

# Patterns in Achievement – Mathematics 2014

### 3.1 Introduction

In this chapter, achievement levels as well as disparities in achievement of students in mathematics are discussed. Students' achievement levels concerning mathematics are presented in relation to such factors as school type, gender, medium of instruction and location of school. Furthermore, strengths and weaknesses of students' achievement are analyzed against various skills and subject contents of mathematics. The present National Assessment is the second study conducted on Grade 8 mathematics syllabus since the new competency based curriculum was introduced in Sri Lanka in 2007. The first study on the same was conducted by NEREC in 2012.

### 3.2 Achievement Levels in Mathematics at All Island and Provincial Levels

The mean value of the achievement level of students stands as 50.87 at all island level. However, the median value is 47.51 indicating that half of the student population has scored below 47.51. Furthermore, 25 percent of students have scored below 35.02 marks while 75 percent of them have scored below 67.51 marks. Table 3.1 below further illustrates the achievement levels at provincial as well as all island levels.

**Table 3.1: All island and provincial achievement in mathematics 2014 –Summary statistics**

Province	Mean	Rank	Standard Deviation	Standard Error of Mean	Percentile (p25)=Q1	Median (p50)=Q2	Percentile (p75)=Q3	Skewness
Western	55.49	1	20.73	0.08	37.61	55.00	72.52	0.00
Southern	53.66	2	21.44	0.11	35.02	52.51	72.62	0.21
Sabaragamuwa	52.35	3	19.46	0.11	37.42	50.02	67.51	0.18
North Western	50.99	4	19.58	0.10	35.02	47.53	65.21	0.31
Eastern	49.28	5	20.28	0.11	32.41	45.21	65.35	0.29
North Central	48.98	6	19.17	0.13	35.05	45.31	62.21	0.42
Uva	47.95	7	18.80	0.13	32.51	45.05	60.42	0.43
Northern	46.05	8	19.55	0.14	30.12	42.52	60.14	0.57
Central	44.96	9	18.77	0.09	30.02	40.01	57.51	0.68
All Island	50.87		20.29	0.04	35.02	47.51	67.51	0.29

When considering the provincial level achievement, mean values of Western, Southern, Sabaragamuwa and North Western Provinces are 55.49, 53.66, 52.35 and 50.99 respectively. While these values are above fifty, Western Province, according to this study, ranks number one in terms of achievement levels of mathematics. Yet, when one looks at the median of the same provinces, one can see that only Western, Southern and Sabaragamuwa show values that are above 50. Although the mean values of the other provinces show levels that are below 50, the lowest is 44.96. Achievement levels in mathematics are further illustrated by the Figure 3.1 below.

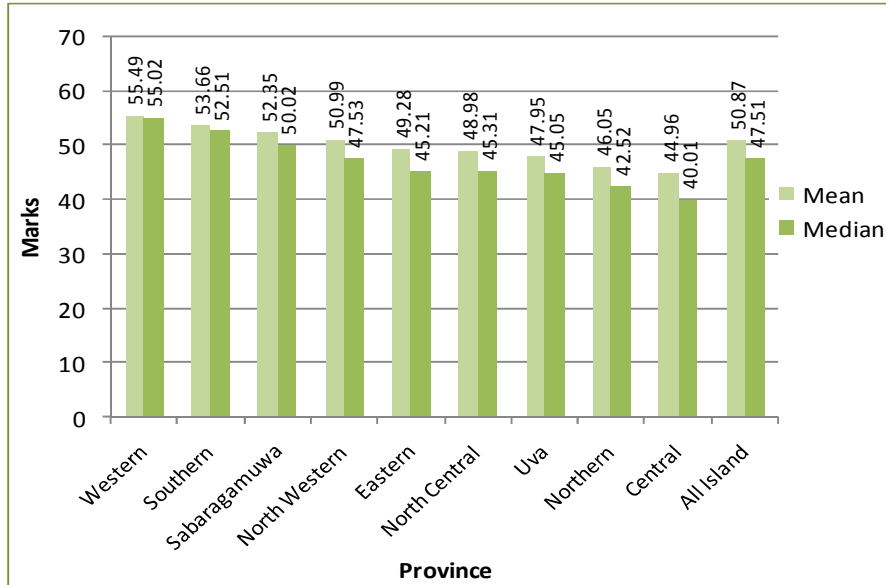


Figure 3.1: Mean values and median values of mathematics marks

### 3.3 Distribution of Test Scores of Mathematics

Standard deviation of marks (SD) which describes how scores are scattered around the mean value is 20.3 at all island level. If the marks are normally distributed nearly 68 percent of students fall between 71.16 (50.87+20.29) and 30.58 (50.87-20.29). However, mathematics scores have a positively skewed distribution (skewness = 0.29), which indicates that the majority of students are low achievers in mathematics. This can be further observed in the Figure 3.2 and Table 3.2 given below.

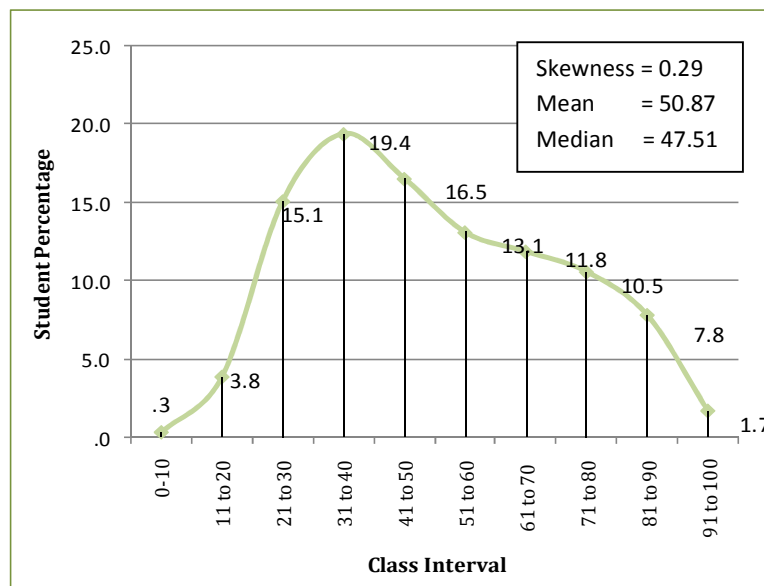


Figure 3.2: All island achievement in mathematics –distribution of marks

**Table 3.2 : Distribution of all island achievement marks of mathematics**

Class Interval	Student %	Cumulative %
00 to 10	.3	.3
11 to 20	3.8	4.1
21 to 30	15.1	19.2
31 to 40	19.4	38.6
41 to 50	16.5	55.1
51 to 60	13.1	68.2
61 to 70	11.8	80.0
71 to 80	10.5	90.6
81 to 90	7.8	98.3
91 to 100	1.7	100.0
Total	100.0	

