book.

Figure 47: Teacher response and EGMA overall percent mean score



Correlation between EGMA overall percent mean score and teacher related variables

Table 29 shows the correlation between teacher related variables and EGMA overall percent scores. The Pearson correlation executed on some teacher related variable showed positive and significant relationship with student performance on EGMA overall percent mean score. Teacher characteristics aggregated on teachers age, qualification and experience showed significant positive correlation r = .12 with EGMA overall mean scores. Teacher response to teacher training also showed significant correlation r = .05 with student performance. Moreover, teachers time spent on teaching mathematics had significant positive relationship r = .04 with student performance.

Table 29: Correlation between EGMA percent mean score and teacher related variables

Teacher related variables	Pearson Correlation	N	Sig. (2-tailed)
How many minutes do you spend teaching mathematics on the days you teach mathematics during the week?	.001	13430	.952
Do you prepare mathematics lesson plans prior to conducting a class session?	.008	14551	.361
Teacher characteristics (age, qualification and experience together)	.120**	12729	.000
Teacher Training (in service and methodology training)	.048*	1795	.043
Teacher use of instructional materials (text books and teacher guides)	.010	9518	.353
Teacher time spent on tasks	.038**	14269	.000
Teacher interaction with their peers	.020	9062	.058
**. Correlation is significant at the 0.01 level (2-tailed).			

Multiple regression analysis of teacher related variables

To identify the contribution of teacher related variable step wise regression was executed. The final model showed teacher characteristics, the time teacher spent on teaching mathematics, usage of instructional material and teacher interaction to others explains 10.5% of the variance on students' performance. Table 30 shows the contribution of teacher related variable to explain students' performance on EGMA overall.

Table 30: Teacher variables model summary stepwise regression

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change
1	.160[a]	.026	.024	18.16851	.026
2	.284[b]	.081	.079	17.65777	.055
3	.323[c]	.104	.101	17.44307	.023
4	.330[d]	.109	.105	17.40698	.005
a. Predictors: Teacher characteristics					
b. Predictors: Teacher characteristic, Teacher time on task					
c. Predictors: Teacher characteristic, Teacher time on task, Teacher instructional material					
d. Predictors: Teacher characteristic, Teacher time on task, Teacher instructional material, Teacher interaction					

Looking at the first model which include only teacher characteristics accounted 2.4% of the variance (Adjusted R square = .024). The inclusion of teacher time in to model 2 resulted in an additional 5.5% of the variance being explained (R^2 change = .055). The final model which includes teacher characteristics, teacher time on task, teacher instructional material and teacher interaction resulted in an additional 2.6% of the variance explained and accounts a total of 10.5% the variance on EGMA overall mean score. Besides, table 31 shows the model to explain the variance on EGMA over all was significant ($F_{(4,791)} = 24.201$, $p < .001$).

Table 31: ANOVA for the final model

Model		Sum of Squares	df	Mean Square	F	Sig.
4	Regression	29331.741	4	7332.935	24.201	.000[e]
	Residual	239675.434	791	303.003		
	Total	269007.175	795			

4.4.3 Principal Related Variables

The study designed an instrument for principals to identify principal related variables that has an impact on students learning. From 400 sampled schools 386 school principals were involved in the study. The result on the records of principals shown in Figure 48illustrates the percentage of female principals participated in the study were 10.96% and males were 89.04%. This indicates majority of schools principals were males. As it was planned, the information was gathered from 90.67% of principals, 6.67% deputy principals and 2.67% others. The record also indicates majority 39.25% of the principals had teacher's training diploma.

Figure 48: Percentage of principals' responses on principal characteristics

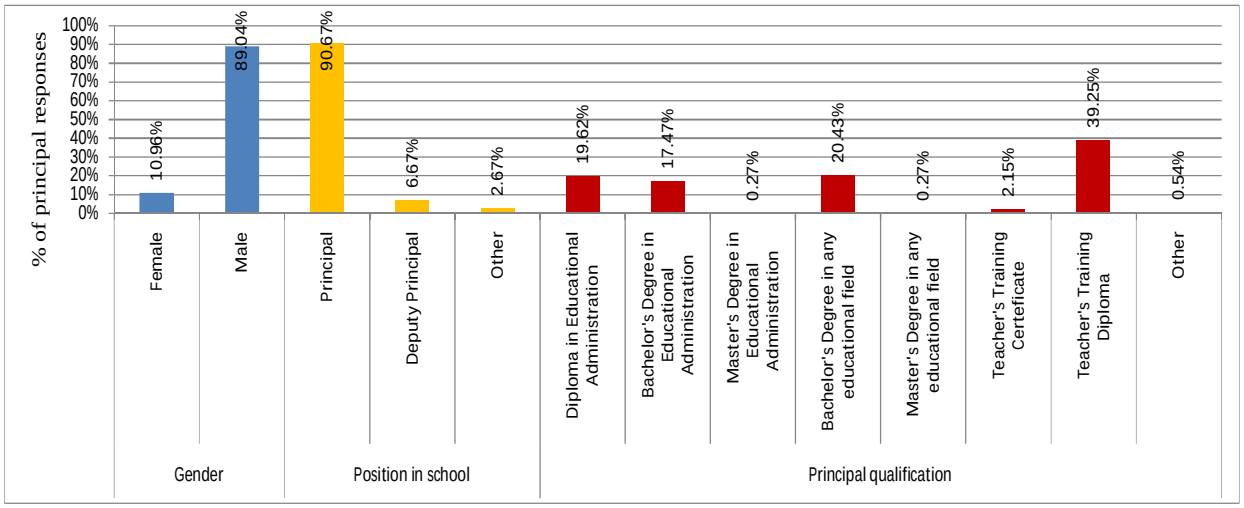


Figure 49 illustrates principals response related to school variables such as instructional language, principal training, instructional time, teaching aids, reading facilities and principals' support. The study revealed that the majority of principals (59.69%) replied 'yes' to the question related to in service training but there were also (40.31%) who respond 'no'. Similarly, more percentage of principals replied 'yes' in providing pedagogy help to teachers (83.88%) and mother tongue as instructional language (89.86%). Related to school calendar, 53.48% of the principal reported the school was closed in the regular school calendar. With respect to availability of mathematics teaching aids for the pupil and the teacher, majority of them 60.36% and 54.66% replied 'yes' respectively. But there were also significant percentage of principals 33.94% and 40.67% respectively who respond 'no'. Similarly, more percentage of principals 51.81% respond the school have a reading room with reading facilities. However, 46.1% of them replied the school has no reading room. It is quite clear that availability of reading room promote students learning.

Figure 49: Percentage of principals' responses on school related variables

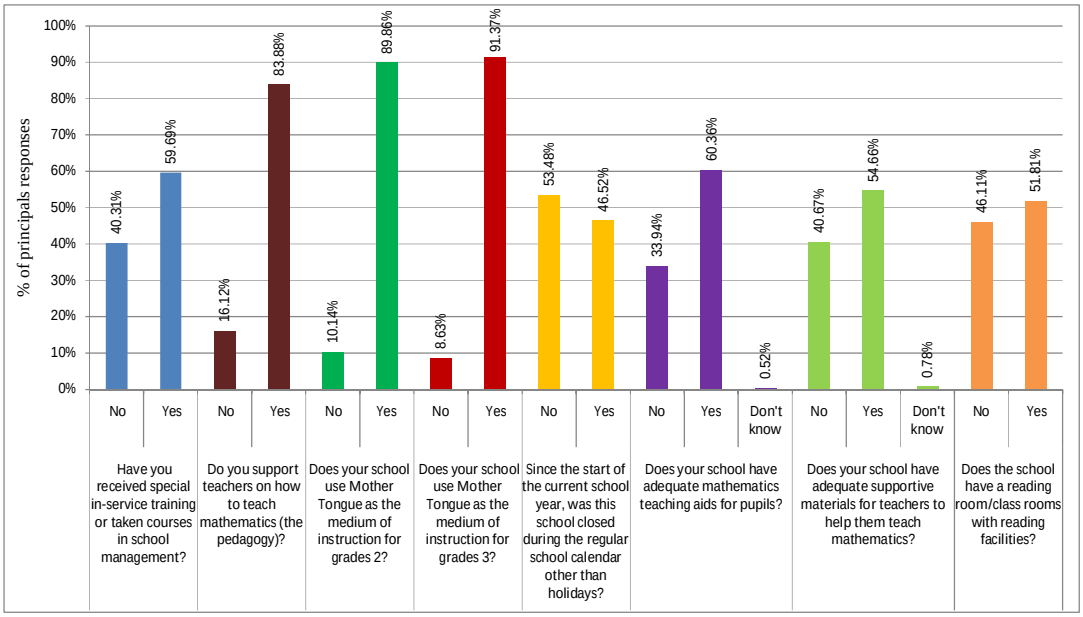


Figure 50 showed principals response to questions related to parent teacher association and proportion of mathematics text book to students. The findings showed that the majority of them responded teacher parent association (PTA) meet once in a semester (61.7%) and have a decision making authority on the different issues listed there (51.7%). Related to availability of mathematics text book, most of them replied the proportion of mathematics text book to students' ratio was 1 to 1 in grade 2 (74.18%) and grade 3 (73.50%). Though the percentage was low, 1.09% in grade 2 and 0.28% in grade 3 principals responded there are students with no books.

Figure 50: Percentage of principals' responses on PTA support and text book ratio

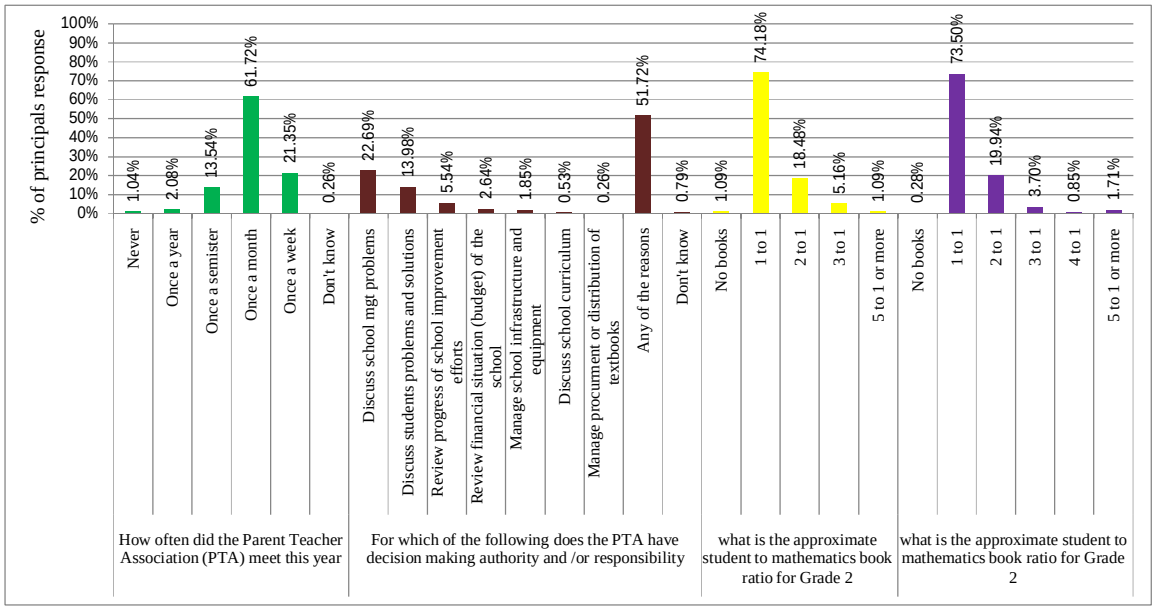


Figure 51 indicates majority of the principals (49.73%) reported that head teacher/principal was responsible for reviewing lesson plans and it was reviewed every week (76.82%). Related to class room observation, more percentage of principals (44.89%) replied head teacher/principal was responsible for observing teachers in their class room and it was conducted four or more times in a semester (44.63%). According to the principals' response, majority of them (44.63%) knew the progress of students using class room observation. Similarly, majority of the principals (49.74 %) responded the most common reason for teachers absenteeism were illness. There were also a response work other jobs (3.89%) and lack of motivation (5.96%) as another reason for teacher absenteeism.

