Study Note

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# Papua New Guinea Sample Mathematics Test Report
# Analysis of Grade 6, 7 & 8, and Teachers College students' performance on a sample Mathematics Test for Papua New Guinea (PNG)

Anda Apex APULE, Hiroki ISHIZAKA, Hiroaki OZAWA, Takeshi KOZAI

International Cooperation Center for the Teacher Education and Training
Naruto University of Education

Abstract

Many Papua New Guineans students at all level of the national education system comment that they always found mathematics a difficult subject to understand. The learning difficulties are experienced by many school students under the current mathematics curriculum. This report is based on a sample mathematics test conducted with a sample population from grade 6, 7 and 8 and teacher training college students. The items were taken from grade four according to PNG mathematics curriculum.

Most of the results obtained were surprisingly unsatisfactory from both the sample primary participating students and the Teacher training college students. The findings indicated common areas of misconception in addition and subtraction of fraction, comparing decimals numbers, addition & subtraction of 2-digit from 3-digit numbers and knowledge geometry questions by school, gender and across different grade level. The similar type of misconception were also noticed from the teacher training college students.

The significant of this report is to inform educators, curriculum planners, teachers and universities the general misconception of teaching and learning in Primary Education in PNG so that focus and framework of the teaching and learning in mathematics in primary education could be restructured regarding students learning difficulties which are revealed in this report.

## 1. Introduction

Mathematics subject is taken as one of the compulsory subject in PNG education. It starts from elementary level with five main strands, Space, Measurement, Number, and Pattern and Chance. These strands displays a typical progression of learning from one grade to the next.

This report contains information about the sample Mathematics Test conducted in Papua New Guinea in two provinces, Central and Nations Capital, Port Moresby. The test was administered by Naruto University of Education academic professors who were part of JICA trainers and consultants assigned to PNG.

This sample test acts as an international instrument tested in PNG to assess the curricular and effectiveness of mathematics education and level of performance standards. The results are presented for the general and overall performance, by gender, grades and schools.

There were four participating schools in the sample Mathematics test. They are labeled A, B, C and D from which three are primary schools and one teacher training college.

Primary school `A` is one of the urban school situated at Port Moresby, the capital city of PNG. This school has highest enrollment figure every year around and regarded has one of the best school in

terms of academic performance.

Primary school `B` and `C` and both located in the central province where school `B` is semi-urban and school `C` is very rural.

School `D` is one of the Teacher Training College for primary school teachers. It is located in Port Moresby and enrolls students from all over Papua Guinea who chooses teaching as their career profession.

The medium of instructions for PNG education is English whereas combination of English and Tok Pisin is the everyday language of communication.

### 2. Participants

The sample includes a total of 572 students from which 51.2 % male and 48.8% female. Upper Primary school students, grade 6, 7 and 8 had 488 participants while the remaining 84 participants come from the first year teacher college students. The primary school students' ages' ranges from 12 -14 years while the college students were from 19 years and above. Details of the information can be seen from Table 1, 2 and the figure 1 below.

Table 1. Total number of participants in each school and grade

| Schools | Frequency | Percent |
|---|---|---|
| A | 259 | 45 |
| B | 127 | 22 |
| C | 102 | 18 |
| D | 84 | 15 |
| Total | 572 | 100 |

Table 2. Total number respondents per grade

| Grade | Frequency | Percent |
|---|---|---|
| 6 | 166 | 29.0 |
| 7 | 164 | 28.7 |
| 8 | 158 | 27.6 |
| TC-Year 1 | 84 | 14.7 |
| Total | 572 | 100.0 |

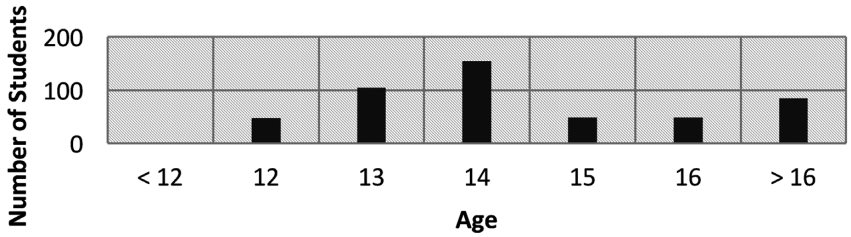



Figure 1. Age and Gender of Participants

### 3. Content and Context of the Sample Test Item

The mathematics sample assessment was framed by two organizing dimensions or aspects, a content domain and a cognitive domain. The sample consist of only two content domains, number and geometry. The cognitive domains include knowing facts and procedures, using concepts, solving routine problems, and reasoning. This is summarized in Table 3 below.