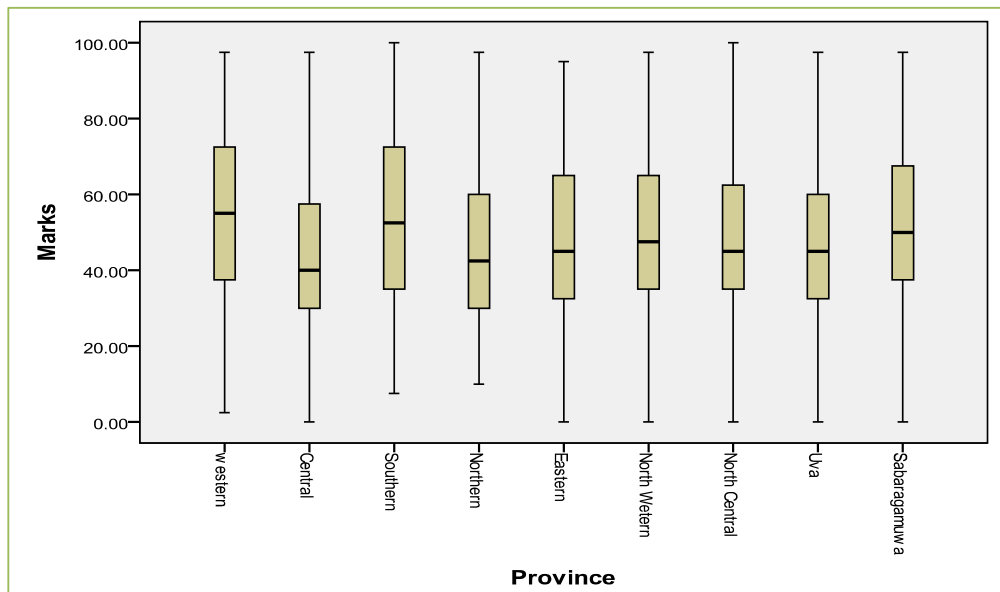
One important phenomenon is that the percentage of highest frequency of students, which is 19.4, belongs to the marks category of 31-40. If conventionally viewed, this development may be seen as undesirable as the highest percentage of students have scored less than 40 marks for mathematics. Moreover, there is a clear indication that the percentages of students belonging to higher marks intervals are very low.

Positive skewness found in the distribution of mathematics marks can be seen in almost all the provinces. It is shown by Figure 3.3. According to the figure, only in Western, Sabaragamuwa and Southern Provinces positive skewness of the distribution of score is somewhat low. Furthermore, these distributions are bimodal distributions. It can be clearly seen in Western, Southern, Eastern and North Western Provinces.



Figure 3.3: Provincial-wise distribution of marks – Mathematics

According to Table 3.1 the differences of SD value of marks among different provinces are minimal. The highest value, which is 21.44, is in the Southern Province while the lowest value, which is 18.80, is seen in both Central and Uva Provinces. However, the skewness of the distribution of scores of various provinces show noticeable variations. While Western province has a negligible skewness (.00), Central Province has a very high skewness (.68). Central, Northern, Uva and North Central Provinces have a very high positive skewness indicating the fact that low achievers are very high. While Southern, Sabaragamuwa, and Eastern Provinces have a comparably low skewness indicating that low achievers are not many in these provinces when compared with other provinces. This skewness is indicated by the box-plot chart in Figure 3.4 given below.



**Figure 3.4 : Mathematics marks representation using boxplot and whisker plot**

### 3.4 Disparities in Achievement in Mathematics

Over the years various efforts have been made to provide equal opportunities for school education in Sri Lanka. Yet, disparities in achievement in mathematics in different groups can still be seen owing to different factors. In this section, in what way the school type, gender, medium of instruction and school location have an influence on these disparities are discussed.

### 3.4.1 Disparities in Achievement in Mathematics in Relation to School Type

Indicators of achievement levels of mathematics according to school type are given in Table 3.3 below.

**Table 3.3: Mathematics achievement marks according to school type**

School Type	Mean	Standard Deviation	Median	Skewness	F	P
1AB	58.70	20.01	60.21	-0.11	31,747.29	.000
1C	42.37	16.42	40.01	0.63		
Type 2	41.54	17.08	37.54	0.76		
<b>All Island</b>	50.87	20.29	47.51	0.29		

According to Table 3.3, students in 1AB schools have shown the highest performance. The mean is 58.70 and median is 60.21, which can be considered as a satisfactory level. Another positive feature is that the distribution of marks of 1AB schools is negatively skewed, with a skewness value of -0.11. This indicates that the majority of students have shown a considerable high performance in mathematics in these schools. When 1C schools are considered, performance levels are lower than 1AB schools. Their mean is 42.37 and their median is 40.01. Their marks distribution is positively skewed, with a skewness value of 0.63 in 1C schools.

Type 2 schools show the lowest performance in mathematics. Their mean is 41.54 while the median is 37.54. This cannot be considered as a satisfactory level. It is a level which is below 50 marks. Another unsatisfactory feature is that the marks distribution in these schools is positively skewed which is 0.76. However, there is no conspicuous difference between the achievement levels of 1C and Type 2 schools. In both 1C and Type 2 schools, the skewness is positive while the skewness of 1AB schools is negative. This is further illustrated by Figure 3.5 below.