Figure 51: Percentage of responses on principals' instructional support

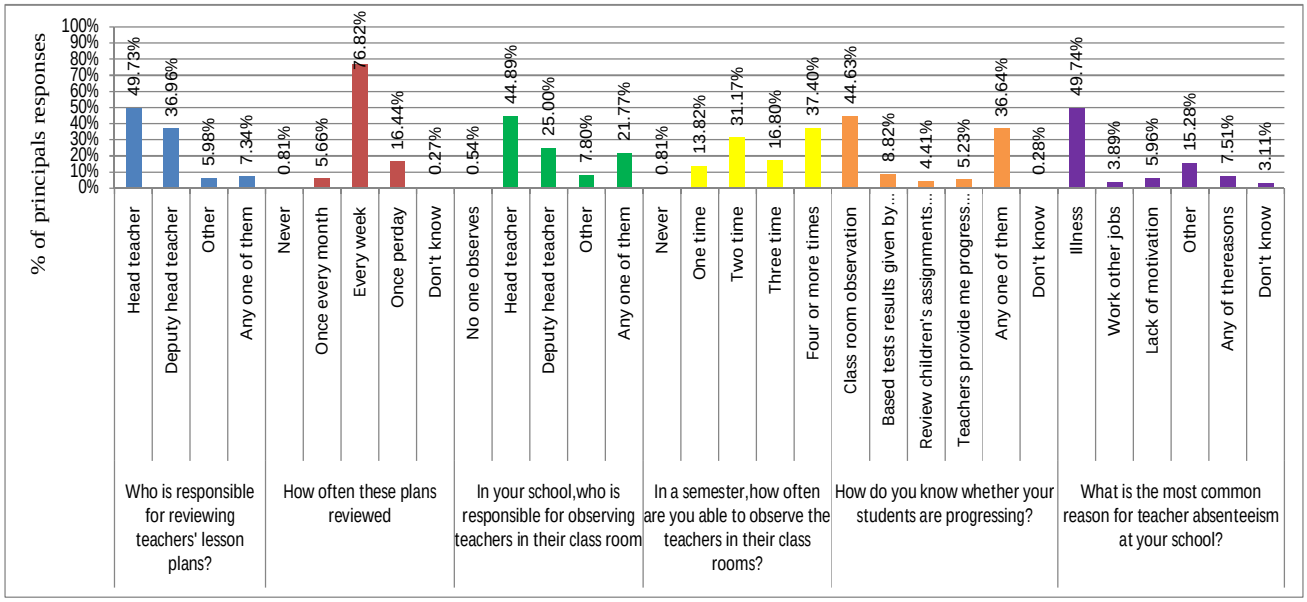
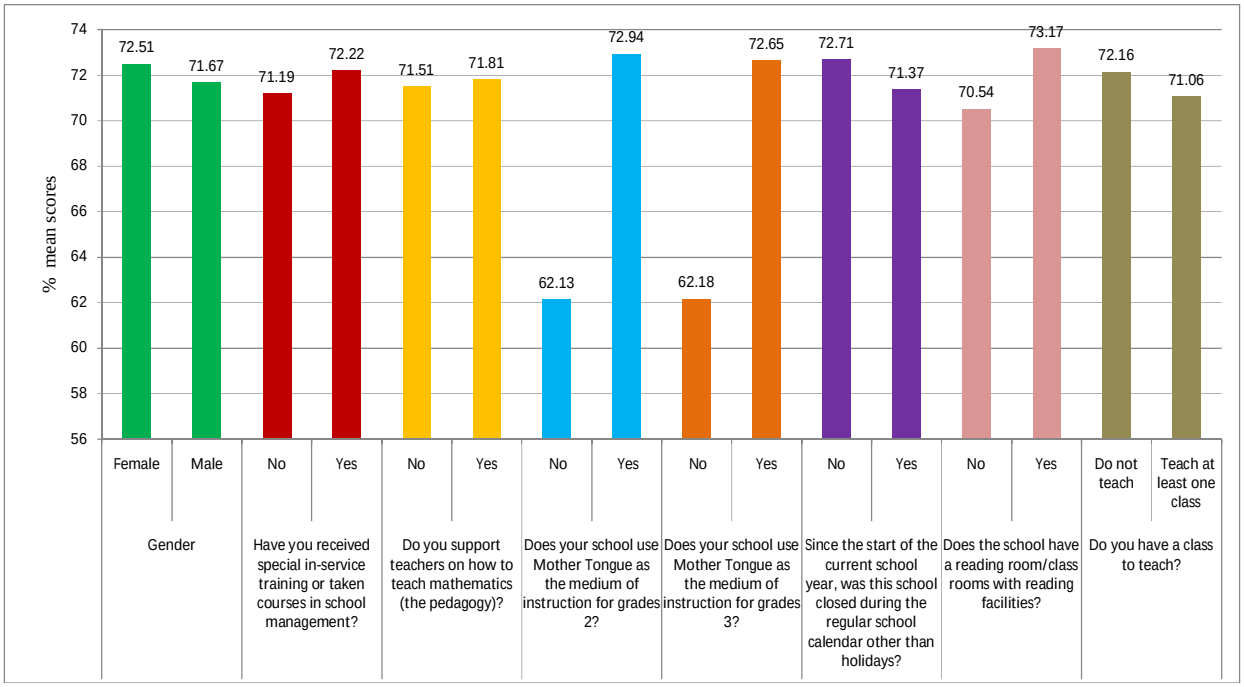


Figure 52 illustrates principal response and EGMA overall percent mean scores. The finding showed that students of female principal perform higher mean (72.51%) than students of male principal (71.67%). This result was similar to female and male teachers. Related to in service training and help teachers in pedagogy, students of principal who answered 'yes' scored higher mean than the 'no' respondents. Similarly, schools that use mother tongue as instructional language scored higher mean than the 'no' respondents. Moreover, schools that were not closed in regular day, have reading room and principal with no class showed higher mean score than the 'no' respondents respectively. All these mean differences except principal gender and support in pedagogy were statistically significant.

Figure 52: EGMA Overall mean score across principals' related variables



Correlations between principal related variables and EGMA overall percent mean score

This section deals with the correlation between some principal related variables and EGMA overall percent mean scores. Some of the variables showed positive significant correlation with EGMA overall mean score were principal experience r = .02, principal qualification r = .02, receiving training in school management r = .03 and proportion of mathematics text book to students in grade 2 r = .05 and in grade 3 r = .05. On the other hand, teaching a class r = -.03, student absenteeism in grade 2 r = -.10, student absenteeism in grade 3 r = -.10 showed significant negative correlation with students performance (table 32). These negative correlations indicate that as the principals' engagement in teaching a class and student absenteeism increases performance decreases and vice versa.

Table 32: Correlation between principals' related variables and EGMA overall percent mean score

Principal Related variable	Pearson Correlation	N	Sig. (2-tailed)	
Experience as principal in the school	.022**	14132	.010	
Highest level of professional qualification?	.023**	14766	.005	
Do you teach a class?	-.026**	14207	.002	
Receiving training in school management?	.026**	15170	.001	
Number of students absent from school last week in Grade 2?	-.098**	10458	.000	
Number of students absent from school last week in Grade 3?	-.098**	10458	.000	
What is the approximate student to mathematics book ratio for Grade 2?	.050**	14606	.000	
What is the approximate student to mathematics book ratio for Grade 3	.050**	14606	.000	
How often did the Parent Teacher Association (PTA) meet this year?	.049**	15246	.000	
How often teacher less plan reviewed?	.016*	14726	.047	
**. Correlation is significant at the 0.01 level (2-tailed).				

Multiple regression analysis of principal related variables

To identify the contribution of principal related variable step wise regression was executed. The final model showed student absenteeism, principal training, principal support and leadership and mathematics text book ratio to students explains 2.9% the variance on students' performance. Table 33: shows the contribution of principal related variables to explain students' performance on EGMA over all.

Table 33: Multiple regression model summary based on variables related to principals

Model Summary					
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**R Square Change**
1	.133[a]	.018	.018	18.28957	.018
2	.163[b]	.027	.026	18.20958	.009
3	.169[c]	.029	.028	18.19233	.002
4	.172[d]	.030	.029	18.18345	.001
a. Predictors: Student absenteeism					
b. Predictors: Student absenteeism , Principal training					
c. Predictors: Student absenteeism , Principal training, principal support and leadership					
d. Predictors: Student absenteeism , Principal training, principal support and leadership ,Mathematics text book student ratio					

Looking at the first model which include only student absenteeism accounted 1.8% (Adjusted R square = .018). The inclusion of principal training in to model 2 resulted in an additional 0.9% of the variance being explained (R^2 change = .009). The final model which includes student absenteeism, principal training, principal support and leadership and mathematics text book student ratio resulted in an additional 0.3% of the variance explained and accounts a total of 2.9% the variance on EGMA overall percent mean score. Besides, Table 34 showed the model to explain the variance on EGMA over all was significant ($F_{(4, 4713)} = 36.084$, $p < .001$).

Table 34: Principal variables model summary stepwise regression

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	47722.856	4	11930.714	36.084	.000[e]
	Residual	1558296.191	4713	330.638		
	Total	1606019.047	4717			

4.5 Variance Partitioning

The intra-class correlation commonly referred to as roh (rate of homogeneity) was calculated to estimate the variance component for EGMA overall percent mean score. Taking the overall mean score as dependent variable and the school as random factor the variance component analysis resulted in an intra-class correlation (roh) of .288. This means 28.8% of the variations in the overall mean score were due to variations that come from the schools. On the other hand, when region is taken as random factor the variance component analysis resulted in an intra-class correlation of .066. This means 6.6% of the variations in the overall mean score was due to variations that come from regions.

