# Gender Differences in Mathematics Performance among Fifth and Sixth Grade Children in Addis Ababa

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**Abstract:** Although a few studies have examined gender differences in mathematics achievement among Ethiopian children, no study as yet has documented these differences in relation to specific mathematics subtests. Nor has there been any study that investigated students' relative performance on different mathematics subtests. The major objectives of this study were thus (1) to identify the mathematical skills in which boys and girls differ and (2) to examine whether the children perform equally well on three mathematics subtests. To this end, the study examined the performance of 177 boys and girls in grades five and six on subtests of mathematics computation, concepts and problem solving. The results indicated no significant differences between fifth grade girls and fifth grade boys on the three subtests. However, at the sixth grade level, boys performed significantly better than girls on the problem solving subtest. The difference on the computation subtest was also marginally significant and in favor of boys. The students in both grades performed better on the computation subtest than on the other two subtests. Overall, the findings evidenced more similarities than differences between boys and girls' mathematics achievement. Unfortunately, weaknesses rather than strengths marked the achievement of both boys and girls.

## Introduction

Gender disparity in education has remained one of the pressing problems of many nations in sub-Saharan Africa. A primary challenge in this regard is the absence of equal opportunity and access to education for boys and girls. In particular, this has been a serious problem in rural Ethiopia -although to a lesser extent, girls in urban areas also face the same problem. For example, should a child in a low-income family has to stay at home for one reason or another (e.g., the family cannot afford to pay school fees for all children in the

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family), this child is more likely to be a girl than a boy. It is important to note, however, that most girls in urban areas like Addis Ababa do not seem to encounter this problem – they can get themselves well into their primary or secondary education. Despite this success, girls are likely to face several other challenges. Among other things, girls tend to lag behind boys in their academic performance, notably in mathematics.

To examine if there are gender differences in mathematics performance in Ethiopia, two previous studies explored gender differences in mathematics achievement at the elementary (Seleshi, 2001) and secondary (Seleshi, 2000) school levels. The main objectives of the studies were to see whether there is any difference between the sexes in mathematics performance, and if there is, to find out the grade level at which such differences first appear. By design, therefore, the studies were limited to examining gender differences in mathematics in general. The studies did not address the specific mathematical contents in which gender differences were observed.

However, noting both the theoretical and practical significance of ascertaining the specific mathematics content area(s) in which boys and girls differ, the above two studies have recommended a further examination of gender differences by administering mathematics subtests. Thus, the present study sought to investigate some of the questions that were left unanswered by the two studies. In particular, the question, "Where exactly does the difference between the sexes lie?" was the focus of this paper. Besides, the study examined the relative strengths and weaknesses of the students by employing comparative analyses of their scores on three mathematics subtests.

Examining the performance of boys and girls on mathematics subtests would pinpoint the specific mathematics contents in which boys and girls differ, and this in turn, might provide useful information particularly for teachers. For instance, among other things, the results could inform mathematics teachers where they should exert effort to improve the mathematics performance of male and female students.

Besides, comparison of the students' performance on the three subtests could be useful to detect where exactly the students' problems lie. This may help to answer some important questions: Is it computational skills that the students are lacking? Or is it only in problem solving that they encounter problems? Or is it mathematical concepts that the students have difficulty understanding? Answers to these and other similar questions would provide a good picture of the students' problems in studying mathematics. This will in turn help to devise appropriate corrective measures to alleviate the problem.

## Review of Literature

### Gender Differences in Mathematics: An Overview

In the past, some comprehensive reviews of sex differences (e.g., Maccoby, 1966) generally concluded that girls do better in verbal and linguistic studies while boys do better in mathematical and visual-spatial problems. With more research in the area, however, it has become clear that such a conclusion is far from accurate. For example, one can easily see that even if boys perform better than girls in mathematics at some grade levels, this could not be true at all levels of schooling. To support the latter contention with evidence, many studies have examined sex-related differences in mathematics at different levels of the educational system. The findings from these studies tended to differ from one level of schooling to another.

