Study Note

NUE Journal of International Educational Cooperation, Volume 11, 73-83, 2017

An In-depth Analysis of Fiji Grade 6 Mathematics External Examination Items and Results

Taura JOWELI

Naruto University of Education

Abstract

The mathematic achievement in Fiji primary schools has been a major concern over the last decade. This was clearly shown by the students' constant poor mathematics results in the three (3) annual national external examinations namely the Literacy and Numeracy Assessment (LANA), Fiji Year 6 Examination (FY6E) and the Fiji Year 8 Examination (FY8E). The purpose of this in-depth analysis of the external examination items, results and the examiner's report is to illustrate an overview of Fiji Grade 6 students' mathematics achievement level and the underlying factors that may have hindered the numeracy achievement progress. The entire analysis covers the Fiji Year Six Examination and Fiji Year Eighth Examination mathematics results of 2015 in addition to the Year 6 Numeracy Results from 2012 to 2015. However, the results analysis has discovered that students' poor numeracy achievement is highly related to students' lack of basic mathematic conceptual knowledge and skills to solve comprehension and application related problems which requires high level thinking influence. In this regard, the quality of mathematic teaching and the teachers' competence level are highly questionable.

1. Introduction

Mathematics Education has been widely regarded as the heart of Fiji economic development. Due to its direct implication in the life of an individual and the nation as a whole, the focus on its quality implementation in and out of the classroom is seriously considered with great intensity. In Fiji, mathematics is taught as a compulsory subject to all students from K-Grade13. At the primary level, the main mathematic topics of teaching are Numbers, Chance and Data, Measurement, Geometry and Algebra.

Despite the numerous recent reforms, strategic initiatives and the huge investment of the Fiji Government in the education sector over the last decade, the academic achievement of students in mathematics continues to hit rock-bottom which is far below the expectations of the government and the communities at large.

In the quest to identify key reasons behind this issue, the initiative was taken to analyze the 2015 Fiji Year 6 and Year 8 External Examination mathematics items and students' results. However, only the Year 6 examination analysis was carried out in much greater details using the national examiner's reports of Grade 6 as a reference. This activity was executed in conjunction with the analysis of the Grade 6 national numeracy assessment results of four consecutive years, that is from 2012-2015 to detect students' competence level and define the contributing factors towards their poor numeracy achievement as well. The analysis of the results covered the diagnosis of the students' performance level for each exam item and the cognitive level of questions used for each item. Such detailed analysis has surely revealed some core causes of poor mathematics examinations results.

However, in Fiji primary schools, tests or exams usually consist of knowledge, comprehension and application-type questions. According to (Blosser, 2000) the basic knowledge level questions simply require the quick recalling of facts, while the comprehension level demands grasping the meaning of a material. At a much higher dimension, the application level commands the use of learned material in creating a new situation or solution.

Furthermore, the analysis report has highlighted the importance of using multiple type of questions during class sessions especially by teachers to enable students to further develop their cognitive skills. With better developed cognitive skills, students will be able to solve mathematics problems very effectively. In the report, quality mathematic teaching and competence of teachers are seen as a way forward for improving students' achievement level. Besides, as examination questions are written in English, the students' literacy skills to understand the meaning of the mathematical terminology used in the text really need big improvements to help them solve comprehension and application questions very well.

2. Overview of Fiji Primary Schools Mathematics Education

Table 1. Primary Mathematics Curriculum Topic For Year 1-8

No.	Strand	Sub-Strands
1	Numbers	Whole Numbers, Operations, Fractions and Decimals.
2	Algebra	Patterns and Equations.
3	Measurement	Length and Area, Volume, Time, Mass, Money and Temperature
4	Geometry	Shapes, Angles, Lines and Directions
5	Chance and Data	Chance and Data Representation and Interpretation

(Source: the author made this table)

Table. 1 shows all the five major teaching strands that feature in all primary grades (G1-8) covering basic concepts and skills in the lower grade and a more advanced concept in the upper grade. The coverage of these strands across all grades is specifically aimed to demonstrate the significance of sequential development of mathematics conceptual understanding and skills from one grade to another.