Table 3. Content, context & performance of test items

| Content domain | Content Topic | Cognitive domain |
|---|---|---|
| Geometry | - Angles<br>- Using Properties of Triangle | - Knowing facts and Procedures<br>- Reasoning<br>- Using concepts |
| Number | - Decimals – Comparing size of decimals<br>- Addition and Subtraction of numbers less than 1,000<br>- Simple word problems involving addition and subtraction<br>- Addition and Subtracting Fractions with common denominator<br>- Addition and Subtraction of Fractions with different denominator | - Knowing facts and Procedures<br>- Reasoning<br>- Solving routine problems<br>- Using concepts |

## 4. Overall Results of the Sample Test Performance

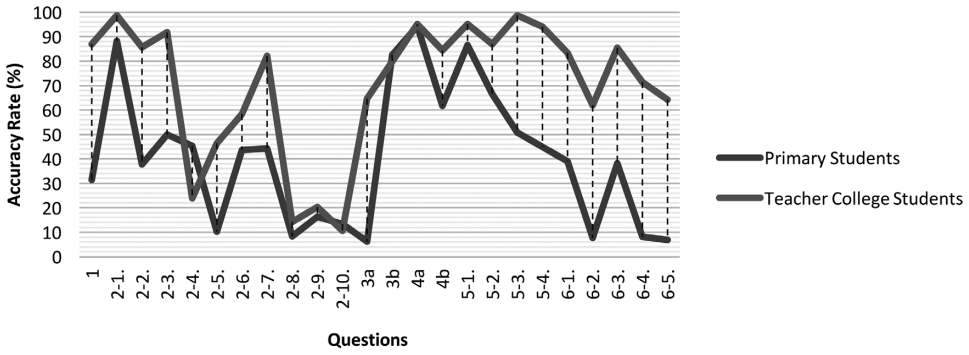



Figure 2: Overall performance for the total respondent population

Figure 2 above describes the overall performance from the total respondents. According to the information, lower the performance from the teacher college students, much lower the performance from the primary students on most of items vice versa. However, for items 2-4, 2-10 and 3b the primary students performed higher than teacher training respondents whereas for item 5-3, the primary school respondents performed much lower while the teacher training respondents' performance was higher. In overall, the total sample population somehow demonstrated same type of understanding and misconception. It means that the misconception in those items that both primary and college respondents did not do well are common problems in PNG Mathematic education.

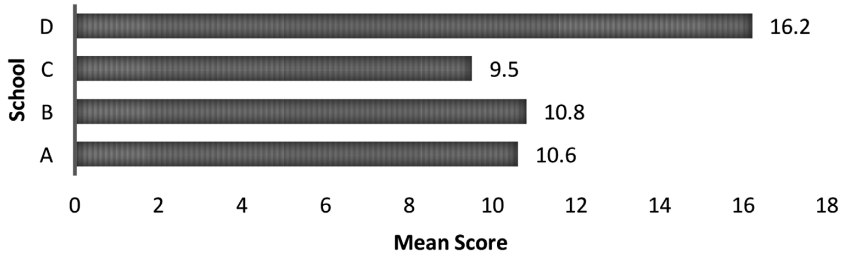



Figure 3. Test performance mean out of 24 items.

The figure 3 above shows the test performance mean out of 24 items. According to the information, the mean performance from the three participating primary school were just about the same. School D, the college students' respondents had a mean of 16.2.

## 5. Primary School Performance for Specific Items

### 5.1 School performance and accuracy for each item

According to figure 4 above, most of the results are far below 50%. Although the results were

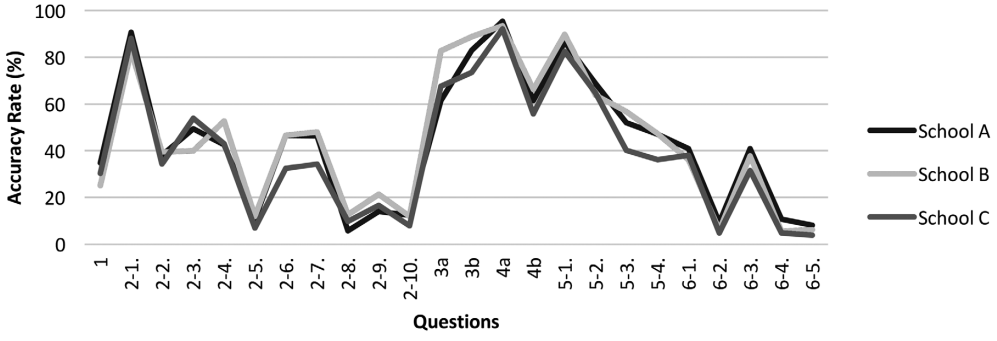



Figure 4: school performance and accuracy on each item from the three primary schools that participated in the sample test.

compared against school, the respondents somehow exposed same type of understanding and misconception on each items. Especially geometry questions, Q1, items 2-2 to 2-10 and fractions questions, items 6-1 to 6-5 had low performance rate. The low performance on these content areas may be caused by teachers skipping of lessons or poor lesson delivery without using concrete objects.