Most studies that have investigated gender differences in mathematics achievement at the secondary school level have found substantial differences in favor of males. For instance, using a longitudinal design, some investigators (Hilton and Berglund, 1974; Sherman, 1980) have disclosed significant difference in favor of boys in grades seven, nine, and eleven. It is important to note, however, that not all findings coming from longitudinal studies are consistent. For instance, whereas Hilton and Berglund's study found significant differences as early as the seventh grade, Sherman did not find such a difference at the eighth grade level. Similarly, Wise, Steel and Mac Donald (cited in Fox, 1981) did not find any significant gender difference in grade nine though they did find such a difference in favor of boys when the students reached grade twelve. From the results of the longitudinal studies it is clear that whenever differences are found, they appeared to be in favor of boys regardless of the grade level at which the differences first became apparent. Like longitudinal studies, cross-sectional investigations have found, using general mathematics tests, consistent differences favoring males among a sample of ninth, tenth, eleventh, and twelfth graders (Fennema and Sherman, 1977).

Regarding elementary school students, some reviews have concluded that boys and girls show equal aptitude and achievement in arithmetic until they are well into the elementary school period (Anastasi, 1958) or until about the fourth grade (Fennema, 1974a). Subsequent empirical studies have also found no gender difference among nine-year olds (Fennema and Carpenter, 1981), fifth graders (Hilton and Berglund, 1974), or sixth graders (Fennema and Sherman, 1978).

Local studies that examined gender differences in mathematics performance are generally scant. The few available studies have found significant differences between males and females, however. One study, for example, examined gender differences in mathematics achievement in grades eight to eleven in North Shoa secondary schools (Seleshi, 2000). The study reported significant differences in favor of males in all grades. Focusing on fifth and sixth graders in Addis Ababa elementary schools, another study (Seleshi, 2001) found significant difference in mathematics performance favoring boys in grade six but not in grade five.

## Boys and Girls' Performance on Mathematics Subtests

The preceding section has presented a brief examination of the gender gap in mathematics performance in general. This section examines what reviews and empirical studies have reported regarding the performance of boys and girls on specific mathematics subtests (computations, concepts, word problems, etc.).

In a frequently cited review of the literature on sex differences in cognitive abilities, Maccoby and Jacklin (cited in Fox, 1981) concluded that boys and girls showed equal aptitude and achievement in mathematics at the elementary school level. At about the same time, Elizabeth Fennema reviewed the research literature and gave a somewhat different conclusion:

> No significant differences between boys' and girls' mathematics achievement were found before boys and girls entered elementary school or during early elementary years. In upper elementary and early high school years significant differences were not always apparent. However, when significant differences did appear they were more apt to be in the boys' favor when higher-level cognitive tasks were being measured and in the girls' favor when lower-level cognitive tasks were being measured. (Fennema, 1974b, pp. 136-137).

A decade later, Marshall (1984) conducted a study with a similar concern on sixth graders and the results confirmed Fennema's conclusion. According to the study, girls were better than boys in solving mathematical computations whereas boys were superior to girls in solving story problems.

In a similar fashion, Fennema and Carpenter (1981) examined sex-related differences among a representative sample of 9-, 13-, and 17-year olds using three mathematics subtests (geometry, algebra, and measurement). The results revealed no clear pattern of differences in achievement at ages nine or thirteen whereas at age seventeen males' average performance exceeded that of females at every cognitive level (knowledge, skills, understanding, and applications).

Other investigators (cited in Fox, 1981) analyzed the same data for 13- and 17-year olds using three subtests (computations, applications, and algebra) that were slightly different from what Fennema and Carpenter (1981) considered. According to this latter study, no significant male-female differences were found at either age on the algebra subtest whereas males at both ages scored significantly higher on the applications subtest. Moreover, 13-year-old females scored significantly higher on the computation subtest than 13-year-old males although no such differences were found among 17-year olds.