Table 2. Common Features of Primary Mathematics Education Across Fiji

Key Area	Distinguishing Features
Mathematics Teachers	Teachers teach all subjects and they are not Maths Specialists.
Teachers Qualifications	Certificate and Diploma in Primary education
Teaching Approach	Great emphasis is placed on teacher -center approach. Teachers are usually exam -oriented and focus more on the acquisition of procedural skills than the conceptual understanding.
Textbook	Textbooks are offered free by the government but there are not enough supplies for all students.
Teachers Guide	Teachers Guide are not readily available. Usually teachers teach using their own ways and understanding of the lesson contents.
Professional Development	There is hardly or no school based professional development conducted nationwide on improving mathematic teaching and learning process.

(Source: the author made this table)

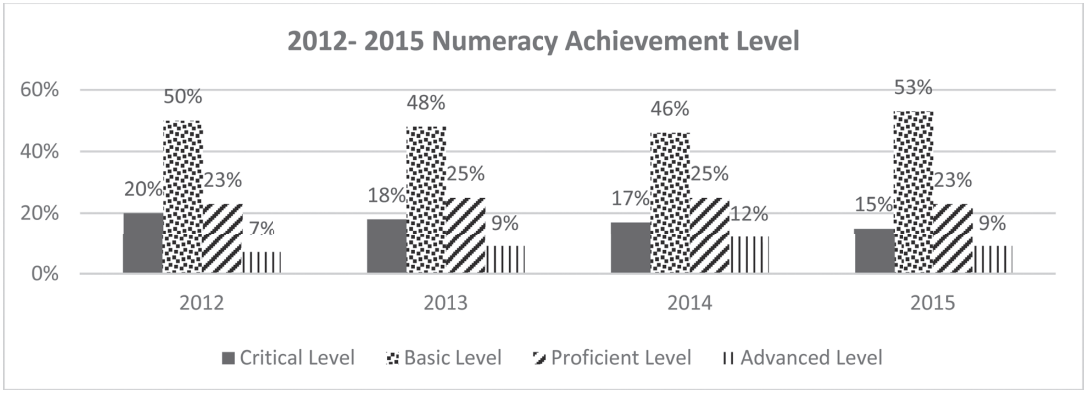
The distinguishing features stated above are common characteristics of Fiji primary mathematics education. Unfortunately, little has been done to review its direct impact on students' learning despite the multiple reforms undertaken by the Ministry of Education.

3. Overview of Fiji Primary Mathematics External Examination Results

(a) Grade 6 National Numeracy Assessment Results

Every year all Grade 6 students across the country undertake the National Literacy and Numeracy Assessment called LANA as part of the Ministry of Education diagnostic tool of assessing students'

competence level in literacy and numeracy. The following numeracy achievement level of students were obtained from the LANA assessment programs that were administered from 2012 to 2015.



(Source: Fiji National Level LANA Report (2016))

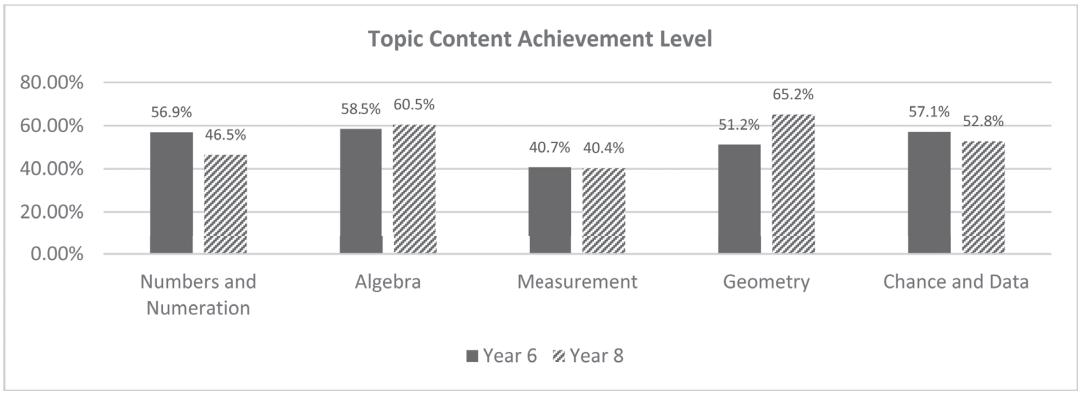
Figure. 1 National Level Year 6 Numeracy (LANA) Results.