5. Conclusion and Recommendation

5.1 Conclusion

The aim of this study was to measure how early grade mathematics skills were acquired among grade 2 and grade 3 students in all regions of Ethiopia. The study also sought to identify student, teacher and principal factors that were related to student performance.

In the study 7953 grade 2 and 8009 grade 3 students were participated following a stratified two stage cluster sampling. There were also 757 teacher and 386 principals involved in the study. The data were collected using instrument constructed for students, teachers and principals. The instrument for students contained background information, interview items and 9 student tasks. The tasks were oral counting, one to one correspondence, number identification, missing number, word problem, addition level 1, addition level 2,subtraction level1, subtraction level2, shape recognition and pattern extension. Oral counting, one to one correspondence, number identification, addition level 1 and subtraction level 1were timed. To analyze the data captured through the instruments both descriptive and inferential statistics were used.

The findings of the study indicated that students average performance in each subtask were more than 50% except in missing number with mean of 48.15%. The maximum score was in one to one correspondence 89.17% and the minimum score was in missing number 48.15%. And, the overall mean score was 71.92 %. Similarly, the result of fluency pointed out that student can count 85.33 number per minute which was the highest score and can subtract 10.92 subtraction level 1 subtasks per minute was the lowest score compared to other fluency sub tasks. Across EGMA overall subtasks, there were fair distribution of zero scores most markedly in missing number (7.1%), addition level 2 (7.10%), subtraction level 1 (8.7 %) and subtraction level 2 (12.30%) of students were unable to respond to a single item. In general, an overall result across subtasks indicated students performed better in most of the subtasks. The level of these performances could be promising to the education sector. However, there are some sub tasks such as missing number and subtraction level 2 (accuracy subtasks); number identification, addition level 1 and subtraction level 1 (fluency) where significant number of students were struggled with.

The performance of students across grade level showed that grade 3 perform significantly higher mean than Grade 2 students both in accuracy and fluency. This result was also similar to gender in favor of male students except in one tone correspondence fluency. Across location, the result both in accuracy and fluency was significantly different in favor of urban schools. The mean difference between region and age was also significantly different.

The analysis of factors related to students showed that in some of the variables student performance were significantly different. A student with full day schooling perform significantly higher mean than school shift/half day students; students with positive feedback significantly score higher mean than no feedback students; students who had teacher follow up in home work performed significantly higher mean than a student who had no follow up; a student who had mathematics text book scored significantly higher mean score than a student who had no text book; student whose home language and instructional language was same performed significantly higher mean score than whose home and instructional language different; student who attended preschool performed significantly higher mean score than who attended no preschool. Some of the variables which had significant positive correlation with students performance were teacher feedback, frequency of homework a student had in a week, teacher follow up of homework, availability of mathematics text book, same home and instructional language, and attending preschool. And, a step wise multiple regression showed that a student related factors which were student absenteeism, availability of mathematics text book, home and instructional language, teacher role and attending preschool explained 8% of the variance in their performance.

The result on teachers related variables indicated that majority of the teacher involved in the study hold trained teachers certificate, prepare lesson plan, exchange ideas with their colleagues to prepare lesson plan, use recommended mathematics text books, use teachers guide and report a problem faced in teaching mathematics to someone else. However, more percentage of teachers had not taken in service training in the year between 2004 and 2005 E.C and had not taken how to teach mathematics. There were also significant percentages of teachers who had no teachers' certificate (14.8%), did not prepare lesson plan prior to class (3.38%), did not use teachers' guide (17.21%). Some of teacher related variables which had significant positive correlation with student performance were teachers' characteristics, teacher training and a time spent on teaching

mathematics. The stepwise multiple regressions showed that teacher characteristics, teacher time spent on tasks, teacher instructional material usage and teacher interaction with other could explain 10.5% the variance on student performance.

The record from principals indicated that more percentage 39.25% of them holds teachers training diploma and some 19.62% of them hold diploma in education. Majority of the principals agreed that they took special in service training in school management, support teachers in pedagogy, the school used mother tongue as medium of instruction, not closed in regular school calendar, had adequate mathematics teaching aids for pupils and teachers, and had reading room with facilities. Similarly, majority of them provided that PTA meets once in a month, made decision in many of school related factors and the approximate ratio of text book to student were 1 to 1. Most of them also said that the principal was responsible for reviewing teacher's lesson plans and it was reviewed every week, principal was responsible for classroom observation and it was the method to know students' progress and reported the most common reason for teacher absenteeism was illness.

5.2 Recommendation

Based on the findings of EGMA the following recommendations are made:

- The result of EGMA indicates that there are significant differences in the performance of students between male and female, urban and rural, and regions. Female and rural students' were performing lower than male and urban students respectively. Some regions like Benishangul Gumuz and Afar were less performing in EGMA overall percent mean score compared to other regions. Hence, it is suggested that teachers, educational experts and policy makers intervene to close these gaps through different affirmative mechanisms such as resource allocation, continuous teacher training, supervision and inspection.

- The students in both grade 2 and 3 had great difficulty with the missing number task compared to other tasks. It appears likely that they receive little instruction in school in counting in the number patterns especially backward counting, although it is included in the curriculum. This could make it difficult for them to master multiplication and other more complex problem-solving tasks later on. Competency in this area could be

improved by providing opportunities for students to practice counting in steps other than one (counting by twos, fives, and tens, counting backwards, etc.), and by ensuring that this is not done only in a rote manner.

- The results also indicated that a significant percentage of students struggle with addition level 2 and subtraction level 2 tasks. It is likely that students receive little instruction on conceptual understanding of addition and subtraction, although number and operation up to 1,000 in grade 2 and 10,000 in grade 3 is included in the curriculum. Thus, teachers could center their teaching approach in the way that children master the foundational skills of addition and subtraction. Children should master the counting strategies at early stages. It is better to assure that teachers focus attention to understanding, reasoning and application, offering opportunity for students to practice calculations in developing learning and understanding, and experience mathematics as a meaningful, sense-making, problem-solving activity rather than memorization of facts, rules, formulas and procedures.

- The study also revealed that student, teacher and principal related variables significantly contributed to variances in the performance of students. The following are some important recommendations from the results of background variables:

    - Students attended in school shift were performed significantly lower than full day. Hence, it is better if regions and schools change their schooling time in to full day. It enhances the instructional time (total school hours) spent on teaching and learning.

    - The performances of students attended in preschool education were significantly higher than those who didn't attend. Then it is better if schools expand/open a preschool class in each school.

    - Children with same home and instructional language also perform better than those do not have same home and instructional language. Though the Ethiopian education policy is for granted in expanding primary education with medium of instruction with mother tongue, a significant number of children were attending their school with their second language/not with mother tongue/. Hence, policy

makers and regional Bureaus could exert much in expanding education for all children with their mother tongue as to the standard.

- ☞ The findings also showed that instructional materials such as text book, mathematics reference books and reading room with facilities had significant contributions for students' performance. Although the result to these variables showed encouraging, a significant number of students and teachers had no adequate teaching and learning aid facilities. Unless students gain the basic mathematics skills in the early grades and are given ample opportunity to practice, they will fall farther and farther behind in school in the later years. Mathematics textbooks and supplemental materials that children can take home to practice are important for children's learning. Hence, the MoE, region, zone and woreda education Bureaus, parent-teacher associations, community members, religious organizations, nongovernmental organizations, the private sector and schools should work together to ensure that all students have text books in school and are allowed to take texts home. Establishing 'classroom book boxes' and community library are examples of what could be done further.

- ☞ In service training of principals and teachers follow up and continuous feedback had significant contributions on students' performance. In response to these findings, continuous capacity building mechanisms such as in service trainings and short term school based trainings could be improved. Professional developments shall be designed in specific instructional strategies and methods focused on mathematics (both pre and in-service training on numeracy instruction) focusing attention on how children are getting the basics, and develop conceptual understanding, adaptive reasoning, and strategic competence (e.g., frequent or daily opportunities to count concrete objects with counters). Efforts to review teacher training strategies employed in both pre and in-service training should take in to considerations based on international researches which match specific teaching strategies to specific stages in children's mathematical concept development /foundational skills. Furthermore, whenever and wherever possible,

teachers placed in the lower primary classrooms should be the one who is competent enough in mathematics.

- ☞ The study also showed that family support had significant contributions on students' performance. Parental and community supports during students study enhance their performance in school. Hence, parents and communities should work closely with teachers and schools to develop and implement programmes to support children's learning at home and in the community. Organizing community - level parent advocacy groups focusing specifically on supporting early grade learning in mathematics; encourage regular school attendance by all children; strongly encourage parents to visit schools often, meet with teachers and discuss how they can help their child at home. The study has shown that student and teacher absenteeism has a negative impact on performance. It has also shown that the availability of textbooks and other resources has a significant impact on performance. Parents and communities need to understand why these issues are important to learning, and to understand the role that they can play in supporting their children's attendance, monitoring teacher absenteeism, and advocating for better resource provision at their schools.

- The study has shown that student absenteeism had negative correlation with students' performance. The study has also shown that pupils who are doing more homework in a week and have a teacher follow up are performing better. Therefore it is important that teachers, educational experts and leaders in each stage should regard the monitoring of these issues as important parts of their work.

- Reviewing text books and other reading materials used in classrooms for appropriateness, materials should be based on a logical scope and sequence and should start simple and get more complicated, paying as much attention to what is taught as to how it is taught. They should improve student learning with conceptual understanding, reasoning and problem solving activity rather than memorization of facts, rules, formulas and procedures. It is also better if the current policies affecting early grade numeracy– such as class size, length of school day and teacher preparation to be reviewed for enhancing student learning.

- The instruments are adapted and developed based on research findings that they measure the basic foundational skills in mathematics. Hence, by adapting these tools regions and classroom teachers may use them to monitor students' progress and their school improvements in general.
- Researchers, assessment experts, regions, government and nongovernment organizations and others are encouraged to conduct their own studies on students learning in early grade mathematics at different levels such as classroom, school, sub city, zone, woreda, and region level to address the issue more widely and provide intervention according to the gap existed in each level.