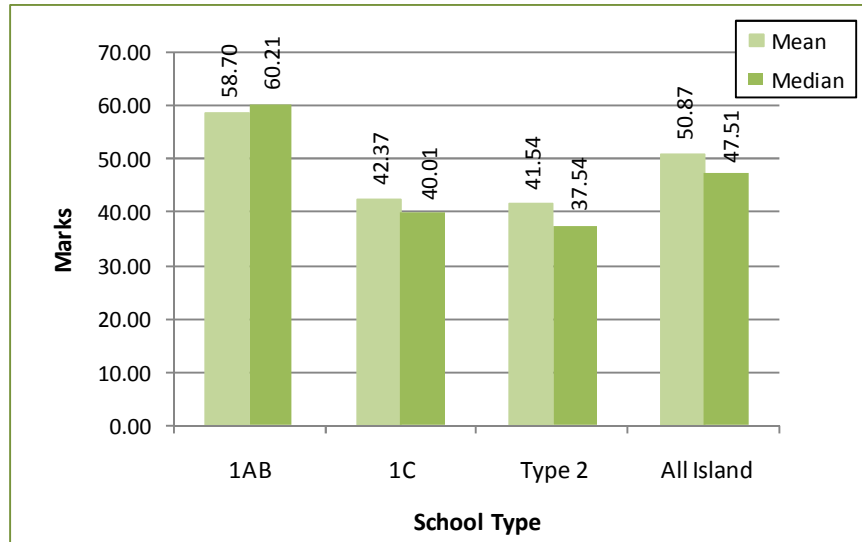


Figure 3.5: Mean values of mathematics marks according to school types

In addition to Table 3.3 above, Table 3.4 and Figure 3.6 also show the nature of the distribution of mathematics marks of students according to school type. This too shows that mathematics marks of 1C and Type 2 schools are positively distributed. Meanwhile, mathematics marks of 1AB schools are distributed with a negative skewness showing a satisfactory situation.

Table 3.4: Distribution of mathematics achievement marks according to school type

Class Interval	1AB Student %	Cumulative %	1C Student %	Cumulative %	Type 2 Student %	Cumulative %
00-10	0.13	0.13	0.43	0.43	0.46	0.46
11-20	1.57	1.70	5.73	6.16	7.42	7.88
21-30	8.24	9.94	22.34	28.50	23.49	31.37
31-40	13.40	23.34	25.86	54.36	26.48	57.85
41-50	14.99	38.33	18.98	73.34	17.04	74.89
51-60	14.36	52.69	12.19	85.53	10.72	85.62
61-70	15.34	68.03	8.32	93.85	7.25	92.86
71-80	16.29	84.32	4.04	97.89	4.18	97.04
81-90	12.76	97.08	1.96	99.85	2.58	99.62
91-100	2.92	100.00	0.15	100.00	0.38	100.00
Total	100.00		100.00		100.00	



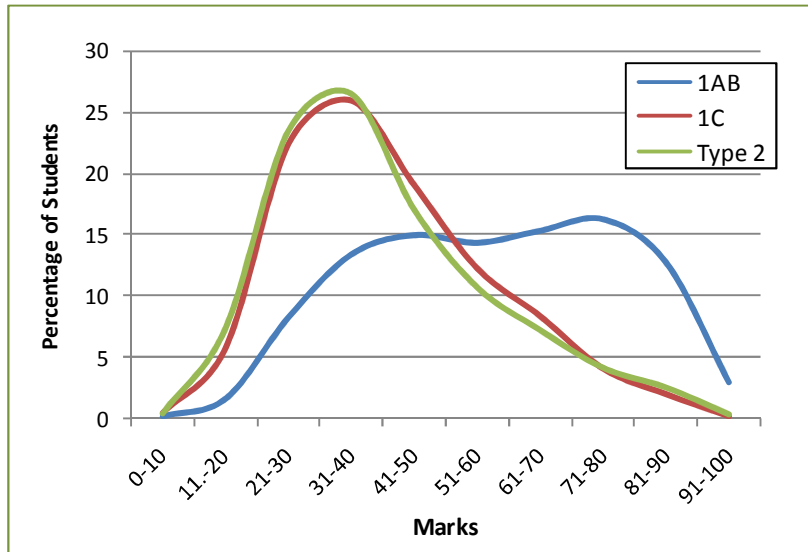


Figure 3.6: Distribution of mathematics achievement marks according to school type

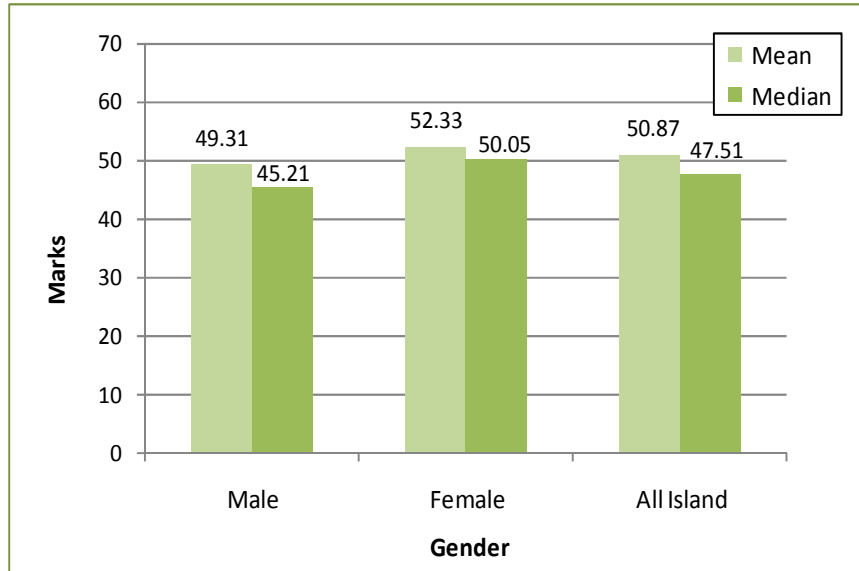
### 3.4.2 Disparities in Achievement in Mathematics in Relation to Gender

Disparities in achievement of students were observed in relation to gender in previous grade 4 and 8 studies conducted by the NEREC. In the present study too, disparities of achievement related to gender were seen. According to Table 3.5 given below, there is a difference between the achievement levels of girls and boys. The mean value of the test scores of boys is 49.31 while the mean value of the test score of girls is 52.33.