According to Figure. 1, an average of 49% of the total candidates who sat the Grade 6 numeracy assessment across the country from 2012 to 2015 are still having basic competence level. In stark contrast, 24% of them are at the proficient level, 9% have managed to reach the advanced level while 18% are still struggling at the critical level. However, there seems to be a consistent trend noticed in all achievement level throughout these four years of assessment. The number of students at the basic level remain high whereas the number of students at the advanced level remain low.

Statistically, critical level is associated with achievement below 50%, basic level category comes between 50%-64% and the proficient level lies within 65%-84% while the 85%-100% achievement range represents the advanced level.

However, with a quick glance at the data presented above in figure. 1, the main cause of this students' incompetence cannot be clearly ascertained. But the data generally depicts that mathematics education in Fiji is not quite effective. With a high number of students' achievement are still at the basic level, as shown by the graph in figure. 1, for more than three or four consecutive years, the teaching techniques and content knowledge of the teachers in the classroom is highly questionable. The students' numeracy competence level are also crucial areas that requires an exclusive investigation. Nonetheless, there is more to imply with regards to the causes of this poor numeracy competence level. Therefore, a detailed analysis of the exam items and the level of cognitive each question represents may present a better insight into the underlying causes of such incompetence of students in mathematics.

(b) Comparative Analysis of the 2015 Fiji Year 6 & 8 Mathematic National Examination Results



(Source: The author made this chart (2017))

Figure. 2 The 2015 National Mathematics Examination Topic Content Achievement Comparative Results Analysis For Year 6 and 8.

According to the graph in figure. 2, both grade 6 and 8 experienced great difficulties in dealing with questions on measurement. Does this show that measurement concepts are harder to teach or learn than other mathematics concepts? Only further research study on this uncertainty will give a clear answer. Moreover, a detailed analysis of the exam results and the level of question difficulty used in the examination is crucial for the identification of the cause of students' difficulty in solving mathematics problems.

However, although students' achievement in both grades on other topics are better, the percentage rate of their correct responses for each other topics mostly stays within the 50-60 % range. This clearly indicates that the students' achievement level is still basically low and the need to address this mathematical incompetency issue is highly required at all school levels.

(c) In-depth Analysis of the 2015 National Mathematics Examination Items and Achievement Rate of Grade 6

The Grade 6 National Examination mathematics items of 2015 and students' achievement rate for all items under each five teaching strands as shown in figure. 1 have been analyzed in detail to assist in the identification of the root causes of students' numeracy incompetence.

Note: In the analysis table, all questions numbers are marked with either (A) for section A (multiple choice) or (B) for section B (short answer) questions. The number next to either A or B, denotes the question number for that particular section while the small letter besides each number represents the parts of a question.

Table 3. Numbers and Numeration Exam Items and Achievement Rate Analysis.