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APPENDICES

Appendix-A: EGMA Scores by Region

Tigray

Task	Grade 2			Grade 3		
	Female	male	Total	female	Male	Total
Accuracy						
1 to 1 corresp	84.65	86.22	85.43	90.42	93.08	91.72
Num Id	53.69	58.59	56.13	72.47	79.33	75.83
Quant Disc	74.94	80.70	77.80	85.10	89.66	87.34
Miss Num	31.87	35.88	33.87	41.92	50.37	46.07
word Prob	61.45	63.07	62.25	70.96	76.09	73.48
Add L1	68.08	77.04	72.56	81.49	86.49	83.94
Add L2	57.71	65.26	61.47	68.67	76.23	72.39
Sub L1	56.80	64.82	60.78	64.89	78.23	71.45
SubL 2	43.22	50.86	47.03	52.90	64.52	58.60
Shape Reco	74.89	78.40	76.64	79.94	82.24	81.06
Patt Ext	58.23	59.60	58.92	61.94	66.93	64.38
EGMA Overall	60.51	65.43	62.95	70.01	76.57	73.22
Fluency						
Oral Count	77.13	81.65	79.37	82.93	87.65	85.25
1 to 1 Corresp	83.20	86.90	84.96	88.08	87.95	88.02
Num Id	18.11	19.28	18.69	25.60	29.34	27.43
Add L1	9.56	11.67	10.61	14.79	16.24	15.50
Sub L1	7.30	8.47	7.88	9.34	12.62	10.96

Afar

	Grade 2			Grade 3		
	Female	Male	Total	Female	Male	Total
Accuracy						
1 to 1 corresp	66.50	84.07	74.68	74.94	81.39	77.90
Num Id	46.03	58.22	51.64	65.62	65.20	65.43
Quant Disc	60.73	77.90	68.62	77.65	84.03	80.59
Miss Num	32.97	51.24	41.38	50.53	57.50	53.75
word Prob	48.58	63.69	55.53	63.21	71.09	66.85
Add L1	57.28	74.95	65.42	78.29	86.32	82.01
Add L2	41.38	61.65	50.74	62.19	74.53	67.89
Sub L1	45.89	67.10	55.66	61.18	78.11	69.04
SubL 2	33.97	53.16	42.79	50.66	64.50	57.07
Shape Reco	66.08	80.05	72.52	72.58	76.19	74.23
Patt Ext	46.96	50.95	48.80	53.05	58.61	55.62
EGMA Overall	49.43	65.46	56.79	64.44	72.44	68.14
Fluency						
Oral Count	74.88	76.27	75.54	76.18	82.89	79.29
1 to 1 Corresp	69.29	81.70	75.61	69.55	76.52	72.76
Num Id	16.36	21.02	18.51	24.56	23.95	24.28
Add L1	7.76	10.69	9.13	11.73	14.52	13.01
Sub L1	6.06	8.37	7.15	8.10	11.84	9.84

Amhara

	Grade 2			Grade 3		
	Female	Male	Total	Female	Male	Total
Accuracy						
1 to 1 corresp	91.13	92.17	91.64	94.76	95.34	95.04
Num Id	68.72	68.67	68.70	83.38	84.29	83.82
Quant Disc	75.99	81.94	78.93	87.28	89.88	88.54
Miss Num	36.45	43.07	39.72	45.41	54.46	49.81
word Prob	65.66	73.90	69.72	77.03	83.00	79.93
Add L1	76.39	80.85	78.59	89.22	90.83	90.00
Add L2	64.17	69.05	66.57	78.47	81.36	79.87
Sub L1	62.16	69.79	65.93	73.88	82.30	77.96
SubL 2	48.64	55.35	51.95	58.40	69.27	63.67
Shape Reco	78.77	81.88	80.29	86.33	87.57	86.92
Patt Ext	58.63	61.49	60.04	66.04	68.64	67.30
EGMA Overall	66.02	70.70	68.33	76.32	80.58	78.38
Fluency						
Oral Count	97.60	100.77	99.16	102.51	104.55	103.49
1 to 1 Corresp	89.60	89.51	89.56	89.22	92.13	90.59
Num Id	24.65	25.07	24.86	32.59	33.41	32.99
Add L1	12.00	13.12	12.55	16.08	17.95	16.99
Sub L1	8.63	10.08	9.35	11.06	13.78	12.38

Oromiya

	Grade 2			Grade 3		
	Female	Male	Total	Female	Male	Total
Accuracy						
1 to 1 corresp	90.11	91.43	90.77	94.58	95.49	95.03
Num Id	65.69	64.46	65.07	77.93	79.31	78.62
Quant Disc	79.15	83.63	81.41	86.95	90.13	88.53
Miss Num	34.60	43.19	38.92	45.70	59.36	52.53
word Prob	66.65	73.37	70.05	74.75	80.67	77.70
Add L1	75.63	82.23	78.95	84.85	89.36	87.10
Add L2	60.93	69.21	65.08	72.10	79.60	75.84
Sub L1	61.95	71.09	66.55	71.89	81.26	76.57
SubL 2	46.72	56.84	51.80	55.78	69.25	62.49
Shape Reco	76.12	78.97	77.55	80.01	84.37	82.18
Patt Ext	54.60	58.33	56.48	61.36	66.05	63.71
EGMA Overall	64.73	70.21	67.49	73.20	79.44	76.31
Fluency						
Oral Count	80.07	84.39	82.23	86.42	90.35	88.36
1 to 1 Corresp	84.58	86.69	85.65	89.38	89.32	89.35
Num Id	22.87	22.36	22.61	28.98	29.56	29.27
Add L1	12.02	14.30	13.17	15.06	18.05	16.55
Sub L1	8.91	11.24	10.08	10.97	14.38	12.67

Somali

	Grade 2			Grade 3		
	Female	Male	Total	Female	Male	Total
1 to 1 corresp	90.76	89.36	90.04	90.07	92.92	91.62
Num Id	62.20	64.46	63.37	68.31	72.26	70.47
Quant Disc	77.53	79.96	78.77	77.36	78.00	77.71
Miss Num	61.62	60.81	61.20	62.82	65.78	64.42
word Prob	73.68	74.32	74.01	76.93	76.45	76.67
Add L1	87.09	88.85	87.98	89.29	88.35	88.79
Add L2	73.51	72.64	73.06	73.58	74.40	74.03
Sub L1	76.21	76.98	76.60	81.01	83.81	82.50
SubL 2	65.20	62.52	63.82	63.91	67.26	65.73
Shape Reco	57.82	60.34	59.10	59.60	63.09	61.52
Patt Ext	55.90	59.00	57.49	58.33	63.71	61.26
EGMA Overall	70.88	71.62	71.26	72.77	74.82	73.89
Fluency						
Oral Count	41.14	43.40	42.25	46.90	44.68	45.75
1 to 1 Corresp	68.04	67.93	67.99	67.51	70.72	69.26
Num Id	20.75	20.55	20.65	22.81	24.99	24.01
Add L1	12.48	12.60	12.54	13.95	13.15	13.53
Sub L1	10.36	10.86	10.61	11.51	12.23	11.89

BenishangulGumuz

	Grade2			Grade3		
	Female	Male	Total	Female	Male	Total
Accuracy						
1 to 1 corresp	80.77	83.97	82.45	88.72	91.21	90.01
Num Id	47.43	46.69	47.04	58.17	62.80	60.55
Quant Disc	65.95	70.91	68.57	75.99	81.57	78.86
Miss Num	31.25	32.78	32.06	35.52	44.21	40.00
word Prob	50.46	53.10	51.86	61.99	66.56	64.34
Add L1	58.29	61.41	59.93	69.64	77.02	73.44
Add L2	41.06	47.05	44.21	55.45	65.83	60.76
Sub L1	45.83	45.50	45.66	53.69	64.36	59.17
SubL 2	32.70	36.47	34.68	40.87	53.88	47.56
Shape Reco	68.59	72.90	70.84	70.23	75.27	72.83
Patt Ext	53.59	54.13	53.88	56.64	59.47	58.10
EGMA Overall	52.14	54.70	53.49	60.50	67.45	64.08
Fluency						
Oral Count	78.58	81.85	80.31	86.99	90.59	88.82
1 to 1 Corresp	84.42	86.19	85.39	88.93	88.90	88.91
Num Id	16.10	15.60	15.84	20.22	21.69	20.97
Add L1	8.09	8.63	8.37	10.42	13.11	11.80
Sub L1	5.77	6.60	6.21	7.04	9.25	8.17

SNNP

	Grade 2			Grade 3		
	Female	Male	Total	Female	Male	Total
Accuracy						
1 to 1 corresp	86.96	86.00	86.47	89.46	87.66	88.55
Num Id	66.92	66.96	66.94	75.74	78.58	77.18
Quant Disc	79.80	80.95	80.39	84.88	88.97	86.96
Miss Num	41.70	45.75	43.78	45.82	56.32	51.11
word Prob	71.26	71.66	71.47	73.46	81.03	77.29
Add L1	79.98	81.34	80.68	83.19	90.28	86.77
Add L2	67.57	69.76	68.69	72.29	83.41	77.95
Sub L1	69.57	70.98	70.29	72.12	82.79	77.51
SubL 2	56.82	57.41	57.12	61.23	72.16	66.78
Shape Reco	81.55	82.71	82.15	83.59	87.81	85.74
Patt Ext	59.60	61.14	60.39	61.52	67.76	64.68
EGMA Overall	69.20	70.46	69.84	72.99	79.77	76.42
Fluency						
Oral Count	84.11	84.22	84.17	88.14	91.37	89.76
1 to 1 Corresp	83.18	82.90	83.04	86.80	84.78	85.81
Num Id	21.38	21.78	21.58	26.21	27.84	27.04
Add L1	13.12	14.61	13.89	15.87	19.89	17.90
Sub L1	10.11	11.80	10.98	11.45	15.08	13.28

Gambella

	Grade 2			Grade 3		
	Female	Male	Total	Female	Male	Total
Accuracy						
1 to 1 corresp	66.26	60.66	63.23	65.11	63.21	64.12
Num Id	63.56	65.58	64.65	67.54	68.85	68.23
Quant Disc	78.52	78.73	78.64	82.39	84.72	83.61
Miss Num	59.60	60.46	60.07	63.73	62.83	63.26
word Prob	75.50	74.68	75.06	79.55	78.80	79.16
Add L1	79.41	80.76	80.14	83.27	86.33	84.87
Add L2	71.10	73.02	72.14	72.93	77.40	75.26
Sub L1	75.30	76.09	75.73	77.39	81.26	79.43
SubL 2	67.40	67.56	67.49	66.41	72.52	69.63
Shape Reco	84.39	86.44	85.48	88.82	85.64	87.15
Patt Ext	70.30	67.51	68.79	71.15	71.52	71.35
EGMA Overall	72.00	71.93	71.96	74.46	75.82	75.17
Fluency						
Oral Count	47.39	41.69	44.34	48.78	46.33	47.50
1 to 1 Corresp	69.30	66.75	68.08	65.85	61.93	63.59
Num Id	21.67	24.71	23.31	24.07	25.53	24.84
Add L1	12.04	12.67	12.38	14.06	14.03	14.05
Sub L1	10.96	11.62	11.31	12.03	12.34	12.19