While most of the above research and review work addressed the problem in the US, Badger (1981) reviewed research works on the same issue in the UK. According to Badger's review, whereas girls excelled at computation, boys were superior in application and in solving word problems. Moreover, Badger reported that these differences became apparent at age 11. A cross-cultural study (Lummis and Stevenson, 1990) that examined gender differences among Kindergarten, first and fifth grade children in Taiwan, Japan, and the United States reported results that are somewhat different. The study found that girls were as good as boys in computation problems involving the basic operations of mathematics. In relation to solving word problems, however, the study found that boys were better than girls as early as the first grade.

Contrary to what many investigators reported, one study (Zambo and Follman, 1994) found sex differences particularly in solving word problems at the sixth grade level. What is unique about Zambo and Follman's study is that girls performed better than boys in mathematics problem solving at the sixth grade level. Nevertheless, a closer examination of Zomba and Follman's study indicates that this rare result could be a function of the test setting (or the testing procedure). The authors themselves admitted that their study did not investigate problem solving in a naturalistic situation. The test required students to utilize a nine-step problem solving plan provided by the authors. Consequently, the students could not solve the problems using their own strategies and this may explain why girls surpassed boys, In other words, by providing a step-by-step plan the problem solving task could be converted to a task that emphasizes computation. It should be reiterated that computation is considered a favorite area for young girls or an area where girls often perform at least as well as boys.

In sum, one could observe from the above studies that mostly the performance of males and females on different mathematics subtests is not that different at the beginning but it gets larger and larger as students progress to secondary education. This is particularly true for tests that emphasize applications. The difference on such tests appears to be significant and in boys' favor. Regarding mathematics computations, however, studies revealed mixed results: while some studies found significant differences in favor of females others reported no significant differences. Whereas results favoring girls are usually reported for elementary school students and sometimes for students up to the age of thirteen, many studies reported no gender difference among older students.

## The Research Questions

As discussed earlier, local research that shows the gender difference in relation to specific mathematical contents is lacking. Besides, little is known as to whether students perform equally well on different mathematics subtests. The present study was thus designed to investigate these issues using three mathematics subtests, namely, mathematical computation, mathematical concepts, and mathematical problem solving. In particular, the study sought to answer the following questions:

- Is there a statistically significant difference between boys and girls in their overall mathematics performance? If so, at which grade level does this difference first appear when curriculum-based tests[1] are employed?

- Is a substantial gender difference evident on every mathematics subtest? If so, does the magnitude of the difference vary as a function of the kind of mathematics subtest considered?
- On which subtest do the students perform best and on which one poorly?

## Method

### Sample

The investigator, with the help of two mathematics teachers (one from each grade level), initially selected a sample of 50 girls and 50 boys from each grade level to participate in the study. That is, 200 children were chosen from the entire fifth and sixth grade classes (6 classes from each grade, 12 classes altogether) of Tsehay Chora Primary school and Junior Secondary School. First, the students were stratified by grade, gender and sections/classes. Then, from each section, either eight or nine boys were chosen using simple random sampling technique. Similarly, either eight or nine girls were chosen from each class.

Finally, however, 13 fifth grade children (5 girls and 8 boys) and 10 sixth grade children (4 girls and 6 boys) did not take the test because they were absent on the exam date. The sample thus included 87 fifth grade students (45 females and 42 males) and 90 sixth grade students (46 females and 44 males) with an overall mean age of 12 ½ years and a standard deviation of 1.37 years. The present study focused on children in grades five and six following some researchers' (e.g., Marshall, 1984; Zambo and Follman, 1994) suggestion that gender differences in mathematics performance become apparent as early as the sixth grade.

### The Mathematics Tests

The study employed two mathematics tests[2] (one for each grade level). The author developed the tests based on the mathematics curricula reflected in grades five and six textbooks. Each test comprised 80 items: 30 items on computation, 30 items on mathematical concepts, and 20 items on problem solving[3].

In developing the tests, care was taken not to take items verbatim from the textbooks. On the other hand, reference to each textbook was frequently made to make sure that the test items correspond to the curriculum, both in content and difficulty level. The test was written in Amharic, the language of instruction at these grade levels in Addis Ababa. The test items were presented in multiple-choice format. Except few items with three alternatives, four choices accompanied each item.