Table 3.5: Mathematics achievement marks according to gender

Gender	Mean	Standard Deviation	Median	Skewness	F	P
Male	49.31	20.30	45.21	0.36	1,753.05	.000
Female	52.33	20.17	50.05	0.23		
<b>All Island</b>	50.87	20.29	47.51	0.29		

With regard to median also this difference can be seen. As such, it is evident in mathematics, performance of girls is better than that of boys. However, the standard deviation which indicates dispersion of marks is almost the same for two groups. This disparity in the achievement level in mathematics is further illustrated by Figure 3.7.



**Figure 3.7: Mean values of mathematics marks according to gender**

Distribution of mathematics marks was analyzed according to gender as well. These results are shown in Table 3.6 and Figure 3.8. According the Table 3.6 and Figure 3.8, it becomes evident that there is no considerable difference between the two groups with regard to the distribution of marks. This shows that there is no notable difference in distribution of marks in terms of gender.

**Table 3.6: Distribution of mathematics achievement marks according to gender**

Class Interval	Male %	Cumulative %	Female %	Cumulative %
00-10	0.37	0.37	0.19	0.19
11-20	4.42	4.79	3.26	3.45
21-30	17.05	21.84	13.23	16.68
31-40	20.35	42.19	18.47	35.14
41-50	16.09	58.28	16.93	52.07
51-60	12.37	70.66	13.74	65.81
61-70	11.00	81.66	12.64	78.45
71-80	9.67	91.33	11.37	89.82
81-90	7.11	98.44	8.43	98.25
91-100	1.56	100.00	1.75	100.00
Total	100.00		100.00	

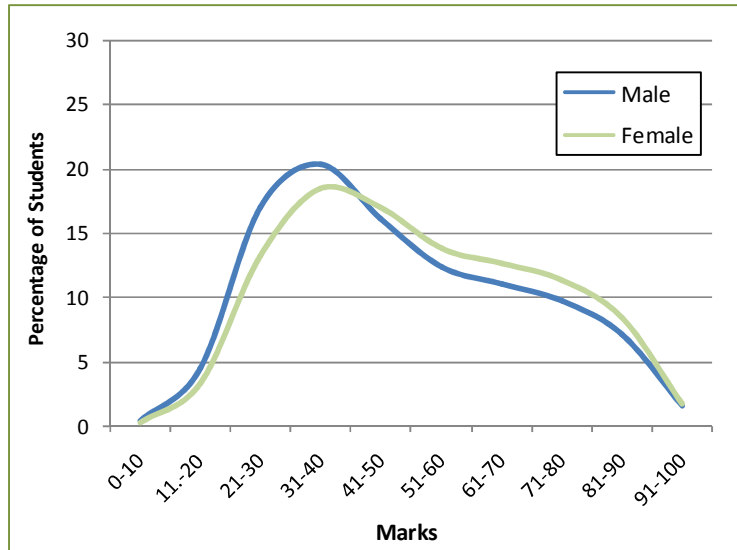


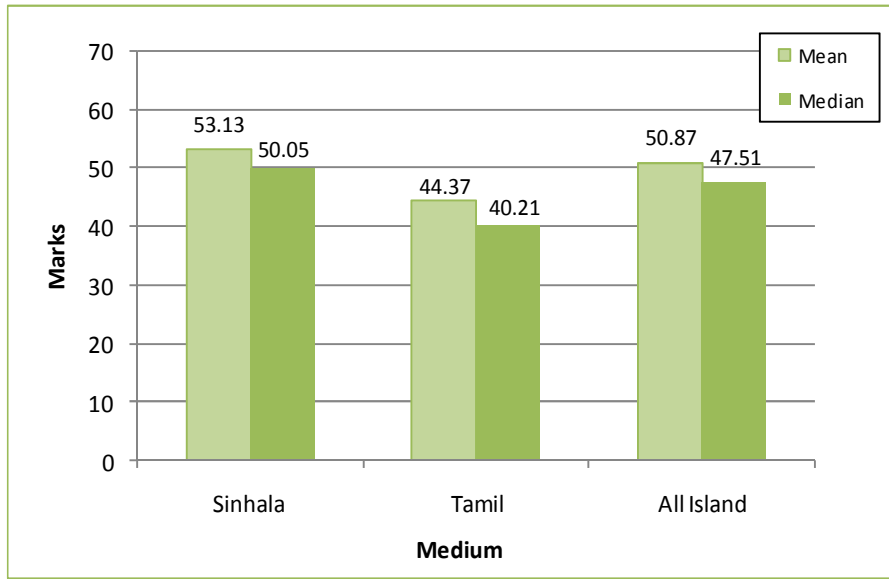
Figure 3.8: Distribution of mathematics achievement marks according to gender

### 3.4.3 Disparities in Achievement in Mathematics in Relation to Medium of Instruction

Either Sinhala or Tamil is the medium of instruction in almost all the schools in Sri Lanka. Those whose native language is Tamil normally study in Tamil medium while those whose native language is Sinhala generally study in Sinhala. Though both groups do their studies in their mother tongue, a difference can be observed in the achievement level in mathematics. The mean value of marks in the achievement of Sinhala medium students is 53.13 while it is 44.37 for the Tamil medium students. It is a noticeable difference. The median values also show the same. The median value of Sinhala medium students is 50.05 while the median value of the Tamil medium students is 40.21. This difference in achievement is further illustrated by Figure 3.9.