Harari

	Grade 2			Grade3		
	Female	Male	Total	Female	Male	Total
Accuracy						
1 to 1 corresp	94.03	93.99	94.01	97.69	97.64	97.66
Num Id	74.22	81.73	78.08	91.30	95.10	93.31
Quant Disc	88.21	91.35	89.81	93.52	96.44	95.06
Miss Num	45.36	57.99	51.89	63.15	69.55	66.53
word Prob	75.96	79.92	78.00	81.28	84.63	83.05
Add L1	87.50	90.00	88.78	93.01	95.84	94.51
Add L2	76.11	80.37	78.30	83.93	87.82	85.97
Sub L1	78.26	84.35	81.38	87.41	89.95	88.76
SubL 2	62.51	70.74	66.68	75.28	76.62	75.99
Shape Reco	85.18	86.63	85.92	82.31	89.17	85.90
Patt Ext	63.12	70.88	67.13	71.30	73.52	72.47
EGMA Overall	75.62	80.72	78.24	83.66	86.93	85.39
Fluency						
Oral Count	87.16	92.36	89.81	95.53	98.60	97.15
1 to 1 Corresp	87.51	90.70	89.09	95.53	94.42	94.97
Num Id	24.94	27.56	26.29	34.49	36.90	35.76
Add L1	13.41	14.18	13.80	17.64	19.06	18.39
Sub L1	10.15	11.43	10.81	13.49	14.60	14.08

Addis Ababa

	Grade 2			Grade 3		
	Female	Male	Total	Female	Male	Total
Accuracy						
1 to 1 corresp	91.81	94.38	93.11	95.93	96.40	96.16
Num Id	79.16	80.91	80.05	92.43	92.26	92.35
Quant Disc	89.18	89.48	89.33	93.06	93.00	93.03
Miss Num	53.53	56.23	54.90	58.99	58.86	58.93
word Prob	71.60	75.12	73.38	81.68	81.16	81.43
Add L1	89.22	91.23	90.24	94.88	93.99	94.45
Add L2	76.45	77.88	77.18	84.88	83.08	84.02
Sub L1	77.95	77.06	77.50	89.12	86.01	87.62
SubL 2	57.11	55.00	56.05	67.73	69.95	68.81
Shape Reco	84.39	85.79	85.10	88.33	87.65	88.00
Patt Ext	73.07	71.58	72.32	79.49	76.86	78.22
EGMA Overall	76.70	77.73	77.22	84.17	83.57	83.88
Fluency						
Oral Count	98.13	101.16	99.67	104.70	107.69	106.16
1 to 1 Corresp	87.55	92.63	90.10	93.45	95.27	94.38
Num Id	30.71	29.96	30.33	41.22	40.43	40.84
Add L1	14.40	14.92	14.67	19.77	19.23	19.51
Sub L1	10.53	9.98	10.25	13.95	13.81	13.89

Diredewa

	Grade 2			Grade3		
	Female	Male	Total	Female	Male	Total
Accuracy						
1 to 1 corresp	91.23	92.64	91.96	92.23	94.43	93.37
Num Id	62.75	75.87	69.58	79.40	87.63	83.73
Quant Disc	79.36	84.46	82.02	84.74	89.95	87.48
Miss Num	35.24	44.31	39.95	48.52	56.57	52.76
word Prob	71.66	75.25	73.53	77.89	83.93	81.06
Add L1	81.06	87.02	84.17	88.58	93.62	91.23
Add L2	62.94	75.00	69.23	75.86	82.54	79.39
Sub L1	69.25	75.51	72.53	78.26	86.90	82.80
SubL 2	56.74	59.85	58.38	63.89	72.95	68.65
Shape Reco	73.90	80.00	77.08	80.64	87.97	84.56
Patt Ext	51.06	55.64	53.44	61.97	61.79	61.88
EGMA Overall	66.88	73.21	70.17	75.57	81.61	78.74
Fluency						
Oral Count	88.04	93.59	90.94	93.82	96.89	95.43
1 to 1 Corresp	85.06	84.92	84.99	87.76	88.03	87.90
Num Id	21.67	27.06	24.48	27.92	33.08	30.61
Add L1	12.89	14.81	13.90	15.34	17.67	16.57
Sub L1	9.37	11.18	10.31	11.37	13.41	12.45

Appendix-B: EGMA Tasks and student questionnaire (English version)

General instructions

It is important to establish a playful and relaxed rapport with the children to be assessed, via some simple initial conversation about topics of interest to the child. The child should perceive the following assessment almost as a game to be enjoyed rather than as a severe situation.

Verbal Consent: Read the text in the box clearly to the child:

Before we start, I want to tell you my name. I'm _____
I work with the Ministry of Education.

- **We want to know how children learn math. You were picked by chance, like in a raffle or lottery.**
- **We would like your help in this. But you do not have to take part if you do not want to.**
- **We are going to play some counting games and some number games.**
- **Using this stopwatch, I will see how long it takes you to count.**
- **This is NOT a test and you will NOT be graded on it for school.**
- **I will also ask you questions about your family, like what language your family uses at home and some of the things your family has.**
- **I will NOT write down your name so no one will know these are your answers.**
- **Once again, you do not have to take part in this if you do not want to. Once we begin, if you do not want to answer a question, that's all right.**
- **Okay, are you ready to start?**

Check box if verbal consent is obtained: ☐ ***YES***

(If verbal consent is not obtained, thank the child and move on to the next child, using this same form)

Demographic Information

A. Date of Assessment	Day ___ Mo ___Yr____
B. Assessor name/code:	
C. Name of School:	
D. Unique School code :	
E. District:	
F. School Shift:	O Morning O Afternoon O Full Day
G. Multi grade?	O Yes O No
H. Assessment Order (1st, 2nd, or 3rd test administered):	O 1 = 1st test O 2 = 2nd test O 3 = 3rd test

I. Teacher Code:	
J. Student's Grade Level:	O 2 = Grade 2 O 3 = Grade 3
k. Student's Section	
L. Unique Student Code:	
M. Student's Age:	
N. Student's gender	O Girl O Boy
O. Start Time:	_____ : _____
P. End Time:	_____ : _____

Student Context Interview

Now I will ask you a few questions about your MATH teacher/lesson:

Q1	What does the teacher do/say when you do well? **[Circle all that apply]**	Nothing ……..... 0 Marks in exercise book…….……..... 1 Praises me... ……..... 2 Asks the class to clap/congratulate, etc……... 3 Gives me a prize(sticker, pencil)…….…... 4 Excuses me from a chore or homework…… 5 Don't know/Refuse…….……...…888
Q 2	What does the teacher normally do when a student is unable to answer or incorrectly answers a question? **[Circle all that apply]**	Teacher rephrases/explains the question…… 1 Teacher asks another learner to try again……...…2 Teacher asks another learner ……. 3 Teacher asks again…….….. 4 Teacher corrects learner but does not scold/punish..... 5 Teacher scolds learner…….……6 Teacher sends learner outside of Classroom……...7 Teacher hits learner …….…….. 8 Don't know/Refuse……. 888
Q 3	Last week, how many times did you get mathematics homework? ***If the child answered never, skip the next question***	Never……0 One time……..…. 1 Two times…….2 Three times……..…….3 Four times……4 Every day…….…….5 Don't know/Refuse…… 888
Q 4	Did your teacher check your mathematics Homework last week	No…….0 Yes……1 Don't know/Refuse….888
Q 5	If you need help with your mathematics homework, who helps you at home? **[CIRCLE ALL THAT APPLY]**	No one……..0 Brother/sister……....1 Mother/father…….…..2 Grandparent…….….3 Other……..…..…..4 Don't know/Refuse…..888
Q6	Do you have a mathematics text book?	No…….0 Yes……1 Don't know/Refuse…..888
Q7	Is your home language (the language you use at home), the same as the instructional language at your school?	No…….0 Yes……1 Don't know/Refuse…..888
Q8	Did you attend any a pre-school (KG or Religious) before enrolled in Grade 1?	No…….0 Yes……1 Don't know/Refuse…..888
Q9	For how many days were you absent from school Last week?	_____ Days.

Thank the student and take her for her/him next assessment, or if she has finished all of them, send her/him back to her classroom.

Task 1:Oral Counting	🕮×	🕐60 seconds
🗣I want you to count for me. I will tell you when to begin and when to stop. Count for me from one to as high as you can count. Are you ready? Okay begin, one… 🗣*[If the child does not start counting]*: Watch me count. One, two, three….ten. Okay, just like me, I want you to count as high as you can. Okay begin, one…		✋ • If a child makes an error • If the time on the stopwatch runs out (60 seconds)
✍ Last number counted correctly		
✍ Time on the stopwatch		

Task 2: Counting: One-to-one correspondence –Practice Item	🕮Sheet A	🕐×
🗣 *[Sweep your hand from left to right over the circles]*. Here are some circles. I want you to point and count these circles for me. *[Point to first circle]* Start here and count the circles. Last circle the child counted correctly: _____ 🗣*[If the child does not say the number of circles after counting them all]:* How many circles are there? Number of circles the child says there are _____ ×🗣*[If the child does not respond or responds with the incorrect answer]*: Count the circles out loud. *[Pointing to each one]* one, two, three, four, five, there are five circles. Now you count the circles. 🗣*[If the child does not say the number of circles after counting them]:* How many circles are there? ✓🗣 That's right, five. Let's do another one. ×🗣 There are five, let's do another one.		✋× ✋×

Task 2: Counting: One-to-one correspondence - Exercise	Sheet B	60 seconds
Here are some more circles. I want you to point and count these circles for me. *[Point to first circle]* Start here and count the circles. Last circle the child counted correctly: _____ *[If the child does not say the number of circles after counting them]:* How many circles are there? Number of circles the child says there are _____		• If the child counts a circle double or incorrectly. makes an error • If the time on the stopwatch runs out (60 seconds)
Last circle the child counted correctly		
Number of circles the child says there are		
Time on the stopwatch		

Task 3:Number Identification	Sheet C	60 seconds
Here are some numbers. I want you to tell me each number I am pointing to. I am going to use this stopwatch and will tell you when to begin and when to stop. When I say begin, say the numbers as best as you can. - *[point to first number]* Start here. Are you ready? . . . Begin. - What number is this? *[Repeat for each item]*.		• If the child makes 4 successive errors one after the other. • If the time on the stopwatch runs out (60 seconds). ➲ • If a child stops on a number for 5 SECONDS.
(/) Incorrect or no response **( ])** After the last number read		
Total correct		
Time on the stopwatch		

					Tot. Cum.
8	37	6	45	164	(5)
4	69	502	10	12	(10)
96	123	51	84	9	(15)
36	94	25	77	272	(20)
73	500	301	986	368	(25)
674	720	838	459	789	(30)

Task 4: Quantity Discrimination - Practice Item	🕮Sheet D1	⏱×
P1: 🗣 Look at these numbers. Tell me which number is greater. 10 4 ✓🗣That's correct, 10 is greater. Let's do another one. ×🗣The greater number is 10. *[Point to 10]* This is 10. *[Point to 4]* This is 4. 10 is greater than 4. Let's do another one.		✋×
P2: 🗣 Look at these numbers. Tell me which number is greater. 12 20 ✓🗣That's right, 20 is greater. Let's continue. ×🗣The greater number is 20. *[Point to 12]* This number is 12. *[Point to 20]* This is 20. 20 is greater than 12. Let's continue.		