Cronbach's coefficient alpha was used to estimate the reliability of the scores obtained from the two tests and the six subtests. The reliability coefficient of the scores on the fifth grade test was 0.85. Analysis of the reliability of the scores on the sixth grade test similarly produced a coefficient of 0.85. Furthermore, the coefficients for the scores of the six subtests ranged from 0.59 to 0.72, with a median of 0.68.

### Procedure

The students took the tests in four classes with an approximate class size of 45 students. Fifth and sixth grade students were in separate classes. The tests had no time limits. That is, students were encouraged to use as long time as was necessary for them to complete the test. To suit this purpose, the test administration took place on a Saturday afternoon.

## Method of Data Analysis

Test scores were analyzed using independent-samples t test in which gender was the independent variable. The scores on the computation subtest, the concept subtest, the problem solving subtest as well as the scores on the total test were the dependent variables. Chi-square test was also employed to compare the students' relative performances on the three subtests. The test for statistical significance was set at 0.05 level.

## Results

### Gender Differences in Overall Performance

The data on students' overall mathematics performance are given in Table 1 below. These data show no statistically significant difference in overall performance between fifth grade boys and fifth grade girls although boys obtained a slightly greater mean score than did girls. At the sixth grade level, however, the gender difference was statistically significant and in favor of boys ($t = -2.20$, $p < .05$, - the proportion of variance in mathematics achievement that was accounted for by gender, partial $\eta^2 = .053$).

**Table 1: Means and Standard Deviations of Total Test Scores by Grade and Gender**

| Grade | Gender | N | Mean | SD | t |
|---|---|---|---|---|---|
| 5 | Female | 45 | 39.04 | 9.36 | |
| | Male | 42 | 41.62 | 10.34 | -1.22 |
| 6 | Female | 46 | 34.28 | 8.66 | |
| | Male | 44 | 38.84 | 10.83 | -2.20* |

Note. Maximum possible score on the test = 80.
* $p < .05$

### Gender Differences in Mathematics Subtests

The scores on the mathematics subtests are presented in Table 2 below. Analysis of the scores indicates that the performances of fifth grade girls and fifth grade boys on subtests of mathematics computations, concepts and problem solving were more or less comparable. That is, like the result for the overall performance, there were no statistically significant gender differences on the three subtests.

Similarly, no statistically significant gender difference was observed between sixth grade boys and girls on the mathematics concept subtest ($t = -1.48$, $p > .05$, partial $\eta^2 = .024$). In contrast, the difference between sixth grade boys and girls on the mathematics computation subtest was marginally significant and in favor of boys ($t = -1.97$, $p = .052$, partial $\eta^2 = .042$). Also, boys obtained a statistically higher mean score than did girls on the problem-solving subtest ($t = -2.29$, $p < .05$, partial $\eta^2 = .057$). Thus, at the sixth grade level, two of the three gender differences were significant.

**Table 2: Means and Standard Deviations of Subtest Scores by Gender and Grade**

| Subtest | Gender | N | Mean | SD | t |
|---|---|---|---|---|---|
| | | **Grade 5** | | | |
| Computations | Female | 45 | 19.82 | 3.71 | |
| | Male | 42 | 20.71 | 3.58 | -1.14 |
| Concepts | Female | 45 | 11.69 | 4.06 | |
| | Male | 42 | 12.76 | 4.39 | -1.19 |
| Problem Solving | Female | 45 | 7.53 | 3.39 | |
| | Male | 42 | 8.14 | 3.92 | -0.78 |
| | | **Grade 6** | | | |
| Computations | Female | 46 | 16.46 | 4.13 | |
| | Male | 44 | 18.20 | 4.28 | -1.97[a] |
| Concepts | Female | 46 | 10.65 | 3.53 | |
| | Male | 44 | 11.82 | 3.95 | -1.48 |
| Problem Solving | Female | 46 | 7.17 | 2.77 | |
| | Male | 44 | 8.82 | 3.93 | -2.29* |