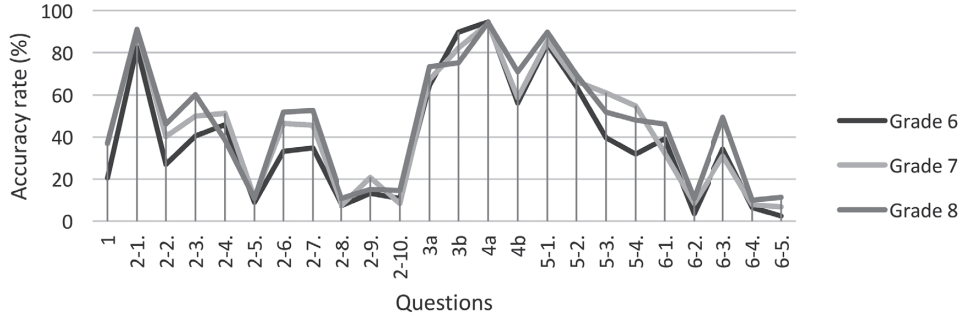



Figure 5: Performance of the upper primary school respondents' by grade in total from the three participating schools.

### 5.2 Grade Performance for specific items

The sample test is further analyzed by grade level as shown on the figure 5 above. According to the information, not much difference in performances by grade level was noticed. For some items, grade 6 and 7 students' results were higher than grade 8 students' respondents. That means there is no clear evidence of step-up process of learning in the curriculum. There is no evidence that student's misconception are corrected before moving to the next grade level. Students move to the next grade level without concrete mathematical skills or knowledge.

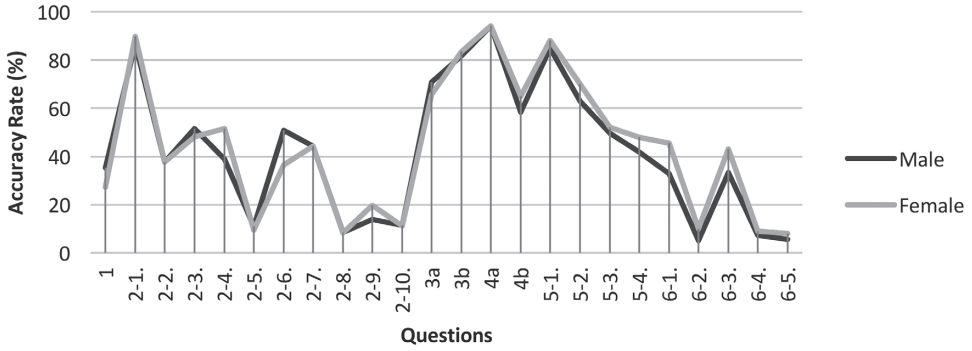



Figure 6: performance by gender for the specific items

### 5.3 Gender Accuracy for specific items

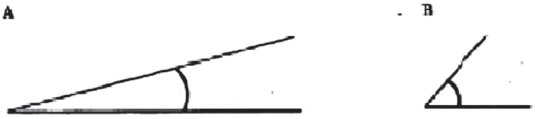
The line graph in figure 6 shows the accuracy rate by gender on the sample test. According to the information the girls performed slightly better than the male participants' from grade 6, 7 and 8 in most of the items. However, the overall performance from both genders revealed common areas of strengths and weakness.

## 6. Examples of Specific Item Performance and Accuracy

### 6.1 Question 1

Which angle (A or B) is larger?

Answer: _____



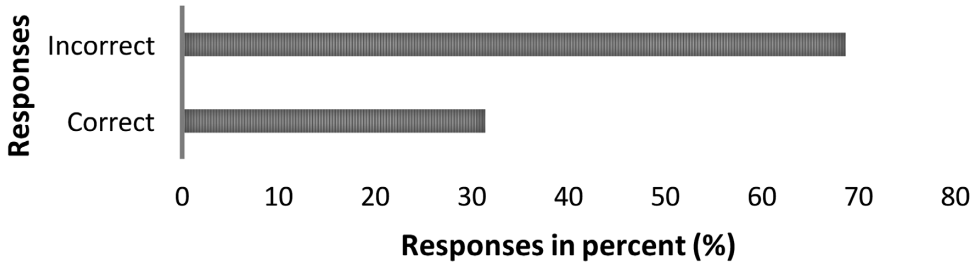



Figure 7: Primary school students' respondents' performance on question 1.

From the bar graph above, it can be seen that less than half of about 31% of the respondents manage to get this question correct whereas 69% of the responses were incorrect. The incorrect responses resulted from misunderstanding the length of the lines and angle included between the lines. This shows that students lack the basic knowledge of geometry. Low performance on this item could be the caused by students poor remembrance or inadequate teaching.