Task4: Quantity Discrimination - Exercise	🕮Sheet D2	⏱×
🗣Look at these numbers. Tell me which number is greater. *[Repeat for each item]*		✋ • If the child gets 4 successive errors one after the other. ➲ If a child doesn't respond within 15 SECONDS.
✍ (✓) 1 = Corrector (×) 0 = Incorrector no response		

8	7	**8**	1	0
15	32	**32**	1	0
5	9	**9**	1	0
98	68	**98**	1	0
50	70	**70**	1	0
44	43	**44**	1	0
52	152	**152**	1	0
514	415	**514**	1	0
523	532	532	1	0
589	967	967	1	0

✍ Total correct	

Task 5: Missing Number - Practice Item	🕮Sheet E1	🕐×
P1: 🗣 Here are some numbers. 1, 2, 3, what number is missing here?  ✓🗣That's correct, 4. ×🗣The number four goes here. Say the numbers with me. [*Point to each number]* . . . 1, 2, 3, 4. 4 is missing here. Let's do another one.		✋×
P2: 🗣Here are some more numbers. 17, *[point to dash]*, 21, 23. What number is missing? *[point to dash again]*  ✓🗣That's right, 19. ×🗣The number 19 goes here. Say the numbers with me. *[Point to each number]* . . . 17, 19, 21, 23. *[Point to dash],* 19 is missing here. Let's do another one.		✋×

Task 5: Missing Number – Exercise	🕮Sheet E2	🕐×
🗣 Here are some more numbers. *[Point to the dash]* ___ What number is missing here? *[Repeat for each item]*		✋×
✍ (✓) 1 = Corrector (×) 0 = Incorrector no response		➲ • If the child does not respond within15 SECONDS.

2	**4**	6	8	1 0		100	200	300	**400**	1 0
89	90	91	92	1 0		30	35	**40**	45	1 0
30	40	50	60	1 0		18	**20**	22	24	1 0
245	250	255	**260**	1 0		348	349	**350**	351	1 0
305	310	**315**	320	1 0		500	400	**300**	200	1 0

✍ Total correct:	

Task 6: Word Problems	🕮×	🕐×
✎❖Counters and stopwatch (to make sure child does not spend too long on one problem).		

🗣 I have some problems that I am going to ask you to solve for me. Here are some things to help you count. You can use them if you need them, but you don't have to. Listen very carefully to each problem. If you need me to, I will repeat the question for you. Okay, let's get started.

<u>Practice Item</u>:

🗣Ali has 2 candies. Almaz has 3 candies. How many candies did they have altogether?

✓🗣That's right. They have 5 candies altogether. Let's do some more.

×🗣They have 5 candies altogether. Watch me. *[Use the counters and read the problem, demonstrating 2 counters for Ali and 3 counters for* Almaz*]*. When we count add them altogether, we get 5 candies. Let's do some more.

🗣Now you will work out more questions that I will read to you. *[Remember some of these questions may be hard even for older children, so it might require ensuring that the child is following attentively]*. Remember, you can use these to help you answer the questions *[point to the counters]* Okay, let's get started.

✍ For each problem:
(✓) 1 = Correct.
(×) 0 = Incorrect or no response.

<u>Problem 1</u>:
Hanna has 2 candies. Her father gave her 5 more candies. How many candies does Hanna have altogether?
✓× Correct answer: 7

<u>Problem 2</u>:
Mahari had 6 bananas. He gave 3 bananas to Muna. How many bananas does Mahari have left?
✓× Correct answer: 3

<u>Problem 3</u>:
There are 9 children walking to school. 6 are boys and the rest are girls. How many girls are walking to school?
✓× Correct answer: 3

<u>Problem 4</u>:
I have 7 oranges. How many more oranges do I need if I want to give one to each of my 12 friends?
✓× Correct answer: 5 [1] [0]

✍ **<u>Didthechild use</u>**: counters/fingers? [Y] [N]

✍ Total number correct: [ ]

✋×

➲

- If a child stops on a number for <u>15 SECONDS</u>. (without using the counters, counting on his/her fingers, etc.)

OR

- If the child does not respond to a question after one minute

Task 7: Addition - Practice Item	Sheet F1	×
Counters and stopwatch (to make sure child does not spend too long on one problem).		
P1: Here is an addition problem. Two plus three. How much is two plus three? 2 + 3 = ✓That's right, two plus three is five. Let's try another. ×The answer is five. [*Use the counters and read the problem demonstrating by pushing two counters to the child*], this is two. [*Then pushing three counters to the child*] this is three. [*Count all the counters aloud*]. Two plus three is five. Let's try another.		
P2: Here is another addition problem. Twelve plus four. How much is twelve plus four? 12 + 4 = ✓That's right, twelve plus four is sixteen. ×The answer is sixteen. [*Use the counters and read the problem demonstrating by pushing twelve counters to the child*], this is twelve. [*Then pushing four counters to the child*] this is four. [*Count all the counters aloud*]. Twelve plus four is sixteen. Let's do some more.		

Task 7: Addition: Level 1– Exercise	Sheet F2:A	60 seconds
Counters and stopwatch (to make sure child does not spend too long on one problem).		
Here are more addition problems. For each problem you will tell me the answer. Ok? I will use this stopwatch. I want you to tell me the first answer that seems right to you. Try to give the right answer. We will start here [*point to the first problem*] and go across [*point along the first row*]. When we finish this row, we will go to the next row and start here [*point to the beginning of the second row*]. - Ready? Begin		• If the time on the stopwatch runs out (60 seconds)
(/) Incorrector no response ( ]) After last ítem attempted.		• If the child does not respond within 5 SECONDS.

4 + 2= **(6)**	7 + 1= **(8)**	(2)
2 + 2 = **(4)**	3 + 4= **(7)**	(4)
1+ 5 = **(6)**	3 + 2= **(5)**	(6)
6 + 2 = **(8)**	5 + 3= **(8)**	(8)
2 + 7 = **(9)**	4 + 5= **(9)**	(10)

Total correct:	
Time on the stopwatch	

Task 7: Addition: Level 2 – Exercise	🕮Sheet F2	🕐120 seconds
✎❖Counters and stopwatch (to make sure child does not spend too long on one problem).		

🗣Here are some more addition problems. For each problem you will tell me the answer. Ok? [*Follow the same procedure as in Task 7: Addition; Level 1*].

- Ready? Begin

✍ (/) Incorrector no response

( ]) After last ítem attempted.

8 + 2 = **(10)**	5 + 6 = **(11)**	(2)
6 + 7 = **(13)**	8 + 9 = **(17)**	(4)
13 + 3 = **(16)**	10 + 5 = **(15)**	(6)
15 + 4 = **(19)**	11 + 9 = **(20)**	(8)
45 + 5 = **(50)**	13 + 12 = **(25)**	(10)

✋

- If the child gets 4 successive errors one after the other.
- If the time on the stopwatch runs out (120 seconds)

➲

- If the child does not respond within 15 SECONDS.

✍ **Didthechild use**: counters/fingers? **Y** **N**

✍ Total correct:

Task 7:Subtraction - Practice Items	🕮Sheet F3	🕐×
🖉❖Counters and stopwatch (to make sure child does not spend too long on one problem).		
P1: 🗣 Here is a subtraction problem. Seven minus two. How much is seven minus two? 7 – 2 = ✓🗣That's right, Seven minus two is five. Let's try another. ×🗣The answer is five. [*Use the counters and read the problem demonstrating by pushing seven counters to the child*], this is seven. [*Then remove two counters from the seven counters you moved toward the child and say*]: minus two. [*Count the counters allowed*]. Five. Seven minus two is five. Let's try another.		✋×
<u>P2:</u> 🗣Here is another subtraction problem. Seventeen minus three. How much is seventeen minus three? 17 – 3 = ✓🗣That's right, seventeen minus three is fourteen. ×🗣The answer is fourteen. [*Use the counters and read the problem demonstrating by pushing seventeen counters to the child*], this is seventeen. [*Then remove three counters from the seventeen counters you moved toward the child and say*] minus three. [*Count the counters allowed*].Fourteen. Seventeen minus three is fourteen. Let's do some more.		

Task 7: Subtraction: Level1– Exercise	🕮SheetF4:A	🕐 60 seconds
🗣Here are more subtraction problems. For each problem you will tell me the answer. Ok? I will use this stopwatch. I want you to tell me the first answer that seems right to you. Try to give the right answer. We will start here [*point to the first problem*] and go across [*point along the first row*]. When we finish this row, we will go to the next row and start here [*point to the beginning of the second row*]. - Ready? Begin		✋ • If the time on the stopwatch runs out (60 seconds) ➲ • If the child does not respond within <u>5 SECONDS.</u>
🖉(/) Incorrector no response ( ]) After last item attempted		

6 - 2 = **(4)**	8 - 1 = **(7)**	(2)
4 - 2 = **(2)**	7 - 3 = **(4)**	(4)
6 - 1 = **(5)**	5 - 3 = **(2)**	(6)
8 - 6 = **(2)**	8 - 5 = **(3)**	(8)
9- 2 = **(7)**	9 - 4 = **(5)**	(10)

🖉 Total correct:	
🖉 Time on the stopwatch:	

Task 7: Subtraction: Level2 – Exercise	🕮Sheet F4:B	🕐 120 seconds
✎❖Counters and stopwatch (to make sure child does not spend too long on one problem).		

🗣Here are some more Subtraction problems. For each problem you will tell me the answer. Ok? [*Follow the same procedure as in Task 7: Subtraction; Level 1*].
- Ready? Begin

✍(/) Incorrect or no response
( ]) After last item attempted

10 - 2 = **(8)**	11 - 6 = **(5)**	(2)
13 - 7 = **(6)**	17 - 8 = **(9)**	(4)
16 - 3 = **(13)**	15 - 5 = **(10)**	(6)
19 - 4 = **(15)**	20 - 9 = **(11)**	(8)
50 - 5 = **(45)**	25 - 12 = **(13)**	(10)

- If the child gets 4 successive errors one after the other.
- If the time on the stopwatch runs out (120 seconds)

➲
- If the child does not respond within 15 SECONDS.