Note. Maximum possible scores: Computation = 30, Concepts = 30, and Problem solving = 20

*$p < .05$ [a] $p = .052$

**Within-Gender Differences in Mathematics Subtests**

Comparison of the performances of students on the subtests was important to see if the students' weaknesses or problems were associated with a specific subtest as indexed by their scores on that subtest. The students' scores on the three subtests were compared by considering the proportion of correctly answered items. The data are presented in Table 3 below. The data, derived from the mean scores and the corresponding maximum possible scores, clearly show that on average the students have performed fairly well on the computation subtest but not on the concept and problem solving subtests. The data also indicate that the mean scores of the students on the latter two subtests were nearly the same.

**Table 3: Percentages of Correct[a] Subtest Scores by Gender and Grade**

| | Grade 5 | | | Grade 6 | | |
|---|---|---|---|---|---|---|
| Subtest | Female | Male | Total | Female | Male | Total |
| Computation | 66.07 | 69.03 | 67.5 | 54.87 | 60.67 | 57.7 |
| Concept | 38.97 | 42.53 | 40.7 | 35.50 | 39.40 | 37.4 |
| Problem Solving | 37.65 | 40.70 | 39.1 | 35.85 | 44.10 | 39.9 |

[a] Percentage correct = mean score divided by maximum possible score multiplied by 100.

As shown in Table 3, examination of the scores of boys and girls on the three subtests indicated a similar pattern of performance at each grade level. Thus, the data for boys and girls were combined for this analysis. Accordingly, chi-square test indicated that the students' performance was relatively better on the computation subtest than on the concept subtest and this was true for students of both grade five ($\chi^2 = 6.64$, df = 1, $p < .05$) and grade six ($\chi^2 = 4.33$, df = 1, $p < .05$). Similarly, fifth graders' performance on the computation subtest was better than their performance on the problem solving subtest ($\chi^2 = 7.57$, df = 1, $p < .01$). However, this was not the case for sixth grade students ($\chi^2$ = 3.25, df = 1, p > .05). The students' scores on the concept and problem solving subtests were about the same and this was true for students of both grades.

## Discussion

The present study examined mathematics performance of fifth and sixth grade boys and girls using three subtests with a view to identifying the mathematical skills in which boys and girls differ significantly. The study also investigated the areas in which the students encounter problems as indicated by their relative performance on each of three subtests.

The mean scores for the fifth grade girls and fifth grade boys on the overall test were more or less the same. In fact, boys have obtained a slightly higher mean score although not high enough to be statistically significant. This result corroborates a finding from a previous study (Seleshi, 2001). Contrary to the result found for fifth graders, sixth grade boys' performance was superior to that of girls. Once again, this result is consistent with the findings of the same study (Seleshi, 2001). Despite differences in their sample sizes and in the comprehensiveness[4] of the mathematics tests they employed, both studies have produced identical results as far as the students' overall performance is concerned. This may strengthen the idea that in Ethiopian government schools, more accurately in Addis Ababa government primary schools, boys and girls show equal performance in grade five but a statistically significant difference begins to appear at the sixth grade level. In this connection, it should be noted that the two studies have employed tests comprising items that required the students to select the answer from the given alternatives rather than those that require examinees to supply the answer. Thus, whether these differences remain the same when other kinds of tests (e.g., tests that include only supply-type items) are administered is an open question, which must await further investigation.

When one considers performance on the separate subtests, gender differences were observed on two of the three subtests at the sixth grade level: (1) the difference in the problem solving subtest was significant and was in boys' favor, and (2) the difference in the computation subtest was marginally significant and was again in favor of boys. The former result is consistent with findings of other studies. For example, like the present study, Marshall (1984) has reported significantly higher scores for sixth grade boys than sixth grade girls on problem solving items. Based on this result, some authors (Zambo and Follman, 1994) have referred to the sixth grade as a "critical" period to stress the idea that it is at this grade level that gender differences first become apparent.