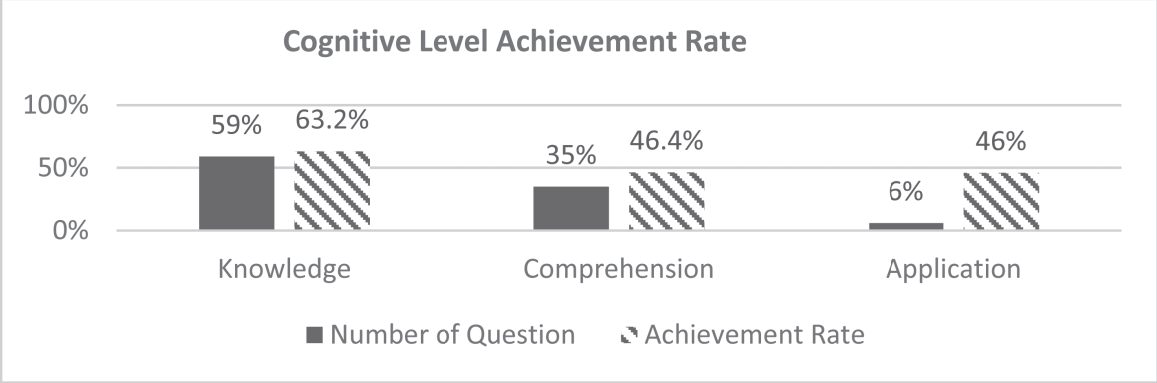
Question No.	Strand	Sub-strand	Cognitive Level	Correct Responses	Incorrect Responses	Causes for Errors
A1	Numbers And Numeration	Round off to the nearest 100	Comprehension	40%	60%	Misunderstanding of place value.
A6		Addition of Decimals	Knowledge	69%	31%	Lack basic decimal addition skills
A11		Number (written in words)	Comprehension	45.5%	54.5%	Inability to read 4-digit numbers
A14		Fraction (written in decimals)	Knowledge	62%	38%	Inability to change fraction to decimal
A17		Operation (Distributive Property)	Comprehension	42.5%	57.5%	Inability to distribute numbers
B1a		Number (Place Value)	Knowledge	60%	40%	Inability to calculate the total value of 16tens.
B1b		Operation (Addition & Multiplication)	Knowledge	63%	37%	Inability to recognize that 7+7+7+7+7+7= 7 × 6.
B1f		Multiplication by 100	Knowledge	70%	30%	Inability to multiply two digits number by 100.
B1j		Addition of Decimal (money)	Knowledge	61%	39%	Wrong alignment of numbers according to its place value.
B3		Addition of Decimal	Knowledge	78%	22%	
B7		Writing word number in numeral	Comprehension	57%	43%	Inability to transcribe 5 digit numerals.
B12		Operation (Division of Integers)	Application	46%	54%	Lack basic division skills.
B10		Fraction Representation	Comprehension	47%	53%	Inability to make fraction representation.
B19a		Operation (multiplication sentence)	Knowledge	54%	46%	Inability to write multiplication sentence.
B20a		Fraction Representation	Knowledge	64%	36%	Inability to make fraction representation.
B20b		Addition of fractions with different denominators	Knowledge	51%	49%	Inability to add fractions with different denominators.
Overall Achievement Average				56.9%		

(Source: The author made this table (2017))

According to Table 3, the overall students' achievement average in Numbers and Numeration is only 56.9%, which indicates a very low and basic competence level. A great deal of students' misconceptions are caused by their deficit in basic knowledge and skills to manipulate numbers and operations concepts especially in decimals and fractions. For example, in Section B, Question 3 (B3), the following item was given:

Q3. Calculate: 3. 1 + 3. 1 + 3. 1 = _____.

As show in Table 3, 22% of the students were not able to answer this simple knowledge question correctly. According to (Ministry of Education(a), 2016) examiner's report these students have placed the numbers in the wrong place values when using vertical addition.



(Source: The author made this chart (2017))

Figure. 3 Cognitive Level Achievement Rate in Numbers and Numeration

According to Figure. 3, students dealt with knowledge-type questions more better than the Comprehension and Application-types. Their ability level to deal with application or high-level thinking questions in Numbers and Numeration is relatively as low as 46% although application problems only represented 6% of the questions for this particular topic.