### 6.2. Question 2

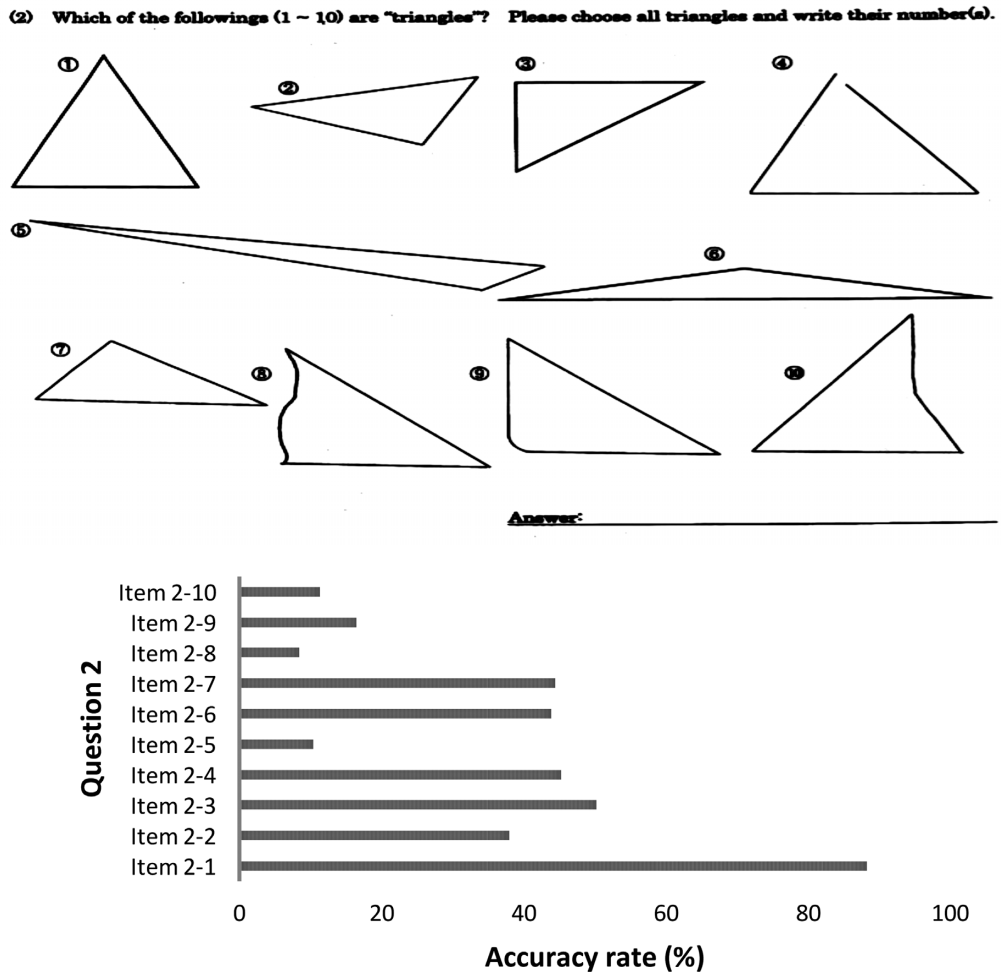



Figure 8: Primary school students' respondents' performance on question 2.

According to figure 8 above it can be seen that students had difficulty on item 2-5, 2-8, 2-9 and 2-10. Question 2 is under the content category of geometry. The performance expectation of these items is simple knowing the facts and properties of a triangle. However, many students displayed their misconception in recalling the facts and properties of a triangle.