Unlike the finding pertaining to the problem solving items, the marginally significant difference found on the computation subtest does not agree with findings of several other studies (e.g., Lummis and Stevenson, 1990; Marshal, 1984; see also Badger, 1981; Fox, 1981). The studies have generally reported either significant differences in favor of girls or no gender differences on computation items. Thus, even on the computation subtest on which girls in other countries usually score better than boys or at least as well as boys, sixth grade girls who participated in the present study did not perform as well as boys of the same grade. This result is worrisome because it suggests the existence of a serious problem in mathematics education of girls perhaps from grade six onwards.

Perhaps of more practical significance particularly to mathematics education is the examination of the relative performance of the students on the subtests. Generally, the students' performance on the computation subtest was by far better than their performance on the concept subtest. This held true for both boys and girls as well as for students of both grades. For instance, fifth grade students have answered, on the average, two-thirds (67.5%) of the computation items correctly. Nonetheless, the same students have correctly answered only twelve of the thirty conceptual items (40.7%). The case was nearly the same for sixth graders.

Similarly, the students in both grades have performed better on the computation subtest than on the problem-solving subtest and this was true for students of both grades. Nonetheless, this difference in performance was statistically significant for grade five students but not for the $6^{th}$ grade. Compared to the former, the latter students have obtained a lower mean score on the computation subtest and that is why the difference in their performance on the subtests was not statistically significant. Overall, it was only on the computation subtest that the students have managed to obtain a mean score greater than 50 percent.

In general, the gender-related findings imply that if there has to be any remedial instruction aimed at improving girls' mathematics achievement until their performance reaches the level of boys, then the instruction must focus on teaching computation and problem solving strategies beginning from grade six. Particularly in relation to problem solving, Zambo and Follman (1994) evidenced that it is possible for girls to solve word problems as well as or even better than boys. According to the study, this could be achieved if students pay attention to several steps they need to follow in solving word problems. By so doing, the study has succeeded to raise girls' problem solving score to a degree where it is higher than that of boys by a small but statistically significant amount.

Apart from this, the problem seems to transcend the issue of gender. As can be seen from the scores on the three subtests, both girls and boys showed weaknesses in almost every mathematics area evaluated but this was more so in solving word problems and understanding mathematical concepts. Even if boys obtained mean scores on the computation and problem-solving subtests which were better than girls, they were not good enough.

In general, it is apparent from the findings that there is a serious problem in correctly answering conceptual and problem solving items. This perhaps is attributable to the emphasis placed on computation in the curriculum and/or possibly to the emphasis given to computation by teachers. In many fields including mathematics it is important for students to understand concepts. The failure to comprehend concepts in any field has serious consequences especially for those who want to pursue their studies in that area. Students with no good knowledge of mathematical concepts at the lower grades will certainly suffer a great deal when studying mathematics and related courses (or subjects) in later grades. The students' domain-specific knowledge will not be adequate enough to guarantee smooth progress in their mathematics studies and in fields that need mathematical applications.

The case of problem solving is no different. Apart from its use in mathematics itself, problem solving is critical for success in many mathematics-related fields, such as engineering and physics (Hyde, Fennema, and Lamon, 1990). Students' inability to solve even half of the items (on average) entails more serious problems in the students' future academic endeavors particularly in mathematics and related fields.

The results generally point to the need for some remedial instruction for all students, which focuses on helping students develop problem solving skills and understand mathematical concepts relevant to each grade. Remedial instruction that focuses on computation strategies is also necessary as students have not performed very well on this subtest given the relatively less difficult nature of computation items. While the remedial instruction is relevant as a short-term measure to alleviate the problem, in the long run an investigation which explores possible causes of the students' problems must be conducted. In this regard, the examination should center, among other things, on the mathematics curriculum, teacher education, and the correspondence between the two.

Another important direction for future research is the identification of variables that help to explain why some girls and boys manage to achieve higher than many in mathematics. If we know these variables through research, the results would provide information on how to improve mathematics performance of both low-achieving boys and girls. In other words, finding out what variables helped the high-achieving group to perform well and examining whether the same variables differentially influence the low-achieving group will provide valuable information in devising measures to improve the performance of the low achievers.