Table 3.7: Mathematics achievement marks according to medium of instruction

Medium of Instruction	Mean	Standard Deviation	Median	Skewness	F	P
Sinhala	53.13	20.34	50.05	0.18	23,597.05	.000
Tamil	44.37	18.69	40.21	0.64		
<b>All Island</b>	50.87	20.29	47.51	0.29		

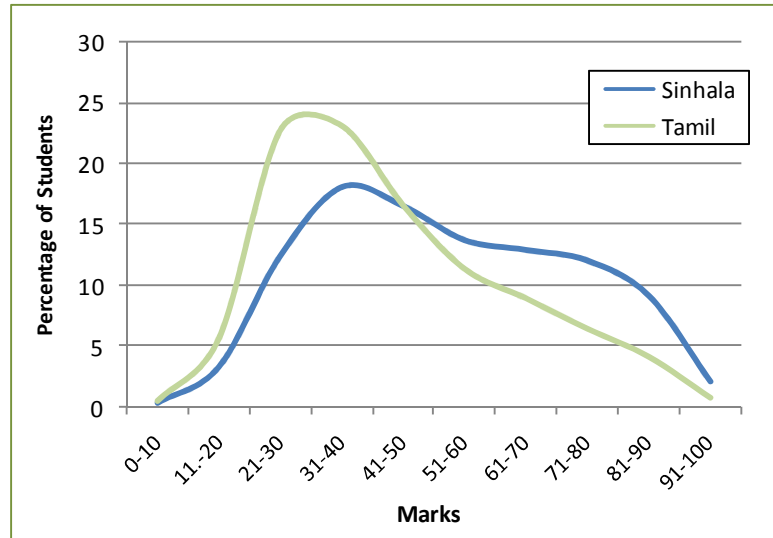


**Figure 3.9: Mean values of mathematics marks according to medium of instruction**

The analysis of the distribution of marks according to medium of instruction is given below in Table 3.8 and further illustrated by Figure 3.10. According to the results shown in Table 3.8 and Figure 3.10, it is apparent that the achievement of Sinhala medium students is more satisfactory than that of Tamil medium students. Although the skewness of distribution of marks is positive for Sinhala and Tamil medium groups, for Tamil medium students, it is considerably higher.

**Table 3.8: Distribution of mathematics achievement marks according to medium of instruction**

Class Interval	Sinhala %	Cumulative %	Tamil %	Cumulative %
00-10	0.21	0.21	0.45	0.45
11-20	3.20	3.42	5.62	6.06
21-30	12.40	15.81	22.77	28.83
31-40	18.07	33.88	23.13	51.96
41-50	16.50	50.38	16.57	68.53
51-60	13.69	64.07	11.34	79.87
61-70	12.87	76.95	8.91	88.78
71-80	11.99	88.94	6.41	95.18
81-90	9.07	98.01	4.09	99.27
91-100	1.99	100.00	0.73	100.00
Total	100.00		100.00	



**Figure 3.10: Distribution of mathematics achievement marks according to medium of instruction**

### 3.4.4 Disparities in Achievement of Mathematics in Relation to Location of School

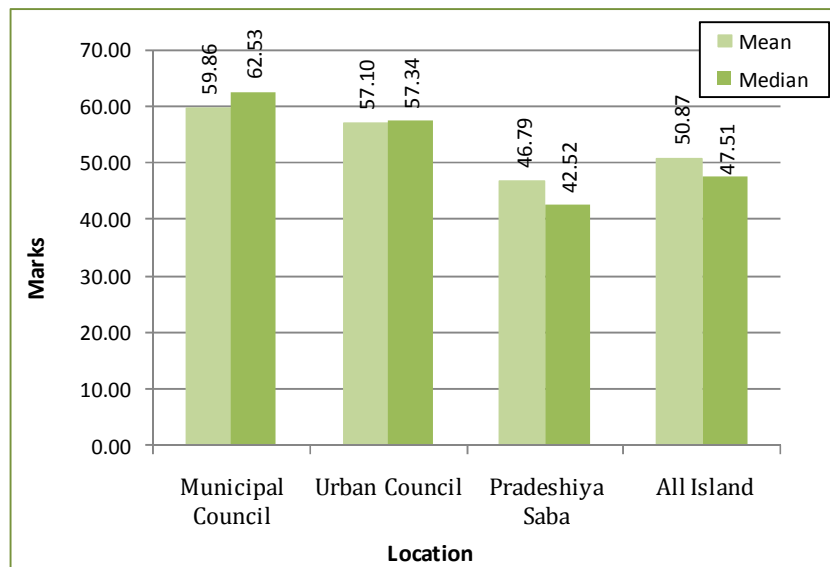
Different governments that came into power have taken numerous efforts to provide equal opportunities to every student studying in public schools irrespective of the location. However, the location of the school has been a leading factor affecting achievement. In this study the achievement level in mathematics of students attending schools located in Municipal Council areas, Urban Council areas and Pradeshiya Sabha areas were analyzed. Such analyzed data are given in Table 3.9 below.

**Table 3.9: Mathematics achievement marks according to location**

Location	Mean	Standard Deviation	Median	Skewness	F	P
Municipal Council	59.86	21.89	62.53	-0.18	13,649.47	.000
Urban Council	57.10	19.50	57.34	-0.15		
Pradeshiya Saba	46.79	18.65	42.52	0.48		
<b>All Island</b>	50.87	20.29	47.51	0.29		

The above table clearly shows that the performance level of students attending schools located in Municipal Council areas is the highest (Mean=59.86) while performance level of students attending schools located in Pradeshiya Sabha areas is the lowest (Mean=46.79).

Though the achievement level of students in Urban Council areas is lower than that of Municipal Council areas, the difference is not relatively high when compared with the difference between Municipal Councils and Pradeshiya Sabhas. This is further illustrated by Figure 3.11.