### 6.3. Question 3

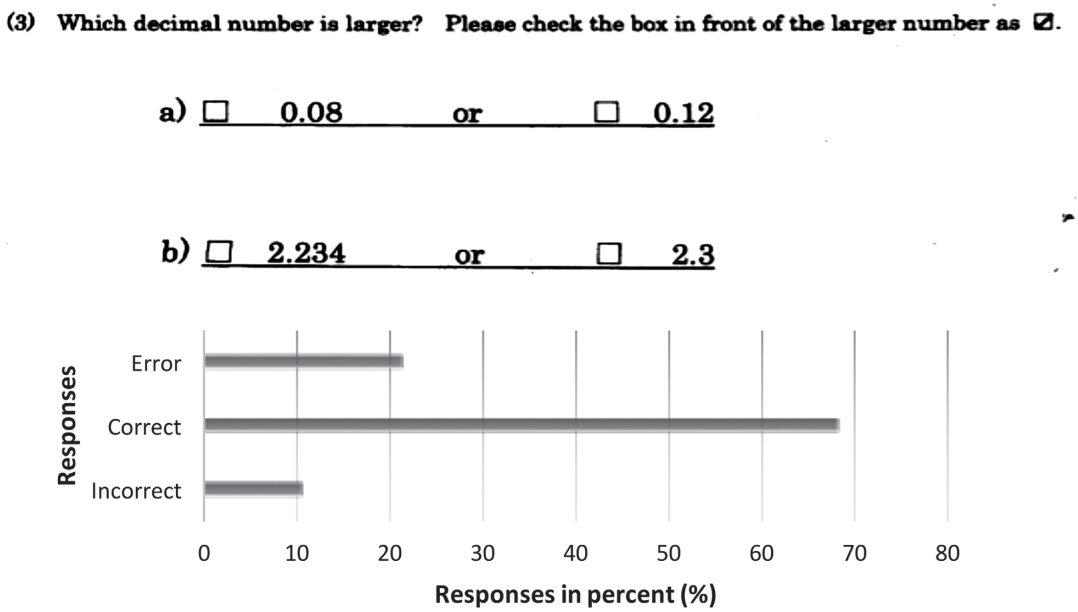



Figure 9: Primary school students' respondents' performance on item 3a.

According to the graph above, it shows that about 68.2% of the respondents checked the correct box. From the 31.8% incorrect answers, 27% (10.5%) of the students' respondents checked the incorrect box while others did not choose any of the options. The incorrect respondents may had the misconception that fewer digits to the right of a decimal point always makes a decimal larger and that any number of tenths is greater than any number of hundredths and that any number of hundredths is greater than any number of thousandths, and so on. Again, this could be the result of poor lesson delivery or without using the concrete materials for students' conceptual understanding on this content area.

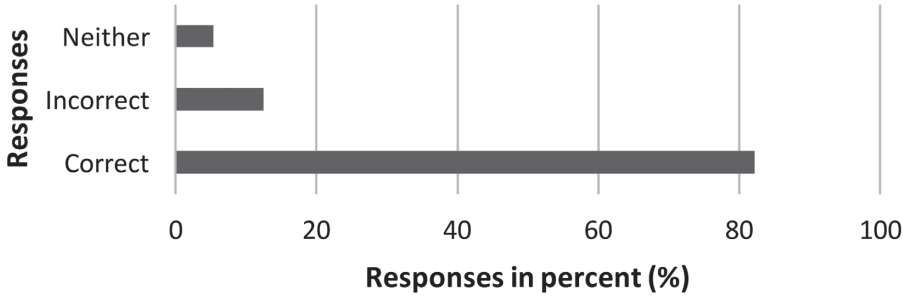



Figure 10: Primary school students' respondents' performance on item 3b.

The graph shows that for this item about 82.2% of the students' respondents had correct answers while 12.2% had incorrect responses. The incorrect responses may have resulted from treating the portion of the number to the right of the decimal point as a whole number, thus thinking that 2.234 > 2.3 because 234 > 3. These observations reflect that the students have neither sense of the quantitative value of decimal numbers nor any understanding of the place value of each decimal place though the basic concepts of decimal numbers such as the place value and its relation with fraction which are discussed at the early stage of learning decimals. Another 5.3% of the respondents did not check any of the choices for this item.

### 6.4. Question 5

Calculate the followings (Please show your calculation process as well)

1. 34 + 28　　2. 234 + 57

3. 53 – 26　　4. 103 – 67

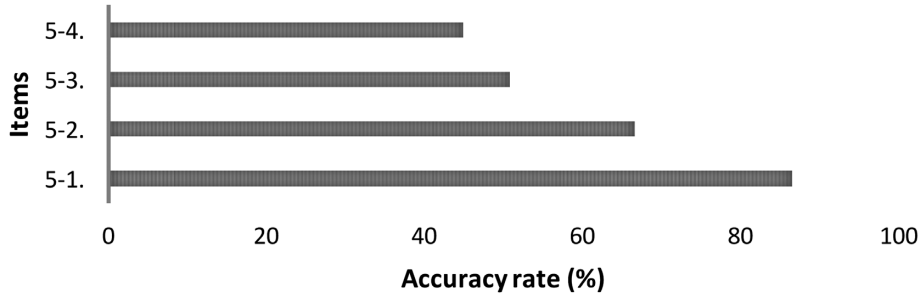



Figure 11: Primary school students' respondents' performance on question 5.

Figure 11 above shows the students' respondents' performance on question 5 items. According to the results, the accuracy rate on items 5-1 and 5-2 (addition) were little better than items 5-3 and 5-4 (subtraction).

### 6.4.1. Analysis of items 5-2 and 5-4

Table 4: Cross analysis of items 5-2 and 5-4.

| | | Item 5-4 | | |
|---|---|---|---|---|
| | | Correct | Incorrect | Total |
| Item 5-2 | Correct | 37.3% | 29.3% | 66.6% |
| | Incorrect | 7.6% | 25.8% | 33.4% |
| | Total | 44.9% | 55.1% | 100% |

Items 5-2 and 5-4 are addition and subtraction of 3-digit with 2-digit numbers respectively. According to the given information on table 4 above, it can be seen that about 25.8% of the students' respondents had incorrect answers from both items whereas 37.3% had correct answers from both items. On the other hand, about 29.3% had correct answer in item 5-2 they were incorrect in item 5-4 while only about 7.6% had incorrect answers in item 5-2 but they were correct in item 5-4. This shows that students' respondents found item 5-4, subtraction of 2-digit number from 3 digit number more difficult than item 5-2, addition of 3-digit number with 2 digit number.