## Summary and Conclusion

In addition to investigating gender differences in mathematics performance, the present study examined whether the students have performed equally well on different subtests of mathematics. The results showed a statistically significant difference between boys and girls in grade six but not in grade five. Whereas a marginally significant gender difference was observed in computation, the gender difference in problem solving was statistically significant. On both subtests, boys performed better than girls. Furthermore, examination of the students' performance on the three subtests showed that the performance of students (boys and girls combined) was relatively better on the computation subtest. It was only on the computation subtest that the students were able to answer slightly more than one-half of the items correctly.

Overall, the findings suggest the presence of acute problems in the learning of mathematics. Despite the small but statistically significant gender differences, the results indicate more similarities than differences between boys and girls. Unfortunately, however, failure rather than success characterizes the similarities. Thus, measures taken to improve girls' achievement should also be directed toward raising boys' performance. These efforts should center more on the development of skills in problem solving and understanding concepts. Along with all these efforts, an attempt should be made to unravel the reason(s) why the students are performing so poorly in mathematics in general.

Because the present study employed mathematics tests with a multiple-choice format, it is difficult to ascertain whether the use of other types of tests would yield the same results. While this should await further research, one may conclude from the present findings that mathematics performances of both boys and girls are generally poor. The performances of both sexes also follow a similar pattern.

Finally, it is important to note that the data on which the present findings are based came from a pilot study. The pilot sample was chosen only from Tsehay Chora Primary and Junior Secondary School. Thus, until the main study establishes the external validity of the present results by replicating them on samples that will be selected from other schools, readers should generalize the results with care.

**Notes**

[1] The present study employed a curriculum-based test for each grade. More specifically, each test was developed in such a way that the items correspond to the curriculum both in content and difficulty.

[2] The two tests were developed to measure students' performance on mathematics computation, concepts and problem solving items. The test development process followed standard procedures of test construction. In this process, first came the analysis of the contents of the textbooks. The contents were listed along with the number of pages they covered in the textbook. This was used to approximate the amount of time a teacher would spend in teaching the contents. The tests were then developed in such a way that the number of items set from each content area was roughly proportional to the approximate time needed to teach it.

[3] Examples of items included in each subtest are presented below.

(a) Computation items refer to test items that require the use of the four basic arithmetic operations to get a single numerical answer. The following items are examples.

- 58 + 5 = ___ (A) 65 (B) 513 (C) 53 (D) 63
- 16 – 9 = ___ (A) 25 (B) 8 (C) 6 (D) 7
- 8 x 2 = ___ (A) 8 (B) 16 (C) 32 (D) 24
- 35 ÷ 5 = ___ (A) 6 (B) 30 (C) 7 (D) 5

(b) Conceptual items are those mathematics items that require students to comprehend principles and mathematical ideas before producing the answer. The following are examples of conceptual items.

- In the numeral 3427, what does 3 represent? (A) 30000 (B) 3000 (C) 300 (D) 30
- The product 6x7 is closer to __. (A) 50 (B) 45 (C) 40 (D) 35
- Which one has the largest weight? (A) 1kg cotton (B) 0.5 kg sugar (C) 750g meat (D) 0.25 kg coffee

(c) Problem solving items, on the other hand, involve at least two steps: representing the word problem by a mathematical equation and solving for the unknown term. Examples are given below.

- Seble has obtained a score of 85 in the first semester mathematics exam. Alemitu's score is higher than Seble's by nine marks. Find Alemitu's mathematics score.
  (A) 94 (B) 93 (C) 85 (D) 76
- There are 1450 students in a school. Among these 755 are girls. How many boys are there in the school?
  (A) 685 (B) 695 (C) 785 (D) 795

[4]The present study employed tests that were more comprehensive than the ones used in the previous study. The test items for the

former tests covered all contents in the textbooks as opposed to the latter, which covered only some portions of the textbooks. More specifically, each test used in this study contained 80 items as opposed to only 25 items in the previous test.

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