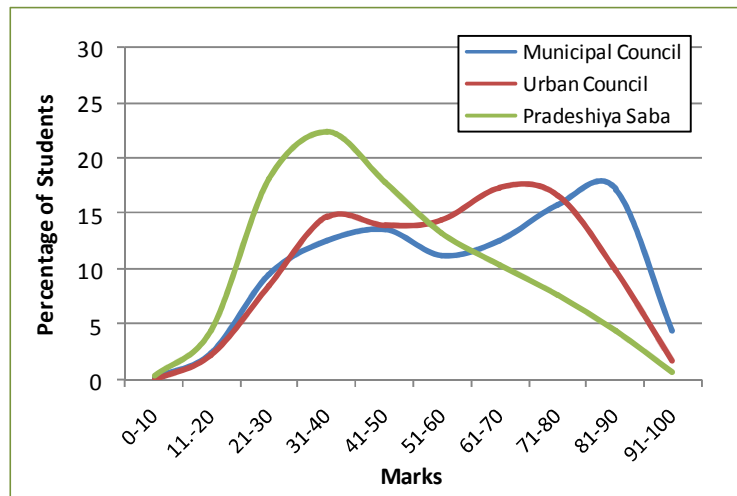
**Figure 3.11: Mean values of mathematics marks according to location**

This pattern of difference is further confirmed when the values of median are compared. It is an important finding to be considered when providing learning opportunities to students studying in schools located in different areas.

Distribution of marks in mathematics was analyzed according to the location of school. Data are presented in Table 3.10. Further it is illustrated in Figure 3.12. Analysis shows that the distribution of marks belonging to Municipal and Urban council areas is negatively skewed indicating a positive sign with regard to the achievement of students. However, in Pradeshiya Saba areas, score distribution is positively skewed which shows that the majority of students are in lower marks categories.

**Table 3.10: Distribution of mathematics achievement marks according to location**

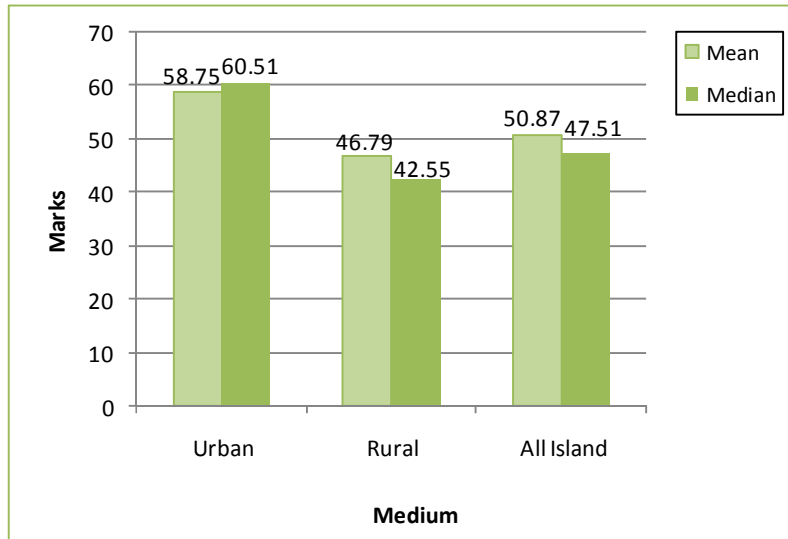
Class Interval	Municipal Council %	Cumulative %	Urban Council %	Cumulative %	Pradshiya Saba %	Cumulative %
00-10	0.22	0.22	0.08	0.08	0.33	0.33
11-20	2.48	2.70	2.32	2.40	4.56	4.89
21-30	9.56	12.26	8.57	10.97	18.14	23.02
31-40	12.58	24.84	14.76	25.73	22.44	45.46
41-50	13.64	38.48	14.04	39.77	17.93	63.39
51-60	11.32	49.80	14.42	54.19	13.35	76.74
61-70	12.63	62.43	17.41	71.60	10.45	87.20
71-80	15.82	78.25	16.74	88.34	7.63	94.83
81-90	17.26	95.51	9.91	98.26	4.41	99.23
91-100	4.49	100.00	1.74	100.00	0.77	100.00
Total	100.00		100.00		100.00	

**Figure 3.12: Distribution of mathematics achievement marks according to location**

Further to the above analysis, Table 3.11 indicates the summary statistics considering the locality as urban and rural. In this analysis both urban council and municipal council schools have been considered as urban while Pradeshiya Saba schools as rural. Data given in the Table 3.11 indicates clearly that the performance of mathematics of students attending the schools situated in urban areas is very high when compared with the performance of students attending schools in rural areas. This is further illustrated by Figure 3.13.

**Table 3.11: Mathematics achievement mark according to location- Urban /Rural**

Location	Mean	Standard Deviation	Median	Skewness	F	P
Urban	58.75	21.01	60.51	-0.15	26,735.6	.000
Rural	46.79	18.65	42.55	0.48		
<b>All Island</b>	50.87	20.29	47.51	0.29		



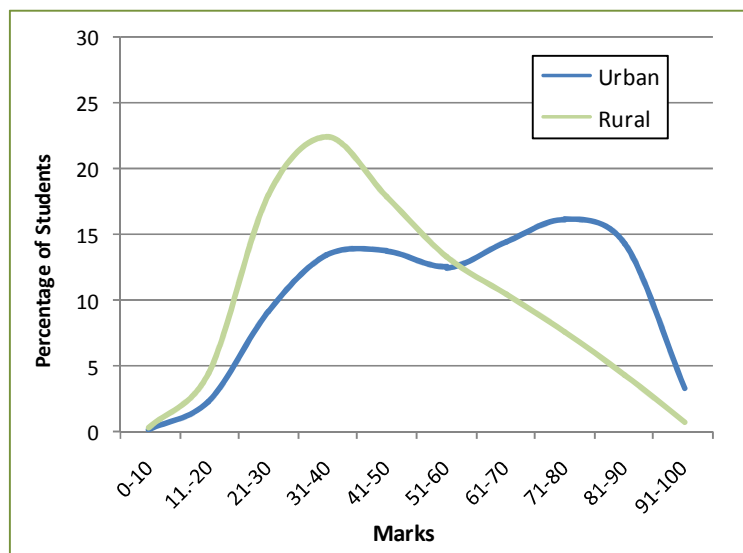
**Figure 3.13: Mean values of mathematics marks according to location – Urban/Rural**

Distribution of marks was analyzed according to the above categorization of schools and is given in Table 3.12 and Figure 3.14 below. This analysis shows that the marks of students in urban areas are negatively distributed while the distribution of marks in rural areas is seen with a positive skewness. As generally seen in educational studies, here too the achievement of students studying in urban schools is higher than that of those studying in rural schools.