Table 5: The specific level of difficulty on items 5-2 and 5-4.

| | Item 5-4 | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Correct | Simple Calculation error | Error in Carrying number | Error in Positional numeration system | Others | Total |
| Item 5-2 | Correct | 37.3% | 4.9% | 19.7% | 1.2% | 3.7% | 66% |
| | Simple Calculation error | 3.1% | 1.4% | 4.1% | 0.2% | 2.0% | 10.8% |
| | Error in Carrying number | 1.2% | 0.0% | 2.7% | 0.0% | 0.6% | 4.5% |
| | Error in Positional numeration system | 3.1% | 1.4% | 1.8% | 5.1% | 1.0% | 12.4% |
| | Others | 0.4% | 0.0% | 0.6% | 0.0% | 5.3% | 6.3% |
| | Total | 45.1% | 7.7% | 28.9% | 6.5% | 12.6% | 100% |

The table 5 above shows the specific level of difficulties from items 5-2 and 5-4 according to students' respondents' performance. From the 29.3% incorrect answers in item 5-4 (refer to table 4), more than half (19.7%) of the respondents had error in carrying number. Even though they can carry or regroup number in addition, they failed to do in subtraction. This means students were not taught well in carrying out the regrouping process concretely for the two operations. Also many other students had difficulty in positional numeration system were they failed to understand the place value of the digits in the calculations.

### 6.5. Question 6

Calculate the following (please show your calculation process as well).

1. $\frac{2}{5}+\frac{1}{5}$
2. $\frac{1}{3}+\frac{3}{4}$
3. $\frac{4}{5}-\frac{1}{5}$
4. $\frac{5}{6}-\frac{3}{4}$
5. $\frac{2}{3}-\frac{1}{4}$

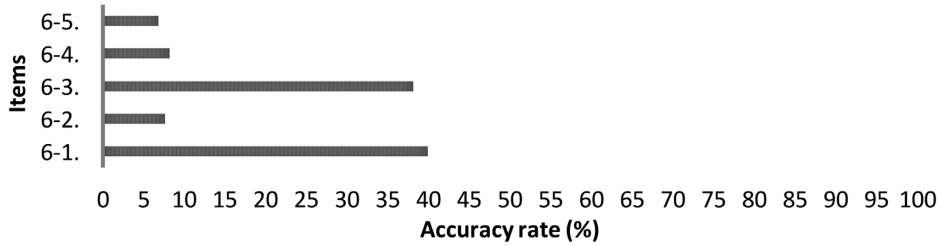



Figure 12: Primary school students' respondents' performance on question 6.

Figure 12 above shows that students did not perform well on the fractions items in the sample test. According to the sample test items, it can be seen that items 6-1 and 6-3 are fractions with common denominator which 39% and 38% respectively were correct whereas the other three items, 6-2, 6-4 and 6-5 are fractions with different denominators which the students' respondents' accuracy rate was very low.

#### 6.5.1. Analysis of item 6-1 and 6-3

Table 6: Cross analysis of items 6-1 and 6-3.

| | | Item 6-3 | | |
|---|---|---|---|---|
| | | Correct | Incorrect | Total |
| Item 6-1 | Correct | 30.1% | 9.0% | 39.1% |
| | Incorrect | 8.0% | 52.9% | 60.9% |
| | Total | 38.1% | 61.9% | 100% |

Items 6-1 and 6-3 are addition and subtraction of fractions with common denominator respectively. The results from both items were items were put together as shown in the table 6 above to see the influence of one item to the other. According to the information, more than half (52.9%) of the students' respondents' had incorrect answers from both items. In contrast, even though 9% had correct answers in item 6-1, they were incorrect in item 6-3. And also 8% had correct answers in item 6-3 but they were incorrect in item 6-1. This shows that students understanding of the related contents (fractions with common denominators) of the two items were insufficient thus resulting getting one item correct while the other wrong.