✍ **Did the child use**: counters/fingers? **Y** **N**

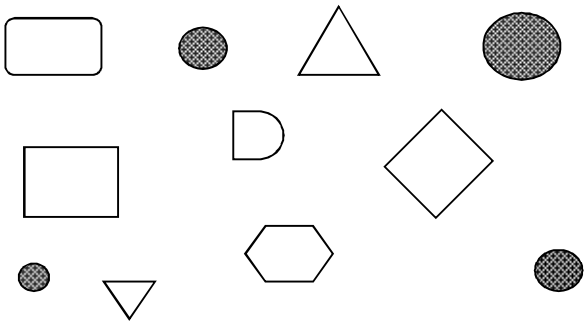
✍ Total correct:

Task 8: Shape Recognition	🕮Sheets G1through G4	🕐×
✎❖Counters and stopwatch (to make sure child does not spend too long on one problem).		

🗣 Now we are going to play another game with shapes. *[Place the counters to the side of the child. Point to the counters]*.I want you to place the counters on all of the circles you find on this sheet. *[Place the sheet in front of the child]*.
[Repeat this instruction for all items(for each shape sheet)]

🕮Sheet G1

✍Once the child finishes placing the counters on top of the shape sheet, mark the shapes with **(✓)** on your sheet.*[The correct shapes are marked with a pattern of dots on them]*.

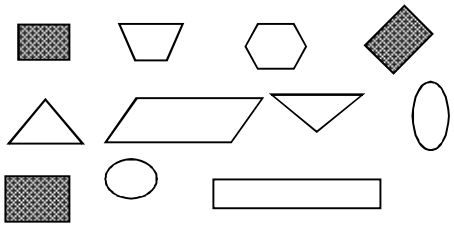


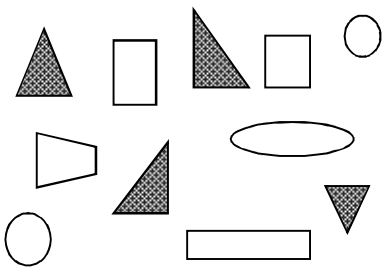
✋×

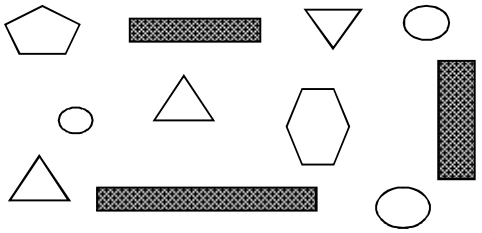
➲
- If a child does not respond within 30 SECONDS.

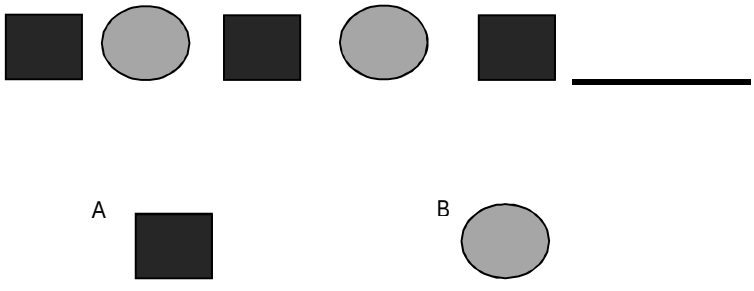
✍ Circle figures counted correctly: **/4**

✍ Figures counted incorrectly:

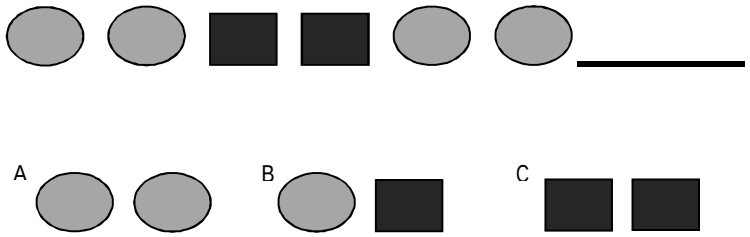
Task 8: Shape Recognition Continued	🕮Sheet G2	🕐×
🗣*[Clear the counters off the circle sheet and place them in the pile to the side of the child]*. 🗣*[Point to the counters]*. Now I want you to place the counters on all of the squares you find on this sheet. *[Place the sheet in front of the child]*.Let me know when you are done.		✋× ➲ • If a child does not respond within 30 SECONDS.
✍Once the child finishes placing the counters on top of the shape sheet, mark the shapes with **(✓)** on your sheet.*[The correct shapes are marked with a pattern of dots on them]*. 		
✍	Square figures counted correctly:	**/3**
✍	Figures counted incorrectly:	

Task 8: Shape Recognition Continued	🕮Sheet G3	🕐×
🗣*[Clear the counters off the circle sheet and place them in the pile to the side of the child]*. 🗣*[Point to the counters]*.Now I want you to place the counters on all of the triangles you fin don this sheet. *[Place the sheet in front of the child]*.Let me know when you are done.		✋× ➲ • If a child does not respond within 30 SECONDS.
✍Once the child finishes placing the counters on top of the shape sheet, mark the shapes with **(✓)** on your sheet.*[The correct shapes are marked with a pattern of dots on them]*. 		
✍	Triangle figures counted correctly:	**/4**
✍	Figures counted incorrectly:	

Task 8: Shape Recognition Continued	🕮Sheet G4	🕐×
🗣*[Clear the counters off the circle sheet and place them in the pile to the side of the child]*. 🗣*[Point to the counters]*. Now I want you to place the counters on all of the rectangles you find on this sheet. *[Place the sheet in front of the child]*. Let me know when you are done.		✋× ➲ •If a child does not respond within 30 SECONDS.
✍Once the child finishes placing the counters on top of the shape sheet, mark the shapes with **(✓)** on your sheet.*[The correct shapes are marked with a pattern of dots on them]*.  ***[This is the end of this task. Please remove the counters from the child and continue to the next task.]***		
✍ Rectangle figures counted correctly:		**/3**
✍ Figures counted incorrectly:		

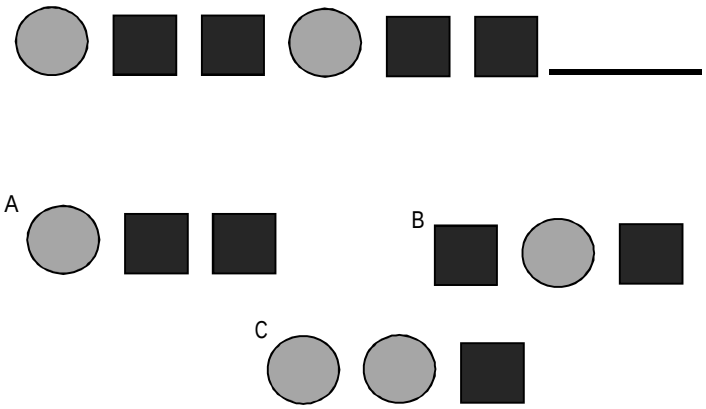
Task 9: Pattern Extension	🕮Sheets H1 through H4	🕐×
	🕮Sheet H1	✋
🗣 I am going to show you a pattern. *[Place sheet H1in front of the child. Point to the pattern moving hand from left to right over pattern]*. I want you to finish this pattern for me. *[Move your hand down the page across response options]*. Which one of these goes here? *[Point to the blank at the end of the pattern]*. *[Repeat this instruction for all items]*		•If a child gets 3 successive errors one after the other. ➲ •If a child does not respond to an item within 30 SECONDS.
✍ (✓) 1 = Corrector (×) 0 = Incorrector no response		
 ✓× Correct answer B [1] [0]		

Task 9: Pattern Extension	🕮Sheets H1 through H4	🕐×
Task 9: Pattern Extension Continued	🕮Sheet H2	🕐×



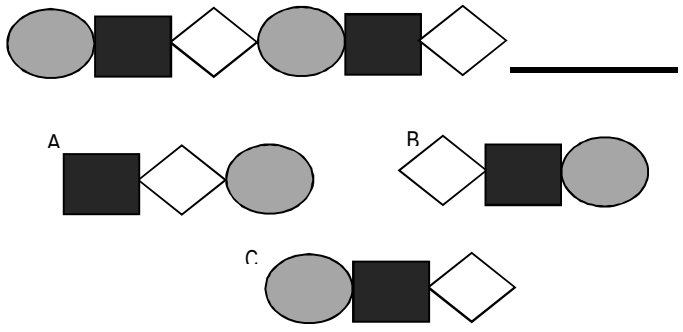
✓× Correct answer C [1] [0]

🕮Sheet H3



✓× Correct answer A [1] [0]

🕮Sheet H4



✓× Correct answer C [1] [0]

✎ Total correct:	***/4***

Appendix-C: Teachers Questionnaire

Early Grade Math Assessment (EGMA): Teacher Questionnaire

Grade ID:	TEACHER ID:
Grade Section:	SCHOOL ID:

- We are conducting a study to better understand how children learn math. Your school was selected through a process of statistical sampling. We would like your help in this. But you do not have to take part if you do not want to.
- Your name will not be recorded on this form, nor mentioned anywhere in the survey data. The results of this survey will be published in the form of collective tables. The information acquired through this instrument will be shared with the Ministry of Education with the hope of identifying areas where additional support may be needed.
- The name of your school and the grade level and class you teach will be recorded, but only so that we can correctly link school, class, and student data so as to analyze relationships between children's learning and the characteristics of the settings in which they learn. Your school's name will not be used in any report or presentation. The results of analysis will be used by the Ministry of Education to help identify additional support that may be needed.
- If you agree to help with this study, please read the consent statement below, check the "Yes" box, and answer the questions in this questionnaire as completely and accurately as you can, regarding your teaching preparation and activities. It should take you no more than 10 minutes. Return the completed form to the Early Grade Math Assessment study team before the team leaves your school.
- If after reading this message you prefer not to participate, please return this form with no markings to the study team.

CONSENT STATEMENT: I understand and agree to participate in this mathematics research by filling out this questionnaire as completely and accurately as possible.

☐ *YES*

For the following questions, please write your response in the space on the right across from each item. Where response options are given, clearly tick the box for the option that corresponds most closely to your response. As seen in the following example for question 1, gender. If you are male, you would check the box directly in front of your response.

Example:

1	Your sex:	☑ 1) Male ☐ 2) Female

We want to learn what is happening in your classroom and in other classrooms where we are doing the Early Grade Mathematics Assessment. Please answer the following questions as accurately as you can. If you do not know how to answer a question, either write "don't know" or circle the number for the response "don't know".