**Table 3.12: Distribution of mathematics achievement marks according to location – Urban/Rural**

Class Interval	Urban %	Cumulative %	Rural %	Cumulative %
00-10	0.16	0.16	0.33	0.33
11-20	2.41	2.58	4.56	4.89
21-30	9.17	11.75	18.14	23.02
31-40	13.45	25.20	22.44	45.46
41-50	13.80	39.00	17.93	63.39
51-60	12.56	51.56	13.35	76.74
61-70	14.54	66.10	10.45	87.20
71-80	16.19	82.29	7.63	94.83
81-90	14.32	96.61	4.41	99.23
91-100	3.39	100.00	0.77	100.00
Total	100.00		100.00	

**Figure 3.14: Distribution of mathematics achievement marks according to location – Urban/Rural**

### 3.5 Achievement of Mathematics by Competency Levels

As mentioned in the second chapter, tests used to assess the achievement level of students in the present study were based on the competencies and competency levels expected to be achieved in each subject. In mathematics, 40 competency levels related to four areas of cognitive abilities, namely, knowledge and skills, communication, relationship, problem solving and reasoning were tested. Results are discussed below.

### 3.5.1 Achievement of Competency Levels Related to Knowledge and Skills

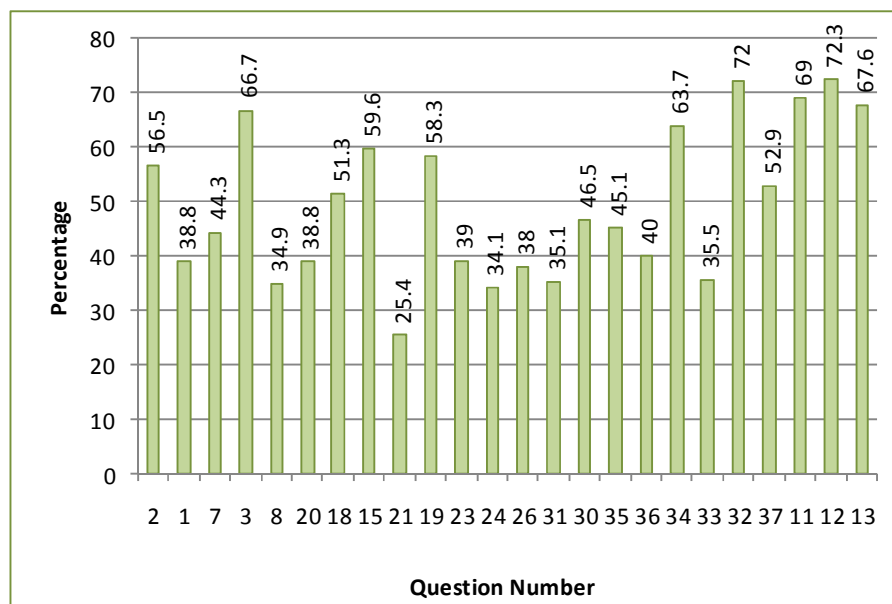
Percentages of students who have achieved expected competency levels related to knowledge and skills are given in Table 3.13.

**Table 3.13: Achievement of competency levels related to knowledge and skills**

Competency Level	Question numbers	Percentage
1.1 Inquires into the relationships between the whole numbers.	2	56.5
1.2 Manipulates directed numbers under the basic mathematical operations	1	38.8
2.1 Builds relationships between the terms of number patterns by investigating various properties	7	44.3
3.1 Manipulates units and parts under multiplication	3	66.7
5.1 Develops the relationship between fractions, ratios and percentages	8	34.9
7.1 Satisfies various requirements by investigating the perimeter of rectilinear plane figures	20	38.8
9.1 Facilitates daily work by investigating large masses	18	51.3
10.1 Determines for daily needs, the space that is taken up by various solids	15	59.6
11.1 Facilitates daily work by investigating the capacity of liquid containers	21	25.4
12.1 Investigates the rotation of earth and inquires into its results	19	58.3
12.2 Investigates the difference in time between countries and finds their relative positions	23	39.0
13.1 Indicates the direction of a location using angles	24	34.1
15.1 Factorizes algebraic expressions	26	38.0
20.2 Illustrates the behavior of a variable pictorially	31	35.1
20.3 Represents location on a Cartesian Plane	30	46.5
21.1 Examines the angles made by various straight lines	35	45.1
21.2 Performs calculations using the relationships between various angles	36	40.0
22.1 Created solids and confirms the relationships between properties related circles	34	63.7
23.1 Inquires into the relationships between the various angles of rectilinear plane figure	33	35.5
24.1 Inquiries into the special properties related to circles	32	72.0
25.1 Inquires into the results of a rotation that are based on symmetry	37	52.9

Competency Level	Question numbers	Percentage
27.1 Compares varies movements with the basic foci	11	69.0
29.1 Inquires into numerical representative values of a group of data	12	72.3
31.1 Determines the likelihood of an event occurring by investigating the various methods of finding a suitable value	13	67.6
Average		49.4

According to Table 3.13, the competency level 29.1 ('Inquires into numerical representative values of a group of data') was achieved by the highest percentage of students which is 72.3 percent. The competency level 11.1 ('Facilitates daily work by investigating the capacity of liquid containers') was achieved by the lowest percentage of students which is 25.4 percent. According to the data in Table 3.13, 11 competency levels out of 24 (nearly half of the tested competency levels) have been achieved by more than 50 percent of students. However, average percentage of students who achieved the competencies related to knowledge and skills areas is 49.4. Percentage of students achieved the competency levels related to knowledge and skills are further illustrated in Figure 3.15 below.



**Figure 3.15: Achievement of competency levels related to knowledge and skills**

### 3.5.2 Achievement of Competency Levels Related to Communication

Another important area with regard to cognitive abilities in mathematics is communication. Ten competency levels were tested related to this area. The percentage of students who achieved these competencies are given in Table 3.14.