Table 7: The specific level of difficulty on items 6-1 and 6-3.

| | Item 6-3 | | | | | | |
|---|---|---|---|---|---|---|---|
| | Responses | Correct | Simple Calculation error | Error in treating numerators and denominators as separate whole numbers | Error in recognizing common denominator | Others | Total |
| Item 6-1 | Correct | 30.1% | 0.6% | 7.4% | 0.4% | 0.6% | 39.1% |
| | Simple Calculation error | 0% | 0.4% | 0.4% | 0.0% | 0.0% | 0.8% |
| | Error in treating numerators and denominators as separate whole numbers | 7.4% | 0.0% | 39.8% | 0.2% | 2.5% | 50.0% |
| | Error in identifying common denominator | 0.2% | 0% | 0.0% | 0.4% | 0.0% | 0.6% |
| | Others | 0.4% | 0.0% | 0.3% | 0.0% | 9.2% | 9.9% |
| | Total | 38.1% | 1.0% | 48.4% | 1.0% | 12.3% | 100% |

Table 7 shows the summary of the students' respondents' performance on items 6-1 and 6-3 and the specific level of difficulty. According to the given information, from the 52.9% (refer to table 6) students' respondents who had incorrect answers from both items, approximately 75% (39.8%) of them had the error in treating numerators and denominators as separate whole numbers, (e.g., 2/5 + 1/5= 3/10 or 4/5 – 1/5= 3/0). These students fail to recognize that denominators define the size of the fractional part and that numerators represent the number of this part.

Also from the 9% incorrect answers in item 6-3 (refer to table 6) more than 82% (7.4%) were error in treating numerators and denominators as separate whole numbers. Likewise, from the 8% incorrect answers in item 6-1, more than 92% (7.4%) had the similar type of error. Other errors were also noticed in smaller portion such as failing to recognize the common denominator (i.e., 2/5 + 1/5= 3/25 or 4/5 – 1/5= 3/25), simple calculations error and other unrecognizable errors. This means students lack understanding the true meaning of fractions and concrete processes involved to solve a given problem.

### 6.5.2. Analysis of item 6-2 and 6-5

Table 8: Cross analysis of items 6-2 and 6-5.

| | | Item 6-5 | | |
|---|---|---|---|---|
| | | Correct | Incorrect | Total |
| Item 6-2 | Correct | 5.8% | 1.8% | 7.6% |
| | Incorrect | 1.0% | 91.4% | 92.4% |
| | Total | 6.8% | 93.2% | 100% |

Item 6-2 and 6-5 are addition and subtraction of fractions with different denominators respectively. The results were put together to see the influence of one item to the other as shown in the table 8 above. According to the information item 6-2 had no influence on the accuracy level of item 6-5. Even though 1.8% had incorrect responses in item 6-5 they were correct in item 6-2, and also about 1.0% incorrect responses in item 6-2 they were correct in item 6-5. In overall, the accuracy rate on these two items were very low as only 5.8% had correct answers from both items.

Table 9: The specific level of difficulty on items 6-2 and 6-5.

| | Item 6-5 | | | | | | |
|---|---|---|---|---|---|---|---|
| Item 6-2 | Responses | Correct | Simple Calculation error | Error in treating numerators and denominators as separate whole numbers | Failing to find common denominator | Others | Total |
| | Correct | 5.8% | 0.6% | 1.0% | 0.0% | 0.2% | 7.6% |
| | Simple Calculation error | 0.2% | 0.0% | 0.0% | 0.0% | 0.2% | 0.4% |
| | Error in treating numerators and denominators as separate whole numbers | 0.4% | 0.6% | 64.5% | 1.2% | 3.7% | 70.4% |
| | Failing to find common denominator | 0.4% | 0.2% | 0.4% | 9.4% | 0.4% | 10.8% |
| | Others | 0.0% | 0.0% | 1.2% | 0.4% | 8.8% | 10.4% |
| | Total | 6.8% | 1.4% | 67.1% | 11.0% | 13.3% | 100% |

Table 9 shows the categories of difficulties according to students' respondents' performance on items 6-2 and 6-5. As it can be recognized from the table above, from the 91.4% incorrect answers (refer to table 8) from both items, more than 70% (64.5%) had error in treating numerators and denominators as separate whole numbers. Another 10 % (9.4%) of the incorrect answer was when students failed to convert fractions to a common, equivalent denominator before adding or subtracting them, instead they just used the larger of the 2 denominators in the answer (e.g., 1/3 + ¾= 4/4 or 2/3 -1/4= ¼). Students did not understand that different denominators reflect different sized unit fractions and that adding and subtracting fractions requires a common unit fractions (i.e., denominators). These results indicate that students understanding of fraction content was very poor.