Table 4. Algebra Exam Items and Achievement Rate Analysis

Question No.	Strand	Sub-strand	Cognitive Level	Correct Responses	Incorrect Responses	Causes for Errors
A2	Algebra	Number Pattern (missing number)	Knowledge	61.5%	38.5%	Inability to identify the pattern.
A12		Number Pattern (missing number)	Knowledge	66%	34%	Inability to identify the pattern.
B1g		Number Pattern (missing letter)	Knowledge	88%	12%	Inability to identify the pattern.
B11		Number Pattern (triangular number)	Application	30%	70%	Inability to identify the pattern.
B13		Number Pattern (missing number)	Knowledge	61%	39%	Inability to identify the pattern.
B19b		Number Pattern (no. of sticks)	Comprehension	42%	58%	Inability to identify the pattern
B19c		Number Pattern (missing number)	Knowledge	61%	39%	Inability to identify the pattern.
Overall Achievement Average				58.5%		

(Source: The author made this table (2017))

Table 4. indicates that the students' average achievement rate in Algebra is only 58.5% which is at a basic level. Students inability to identify the pattern in different sequential contexts is a major area of concern. The use of operation like addition or subtraction to find the missing data is seen to be

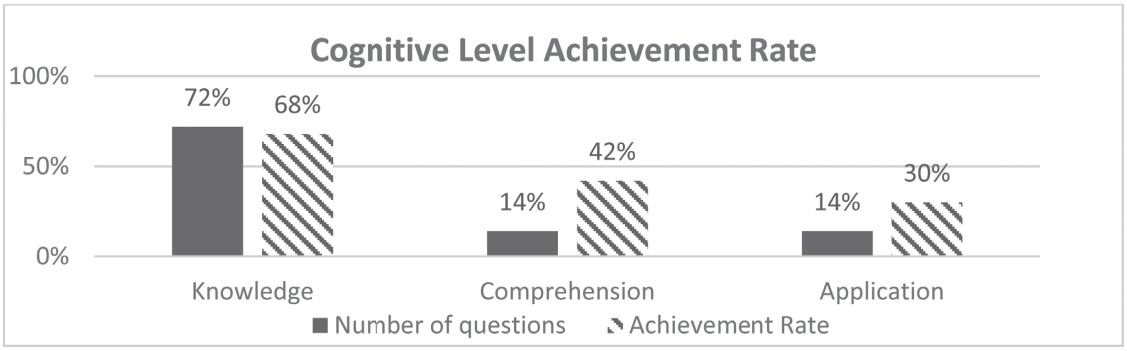
a major struggle for some students. For example, in Section A multiple-choice question 12, (A12), the following item was given:

Q12. Which number will correctly complete the number pattern written below?

645, 644, 647, 646, 649, _____

A. 653 B. 652 C. 651 D. 648

As shown in table 4. , only 66% got the correct answer (D) as some of them were not able to identify the pattern or failed to add or subtract values correctly. However, 6.5% of them chose A, 10.5% chose B, 9.5% chose C and 7.5% did not give any answer.



(Source: The author made this chart (2017))

Figure. 4 Cognitive Achievement Rate in Algebra

As shown in Figure. 4, students performed better in the knowledge-type questions but did extremely badly in the comprehension and application based questions. Their abilities to deal with high level thinking questions in Algebra is relatively as low as 30%. Although comprehension and application have the same number of questions, students seemed to experience a great deal of difficulties dealing with the application questions which requires a lot of thinking and processing at a higher dimension.

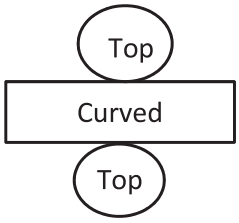
Table 5. Measurement Exam Items and Achievement Rate Analysis