**Table 3.14: Achievement of competency levels related to communication**

Competency level	Question No.	Percentage
3.2 Manipulates units and parts of units under division	9	27.9
3.3 Manipulates decimal numbers under the mathematical operations of multiplication and division.	4	72.5
6.2 Expands a power of a negative integer and finds the value	5	65.6
8.2 Fulfils daily needs by investigating the surface area of various solids	16	18.5
13.2 Describes various locations in the environment using scale drawings	22	65.6
14.1 Simplifies algebraic expressions by removing brackets and finds the value by substitution.	25	48.3
18.1 Uses the relationships between two quantities that can be used to enhance beauty.	28	52.5
20.1 Uses a number line to represent fractions and decimal numbers	29	36.8
26.1 Studies shapes by creating various patterns that can be used to enhance beauty.	39	59.4
30.1 Analyze the various relationships related to sets.	40	64.6
Average		51.2

The competency level related to communication achieved by the highest percentage (72.5) of students is ‘Manipulates decimal numbers under the mathematical operations of multiplication and division’ while the competency level achieved by the lowest percentage (18.5) of students is ‘Fulfils daily needs by investigating the surface area of various solids’. As a whole, average percentage of students who achieved the competency levels related to communication is 51.2. Percentage of students who have achieved the above mentioned competency levels are given in Figure 3.16

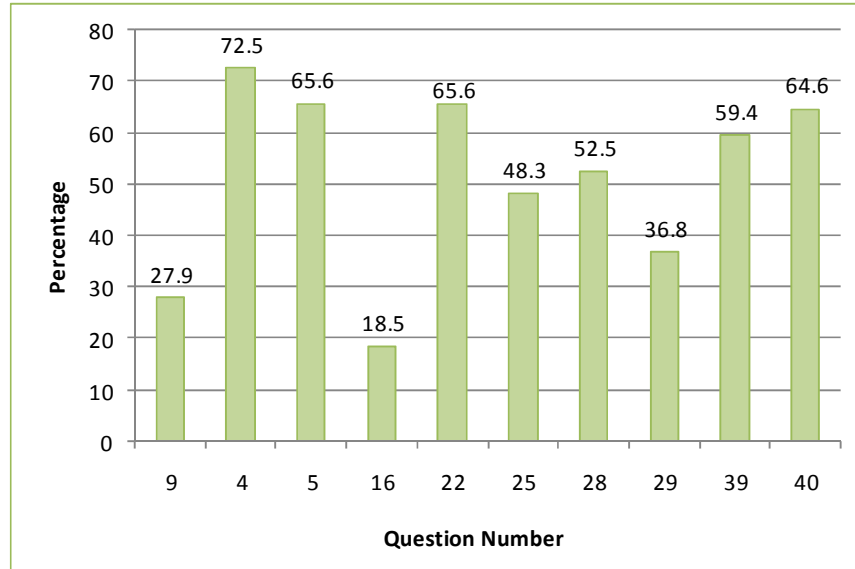


Figure 3.16: Achievement of competency levels related to communication

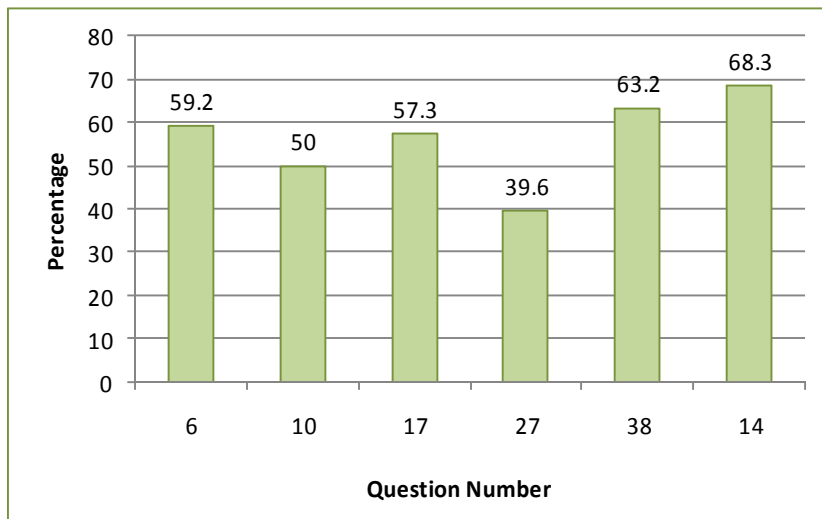
### 3.5.3 Achievement of Competency Levels Related to Relationship, Reasoning and Problem-Solving

Competency levels achieved by the students related to relationship, reasoning and problem-solving are given in Table 3.15

Table 3.15: Achievement of competency levels related to relationships, reasoning and problem solving

Standard	Competency Level	Question No.	Percentage
Relationships	4.1 Uses ratios in day to day activities	6	59.2
	4.2 Solves problems constructing relationships between two ratios	10	50.0
Problem solving	8.1 Finds the area of a compound plane figure in the environment and has an awareness of the space allocated for them.	17	57.3
	17.1 Uses linear equations to solve problems	27	39.6
Reasoning	27.2 Constructs triangles	38	63.2
	28.1 Represents data such that comparison is facilitated	14	68.3

It is clear that the percentage of students who achieved competency level related to reasoning is significantly high. It is 65.7 percent. Competency level related to relationship has also been achieved by the majority of students (54.6%). However, competency levels related to problem solving have been achieved by the lowest percentage of students. Average percentage is 48.45. This is not particularly encouraging because problem solving is a very important ability students should have developed, especially in mathematics. These results of competency level achievement are further illustrated in Figure 3.17.



**Figure 3.17: Achievement of competency levels related to relationships, reasoning and problem solving**

### 3.6 Summary

In this chapter, achievement levels as well as disparities in achievement of students in mathematics were discussed. Average achievement of mathematics is above 50. The majority of the students belong to low marks categories. Disparities in achievement levels can be seen in terms of type of school, gender, medium of instruction and location of school.