## 7. Teacher Training College Performance

According to the line graph, it can be seen that overall performance of the first year teacher college students on this sample test was satisfactory. Students at this level of education also displayed an unexpected

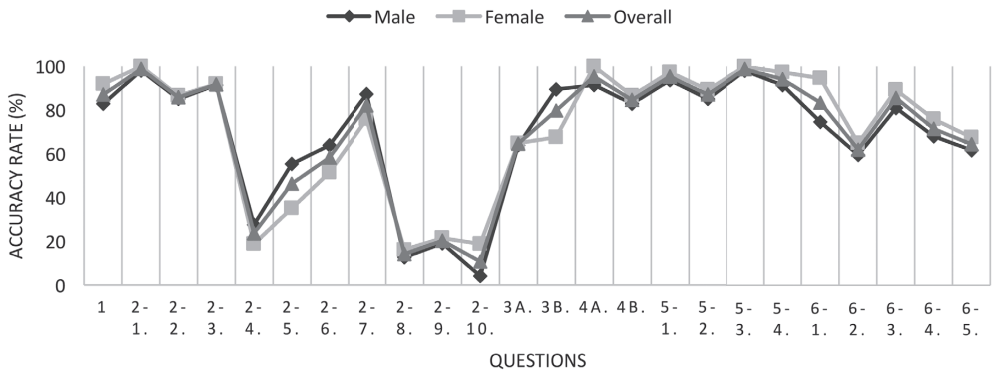



Figure 13: the performance of the teacher college students on each sample item by gender and the overall performance.

performances on some of the basic numeracy skills. For example, basic fractions ideas of adding and subtracting fractions with different denominator, items 6-2, 6-4 and 6-5 and knowing basic shape properties in geometry, items 1, 2-4, 2-5, 2-6, 2-8, 2-9, 2-10 and also comparing decimal numbers, item 3a were performed poorly as expected by this group of respondents. These items were much more poorly done by the upper primary students. This means that those misconceptions are not correctly even though they progressed to the higher grade level. These results may also mean that PNG teacher college students still lack basic mathematics skills.

## 8. Conclusion

This survey or sample mathematics test was successfully conducted in the three upper primary students and one teacher training college. The primary schools were fairly selected to conduct this research, one urban primary school, one semi-urban and one very rural primary school. There were also fair participants from both gender from the 572 total participants. The sample test consisted of items taken from lower primary contents according to PNG mathematics syllabus.

From the results obtained the performance from all the three participating primary school were about the same. It was also observed that there were no improvement when the data was analyzed by grade. The grade 8 students' performance make no difference compared top grade 7 and then Grade 6. Though difference in grade levels, the level of understanding and misconception on each items were the same. That means that there is no clear level of inclination in mathematics content as grade level increases. Also it can mean that students proceed to the next grade level without concrete knowledge. With those misconception in their mind, understanding higher concepts becomes much more difficult for them.

Furthermore, items on fractions with different denominator were poorly done. The fractions content is taught from grade 3 onwards according to the Lower primary syllabus in PNG mathematics education. However, the results showed that grade 6, 7 and 8 students had a lot of misconception in solving these items. It means that teaching and understanding of fraction content is a big problem and needs to be improved in PNG mathematics education.

Also in the content domain geometry it was discovered that students could not distinguish between angle size and length. They also had problem of recalling the properties of triangles. This may be result of effective teaching, not having essential text books to support the teaching and learning and so on.

Under the analysis of first year teacher college performance on this sample test, it was observed that some items on geometry and number especially fractions were unsatisfactorily performed by this level of respondents. It is very critical that the probability of circulating the misconception of basic mathematical ideas from graduating teachers to students is at large. If these teachers go into the classroom and teach, they may pass their misconception to the students.

Hence, in order to improve quality of mathematics education in Papua New Guinea, it is essential to consider the following recommendations.

Firstly, in order to generate good and content qualified teachers, the department of education through the Teacher Education Division must central-

ize selection for students entering teachers colleges. That means the selection of the new intakes must be done by a committee under TED. The GPA must be raised and qualified students must have at least C or higher grades in Mathematics subject.

Secondly, Papua New Guinea Education Institute (PNGEI) as the premier in-service Institute and other teachers colleges must run short term content based training for the field teachers especially in the area of Mathematics and Science

Thirdly, Subject specialist teachers must be assigned to teach upper primary classes. The system of one teacher teaching all subjects must be stopped immediately to improve the standard of mathematics learning. Teachers are forced to teach all subjects even though they are poor in teaching the subject. The consequence is that for subjects like mathematics many of the content learning areas are skipped. The results also confirmed no improvement in mathematics achievement even though grade level progressed up.

And finally, the curriculum alignment done must be clearly stated and spelt out to the teachers and students so that appropriate content at each grade is delivered to the students. To achieve coherence, a curriculum program must build new ideas and skills on earlier ones within lessons, from lesson to lesson, from unit to unit, and from year to year, while avoiding excessive repetition. As students construct and develop new ideas and skills, the concepts and processes they learn become richer and more complex.

It is about time that PNG needs to produce quality teachers. Without a good teacher and good curriculum alignment which is very clear to the teachers and students can raise the standard of mathematics education.

The gateway to the future learning of mathematics depends on the type of curriculum we have and quality of teachers we have in the primary sector of the education system.

Therefore, for PNG to produce top quality students and citizens who can participate in the modern society, we need to immediately act on some of the recommendation above to improve and raise our educations standard that is competent with the rest of the world.

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