Question No.	Strand	Sub-strand	Cognitive Level	Correct Responses	Incorrect Responses	Causes for Errors
A5	Measurement	Length (unit conversion) m to cm	Comprehension	48%	52%	Inability to change 1m to cm.
A13		Length (unit conversion) m to cm	Comprehension	48%	52%	Inability to change 3m to cm.
A20		Volume of a box (l × w × h)	Application	37.5%	62.5%	Misunderstanding of volume formula
B1c		Time (unit comparison)	Knowledge	80%	20%	Inability to change hours to minutes.
B1e		Volume (unit conversion) ml to L	Knowledge	53%	47%	Inability to change millilitres to litres.
B4		Length(rectangle perimeter)	Application	32%	68%	Inability to calculate the perimeter.
B9		Length (unit conversion) cm to m	Comprehension	56%	44%	Inability to change cm to m.
B14a		Money (total amount)	Comprehension	28%	72%	Inability to express the total amount in figures.
B14b		Money (total amount)	Application	24%	76%	Inability to calculate the total amount
B22a		Volume (quantity)	Application	40%	60%	Inability to understand quantities.
B22b		Volume (quantity)	Application	36%	64%	Inability to calculate quantities.
B22c		Volume (quantity)	Application	6%	94%	Inability to express fractional quantities.
Overall Achievement Average				40.7%		

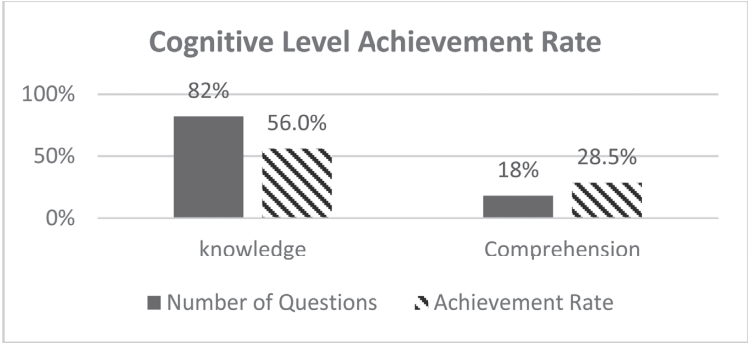
(Source: The author made this table (2017))

The 51.2% achievement rate of students on Geometry is at the basic level category. A great deal of errors seems to be caused by the students' misunderstanding of basic concepts of geometry which are illustrated as sub-strands in Table 6 above. For example, in Section B, Question 5 (B5), the following item was given:

Q5. The diagram shows the net of a _____.



As shown in table 6. Above, 85% of the students were not able to comprehend the net diagram of a cylinder correctly.



(Source: The author made this chart (2017))

Figure. 6 Cognitive Achievement Rate in Geometry

Figure. 6 clearly shows that students have a higher achievement rate in solving knowledge-type questions than the comprehension based type. However, despite the high achievement rate in the knowledge domain, the achievement scores of students are only 56% which proves that quite a number of students still lack basic knowledge of Geometry concepts.

Table 7. Chance and Data Exam Items and Achievement Rate Analysis

Question No.	Strand	Sub-strand	Cognitive Level	Correct Responses	Incorrect Responses	Causes for Errors
A3	Chance and Data	Probability	Comprehension	22%	78%	Misunderstanding of the problems.
A8		Probability (%)	Comprehension	37.5%	62.5%	Inability to express the answer in percentage.
A18		Data interpretation (bar graph)	Knowledge	73%	27%	Inability to interpret the data on the graph.
A19		Data interpretation (bar graph)	Knowledge	77%	23%	Inability to interpret the data on the graph.
B1h		Average	Application	39%	61%	Wrong calculation of the average.
B6		Data Interpretation (table)	Knowledge	54%	46%	Misunderstanding of the word'least'
B16a		Data Interpretation (bar graph)	Knowledge	72%	28%	Inability to interpret the data.
B16b		Data Interpretation (bar graph)	Application	46%	54%	Inability to add up the total amount rainfall.
B17a		Data Interpretation (table)	Knowledge	58%	42%	Inability to interpret data on the table.
B17b		Data Interpretation (table)	Knowledge	68%	32%	Inability to understand data on a calendar.
B17c		Data Interpretation (table)	Knowledge	78%	22%	Inability to understand data on a calendar.
B21a		Data Interpretation (pictograms)	Comprehension	72%	28%	Inability to interpret data on the pictogram.
B21b		Data Interpretation (pictograms)	Application	46%	54%	Inability to understand the problems.
Average Overall Achievement				57.1%		