1	Your sex:	☐1) Male ☐2) Female
2	Your age range	☐1) below 20 years ☐2) 20 – 29 years ☐3) 30 – 39 years ☐4) 40 – 49 years ☐5) 50 – 59 years ☐6) 60 years and above
3	Name of School: _____	
4	Grade level(s) you are teaching this year: (Check ALL the grades that apply)	☐1) Grade 1 ☐5) Grade 5 ☐2) Grade 2 ☐6) Grade 6 ☐3) Grade 3 ☐ 7) Grade 7 ☐4) Grade 4 ☐8) Grade 8

5	Name of your Class: (grade and section of your class where children are being interviewed)	Grade _____ Section _____
6	Have you been teaching this class since the beginning of the school year?	☐0) No ☐1) Yes
7	Number of students in your class (indicate numbers by gender)	Number of boys: _____ Number of girls: _____
8	Do you hold a Trained Teacher's Certificate?	☐0) No ☐1) Yes
9	What is your highest professional qualification? (Tick Mark One)	☐ 1) None ☐ 2) Trained Teacher's Certificate ☐ 3) Diploma in Education ☐ 4) Bachelor's of Education ☐ 5) Master's in Education ☐6) Other - please specify: _____ _____
10	If you have a teacher's certificate, bachelor's degree, master's degree, or other type training, how many years have you been teaching since receiving this training?	_____ years
11	How many years have you been teaching overall?	_____ years
12	Have you attended any in-service training or professional development sessions such as workshops in the last year (between July 2004 E.C. and July 2005 E.C.)?	☐0) No → **Skip to 13a** ☐1) Yes ☐9) Don't know If you answered Yes, how many days did the workshops last? _____
13a, 13b, 13c,	13 a. Have you received teacher training on how to teach mathematics?	☐ 0) No → **Skip to 14a & 14b** ☐ 1) Yes

& 13d		13b. If you answered Yes, was this in-service training in mathematics? ☐1) Yes ☐2) No
		13c. Did you receive pre-service teacher training in mathematics? ☐1) Yes ☐2) No
		13d. Did the trainings actually help you teach better in the classroom? ☐0) No ☐1) Yes
14	14a. Do you prepare mathematics lesson plans prior to conducting a class session?	☐0) No → **Skip to 15a** ☐1) Yes
		14b. If you answered Yes, did you face any difficulties in preparing the lesson plans? ☐1) No → **Skip to 15a** ☐2) Yes
15a & 15b	15a. Do you plan your mathematics lessons together with other teachers, exchange ideas, share teacher plans or share materials?	☐0) No → **Skip to 16a** ☐1) Yes
		15b. If you answered Yes, how often? ☐1) Once a week ☐2) Once a month ☐3) Once a year ☐4) Other – please specify: _____

16a & 16b	16a. Do you use recommended mathematics textbook(s) during mathematics lessons?	☐0) No → **Skip to 19a** ☐1) Yes
		16b. If you answered Yes, what are the names of the textbooks you are using? _____
17	If you answered Yes to Question 16a, how often do you use the recommended mathematics textbook(s) during math lessons?	☐1) Never ☐2) Rarely ☐3) About half the time ☐4) Most of the lessons ☐5) Every lesson
18	If you answered Yes to Question 16a, how useful do you find the recommended mathematics textbook(s)?	☐1) Not at all useful ☐2) A little useful ☐3) Somewhat useful ☐4) Very useful
19a & 19b	Do you use a teacher's guide during mathematics lessons?	☐0) No → **Skip to 20** ☐1) Yes
		22b. If you answered Yes, how helpful is this teacher's guide? ☐1) Not at all helpful ☐2) A little helpful ☐3) Somewhat helpful ☐4) Very helpful
20	How many minutes do you spend teaching mathematics on the days you teach mathematics during the week?	_____ Minutes/per day

Thinking about the last 5 school days, indicate how often each of the following activities (items 21 through 27) took place. Circle the number on the right that corresponds to the closest frequency:

		Number of Days					
		0 days	**1 day**	**2 days**	**3 days**	**4 days**	**5 days**
21	Identifying shapes by name	0	1	2	3	4	5
22	Practice reading and writing numbers	0	1	2	3	4	5
23	Practice counting	0	1	2	3	4	5
24	Adding / subtracting single digit numbers	0	1	2	3	4	5
25	Adding / subtracting multi-digit numbers	0	1	2	3	4	5
26	Working with word problems	0	1	2	3	4	5
27	Multiplication	0	1	2	3	4	5

28a, 28b, & 28c	Have you ever reported to someone, a problem you experienced in teaching mathematics?	☐0) No ☑ 1) Yes
		35b. If you answered Yes, who did you report this to? ☐1) Another Teacher ☐2) Department Head ☐3) Head Teacher ☐4) District Education Expert ☐5) Professional Development Provider ☐6) Other: _____ 35c. Did you receive help from this person that improved how you teach mathematics? ☐0) No ☐1) Yes

Thank you for taking the time to fill out our questionnaire. Your participation will help us understand mathematics in your school and classroom better.

Appendix-D: Principals Questionnaire

NATIONAL EDUCATIONAL ASSESSMENT AND EXAMINATIONS AGENCY

Early Grade Mathematics Assessment (EGMA) – Ethiopia

Principal's Questionnaire

2013/2005 E.C.

School information

Region:	Zone:
District/Woreda:	School Name:
SCHOOL ID:	The highest Grade taught in this school:

Early Grade Mathematics Assessment (EGMA)
Principals Questionnaire

The National Educational Assessment and Examinations Agency is conducting a study to better understand how children learn mathematics in the early grades (Grades 2 and 3). This survey is called Early Grade Mathematics Assessment or EGMA. We are also gathering information about schools and school staff to learn more about conditions and practices that may affect children's learning in mathematics.

This school was randomly selected through a process of statistical sampling for participation in the survey. Your **name** will **not** be recorded on this form, nor mentioned anywhere in the survey data. The results of this survey will be published in the form of collective tables. The information acquired through this instrument will be shared with the Ministry of Education with the hope of identifying areas where additional supports may be needed. The name of your school and the grade level be recorded, but only so that we can correctly link school, class, and student data so as to analyze relationships between children's learning and the characteristics of the settings in which they learn. Your school's name will not be used in any report or presentation.

Thus, since your participation is very important, answer the questions in this questionnaire as completely and accurately as you can, regarding your preparation in the teaching learning activities. It should take you no more than 10 minutes. Return the completed form to the Early Grade Math Assessment study team before the team leaves your school.

INSTRUCTION

For the following questions, Please answer all questions truthfully. Write each response in the space on the right across from each item. Where response options are given, clearly circle the number on the far right of the option that corresponds most closely to your response.

1	Gender	Female …….……....1 Male …….…....2	
2	Your position in the school	Principal …….. 1 Deputy Principal …….. …… 2 Other …… 3	
3	How many years have you been serving as a principal or deputy principal **throughout your career**?	_____ years	
4	How many years have you been serving as a principal or deputy principal **in this school**?	_____ years	
5	What is your highest level of professional qualification?	Diploma in educational administration.....……1 Bachelor's Degree in educational administration ...2 Master's degree in educational administration …..3 Bachelor's Degree in any educational field….. …..4 Master's degree in any educational field ……..…..5 Teacher's Training Certificate..…..……..6 Teacher's Training Diploma ..……..……..… 7 Other…… 8	
6	How many hours a week do you teach? (Put zero if none)	_____ hours	
7	Have you received special in-service training or taken courses in school management?	Yes .....1 No .....0 IF NO, GO TO QUESTION 9	
8	What was the length of the program?	_____Days	
9	Do you support teachers on how to teach mathematics (the pedagogy)?	Yes .....1 No 0	
10	What is the average daily number of students absent from school last week?	**Grade 2** _____ Students	**Grade 3** _____ Students
11	Does your school use *Mother Tongue* as the medium of instruction for grades 2 and 3?	**Grade 2** Yes …….. 1 No …… 0	**Grade 3** Yes …….. 1 No …… 0
12	Since the start of the current school year, was this school closed during the regular school calendar other than holidays?	Yes .....1 No 0	

		IF NO GO TO QUESTION 14	
13	If yes, how many days was the school closed?	Number of days: _____	
14	How many Grade 2 and 3 mathematics teachers were absent last week?	**Grade 2**	**Grade 3**
		_____ teachers Don't know 99	_____ teachers Don't know 99
15	How many Grade 2 and 3 mathematics teachers arrived after the start of classes last week?	**Grade 2**	**Grade 3**
		_____ teachers Don't know 99	_____ teachers Don't know 99
16	What is the **most** common reason for teacher absenteeism at your school?	Illness ..... 1 Work other jobs ..... 2 Lack of motivation.....3 Other ..... 4 Do not know 99	
17	Who is responsible for reviewing teachers' lesson plans?	No one .....0 IF NO ONE, GO TO QUESTION 19 Head teacher .....1 Deputy head teacher .....2 Other 3	
18	How often are these plans reviewed?	Never .....0 Once every month .....1 Every week .....2 Once per day .....3 Don't Know.....99	
19	In your school, who is responsible for observing teachers in their classrooms?	No one observes .....0 IF NO ONE, GO TO QUESTION 21 Head Teacher .....1 Deputy Head Teacher .....2 Other 3	
20	In a semester, how often are you able to observe the teachers in their classrooms?	Never ..... 0 One time .....1 Two times .....2 Three Times .....3 Four or more times 4	
21	How do you know whether your students are progressing? **[CIRCLE 1 FORALL THAT APPLY]**	Classroom observation .....1 Based on tests results given by teachers..... 1 Review children's assignments or Home works .....1 Teachers provide me progress reports .....1 Don't know 99	
22	Does your school have adequate mathematics teaching aids for pupils?	No .....0 Yes .....1 Don't know.....99	
23	Does your school have adequate supportive materials for teachers to help them teach mathematics?	No .....0 Yes .....1 Don't know.....99	
24	What is the approximate student to **mathematics**	**Grade 2**	**Grade 3**

	book ratio for Grade 2 & 3?	No books …….0 1 to 1…….1 2 to 1…….2 3 to 1…….3 4 to 1…….4 5 to 1 or more……....5 Don't know…….99	No books …….0 1 to 1…….1 2 to 1…….2 3 to 1…….3 4 to 1…….4 5 to 1 or more……....5 Don't know …….99
25	How often did the Parent Teacher Association (PTA) meet this year?	Never ……..0 Once a year ……1 Once a semester ……2 Once a month ……3 Once a week ……...4 Don't know/no response ……..99	
26	For which of the following does the PTA have decision making authority and/or responsibility? **[CIRCLE 1 FOR ALL THAT APPLY]**	Discuss school Management problems?……. 1 Discuss students' problems and solutions?..... 1 Review progress of school improvement efforts? …...…1 Review financial situation (budgets) of the school…...…1 Manage school infrastructure and Equipment ……1 Discuss school curriculum?.....1 Raise funds ……..……..…1 Manage procurement or Distribution of textbooks? ……..……...…….1 Don't know……..…….. 99	
27	Does the school have a reading room/class rooms with reading facilities?	Yes ……..1 No ……0	
28	What was the school's mean score on Grade 2 and 3 mathematics assessment (exam) result last semester?		**Grade 2** / **Grade 3**
		Boys	
		Girls	
		MEAN	

Thank you for your participation! You have been very helpful.