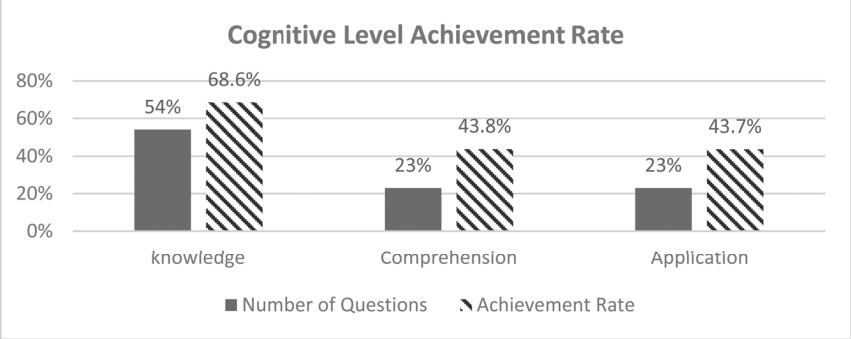
(Source: The author made this table (2017))

As shown in Table 7, the 57.1% average overall achievement clearly indicates that students understanding level of Chance and Data is still in the basic level category. The students' inability to understand, interpret and calculate data is a major obstacle for them to achieve better results. For example, in Section A multiple choice questions 3, (A3), the following item was given:

Q. 3 How many possible outcomes are there when a coin is tossed?

A. 4 B. 1 C. 2 D. ½

According to (Ministry of Education(a), 2016) examiner's report, only 22% of the students got the correct answer, C. However, 14% of them chose A, 15% chose B, 42% chose D whereas 7% gave no answer at all. Most of them chose D due to their misinterpretation or inability to draw distinction between numbers and chances.



(Source: The author made this chart (2017))

Figure. 7 Cognitive Achievement Rate in Chance and Data

According to Figure. 7, the students gained more marks in the knowledge-type questions than in the comprehension and application based type. The high numbers of knowledge based questions taken from the chance and data strand has caused the overall achievement average to be at 57.1% as shown in Table 7.

Table. 8 Summary of the overall cognitive level Achievement Rate for all topics.

	Knowledge		Comprehension		Application		
Strand	No. of Questions	Achievement Rate	No. of Questions	Achievement Rate	No. of Questions	Achievement Rate	Overall Average
Numbers	10	59%	5	46.4%	1	46%	56.9%
Algebra	5	67.5%	1	42%	1	30%	58.5%
Measurement	2	66.5%	4	45%	6	29.25%	40.7%
Geometry	9	56%	2	28.5%	-----	----	51.2%
Chance and Data	7	68.6%	3	43.8%	3	43.7%	57.1%
Total Achievement	52.9%						

(Source: the author made this table (2017))

According to the summary shown in Table. 8, students' overall achievement rate in measurement is 40.7% which is the lowest when compared with their achievement in other strands. This has been discovered to be highly influenced by the biggest number of application and comprehension questions but with only a much smaller quantity of simple knowledge-type questions students had to answer for this particular strand. However, Algebra in deep contrast records the highest overall achievement rate of (58.5%) because it has the least number of application and comprehension questions although the number of its knowledge questions was not the highest as depicted in Table. 8 above.

Nonetheless, it is clearly shown by the data that the strand which has a high number of knowledge

questions but less number of comprehension and application-type questions like Algebra in this case, relatively assumed a high achievement rate as students experienced less difficulties in solving simple knowledge questions than dealing with comprehension and application problems. On the contrary, strands that gained a relatively low achievement rate seems to contain a higher percentage of comprehension and application questions like Measurement in this regard, which students found it difficult to solve.

Overall, although the exam paper was quite a fair one in terms of questions distribution to the three-cognitive skill level, the general performance of grade 6 students in this particular examination is extremely low with only 52.9% achievement rate. This controversial mathematical incompetence issue is entirely due to students' lack of basic mathematic content knowledge and problem-solving skills to tackle any mathematical problems especially the ones that requires a higher degree of thinking and processing abilities.

(d) Conclusion

The general study of Fiji Primary School Mathematics Education and the detailed analysis of the Grade 6 National Examinations Items and Results have revealed that the following factors have profound influence on students' incompetence in mathematics:

(i) Students' deficit in basic mathematical conceptual knowledge and skills.
(ii) Students' inability to deal with high cognitive level questions namely the comprehension and application mathematical problems.
(iii) Students' lack of literacy skills.

The in-depth analysis of the causes for students' errors in each exam items, has shown that many students are still not having enough basic knowledge and skills of mathematic concepts especially in addition, subtraction, multiplication and division. This issue really challenges not only the quality of mathematic teaching in the classroom but the competence of a teacher as well. Moreover, the students' inability to deal with the high cognitive level problems raises a lot of concerns over the kind of questioning skills students are being exposed to in the classroom by their teachers. It seems crystal clear that students are most often given simple mathematic knowledge questions only which does not require high-level thinking in the classroom. This was clearly demonstrated by the students' poor achievement rate in solving the comprehension and the application questions for all teaching strands as shown in Table 8. According to Blosser (2000), professors who are using various question types during class sessions are enabling students to practice a wide range of thought processes. If professors continually use one particular type of question, students thinking may not be challenged at the higher cognitive levels. Furthermore, the standard of the students' literacy competence too is a major obstacle to their understanding of the problems both in lessons and exams. As English is the students' second or third language, understanding of the questions can be very difficult at times. This was shown by their inability to answer simple and basic knowledge questions correctly in the exam.

However, such issue of students' incompetence in mathematics can be addressed if the following actions are taken at a school level. Firstly, all school mathematic teachers should review their traditional teaching approaches. There is a strong need for teachers to develop their content knowledge and teaching pedagogy on a regular basis. Similarly, students should be challenged with all cognitive level questions, that is, from the least difficult to the most difficult ones. In this way, students will have the opportunity to develop their own thinking and creativity skills in problem solving. Secondly, more emphasis should also be focused on improving students' literacy skills and knowledge of mathematical terminology used in a text under each strand to avoid misconceptions and ambiguity during lessons or exams. Thirdly, there is a dire need for all schools to provide their teachers with high-quality and responsive ongoing technical assistance such as professional developments, expert consultations and workshops for developing their content knowledge and teaching skills. On the same note, it is highly crucial that teachers are also provided with quality mathematic teaching support and resources to raise the students' learning and achievement level.

Last but not least, a further and more exclusive research on Fiji primary school students' incompetence in mathematics is a course of action that is worth considering in the near future. As this will assist teachers, not only to gain a deeper understanding

of the root causes of this learning predicament but also equip them with effective teaching strategies to address mathematics achievement disparities successfully in the classroom. Above all, adequate attention and collective efforts by all stakeholders to address this incompetence issue is highly indispensable if students are to yield better mathematics results in years to come.

References:

Ministry of Education(a). (2016). Fiji National Examiner's Report For Year 6, 2015, Suva, Fiji: Ministry of Education. Retrieved from http://www. education. gov. fj/images/2016/EXAMINERS_REPORT_FY6E/PDF_2015_Year_6_Mathematics_Ex_Report. pdf.

Ministry of Education(b). (2016). Fiji National Examiner's Report For Year 8, 2015, Suva, Fiji: Ministry of Education. Retrieved from http://www. education. gov. fj/images/2016/EXAMINERS_REPORT_FY8E/PDF_2015_Year_8_Mathematics_Ex_Report. pdf.

Ministry of Education(c). (2016). Fiji National Level LANA Report, Suva, Fiji: Ministry of Education. Retrieved from http://www. education. gov. fj/images/lana_2016/New%20LANA%20Reports. pdf.

Ministry of Education(d). (2015). Fiji National Examination Papers, Suva, Fiji: Ministry of Education. Retrieved from http://www. education. gov. fj/index. php/school/past-exam-papers/33-past-exam-papers/304-2015-fy6e.

Blosser, P. M. (2000). How to ask the right questions. Arlinton. VA: National Science Teachers Association.