Patterns in Achievement – Science 2014

4.1 Introduction

This chapter presents the achievement levels of science which is one of the core subjects in grade 8 curriculum and tested in national assessment of achievement of grade completing grade 8 in year 2014. In 2007, a competency based curriculum was introduced for science as well. The present National Assessment is the second study conducted on the Grade 8 science curriculum since the new curriculum was introduced. The first one was conducted in 2012. In this chapter, firstly achievement levels in science at national and provincial levels are addressed followed by a discussion of distribution of marks in science. Afterwards, disparities in achievement levels with regard to the type of the school, gender, location of the school and the medium of instruction have been analyzed. Achievement levels of different competencies and competency levels in this subject are also examined.

4.2 Achievement Levels in Science at All Island and Provincial Levels

Mean value of science marks at all island level is 41.16. Although 41.16 is not a high mark, it may be desirable. Yet, it is below 50 marks. Even when the median is concerned it is nearly 40.

These values at all island level as well as provincial levels are given in Table 4.1 below.

Table 4.1: All island and provincial achievement in science 2014 – Summary statistics

Province	Mean	Rank	Standard Deviation	Standard Error of Mean	Percentile (p25)=Q1	Median (p50)=Q2	Percentile (p75)=Q3	Skewness
Southern	46.95	1	22.58	0.12	28.21	44.21	65.10	0.29
Sabaragamuwa	44.02	2	19.97	0.12	29.34	43.42	59.22	0.17
Western	43.76	3	22.08	0.08	25.25	41.51	62.32	0.25
North Western	42.78	4	20.09	0.10	27.41	40.70	57.41	0.37
North Central	41.15	5	19.44	0.13	26.61	38.51	55.61	0.45
Uva	39.41	6	19.31	0.13	24.21	37.42	52.71	0.52
Eastern	37.44	7	19.64	0.11	22.70	33.35	50.82	0.60
Central	34.91	8	18.96	0.09	20.61	30.81	47.51	0.76
Northern	34.15	9	18.78	0.13	20.50	29.27	46.31	0.73
All Island	41.16		20.92	0.04	25.21	40.05	58.21	0.44

Achievement level of students is indicated by both mean and median values. In a situation where scores are distributed with a high skewness, like in the present study, median value gives a better picture about the achievement level of students. In the present study, mean value of science marks at all island level is 41.16. It is not a high mark. Yet, it may be as satisfactory. The median value of the same subject is 40.05. This too is a low mark. It means that half of the students have scored below 40.05. The value of Q1 is 25.21. It indicates that 25 percent of students in grade has scored below 25.21. Meanwhile, according to the above table 75 percent of students are below 58.21. When standard deviation is concerned (SD=20.92), a considerably high dispersion of marks can be seen at all island level.
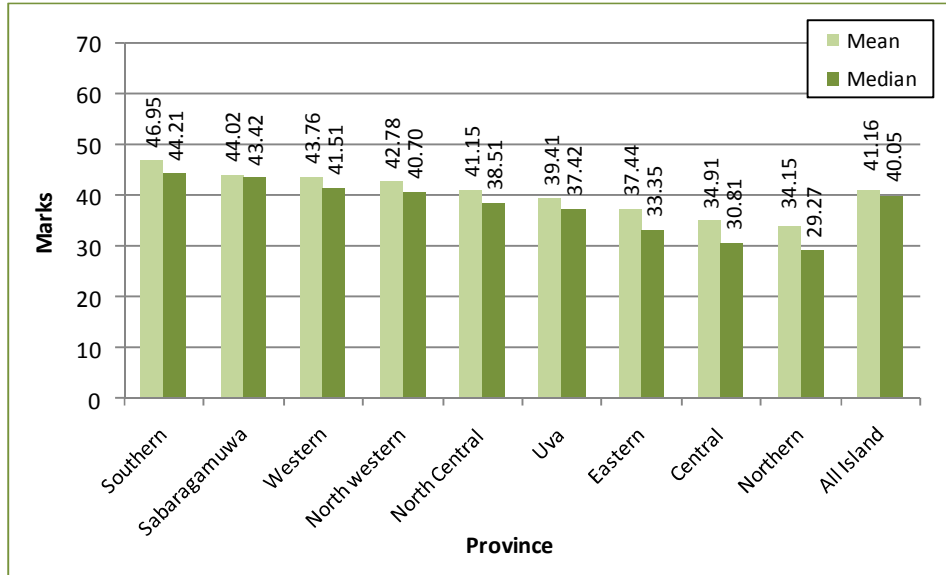
This is further illustrated by Figure 4.1

Figure 4.1: Mean values and median values of science marks

4.3 Distribution of Test Scores of Science

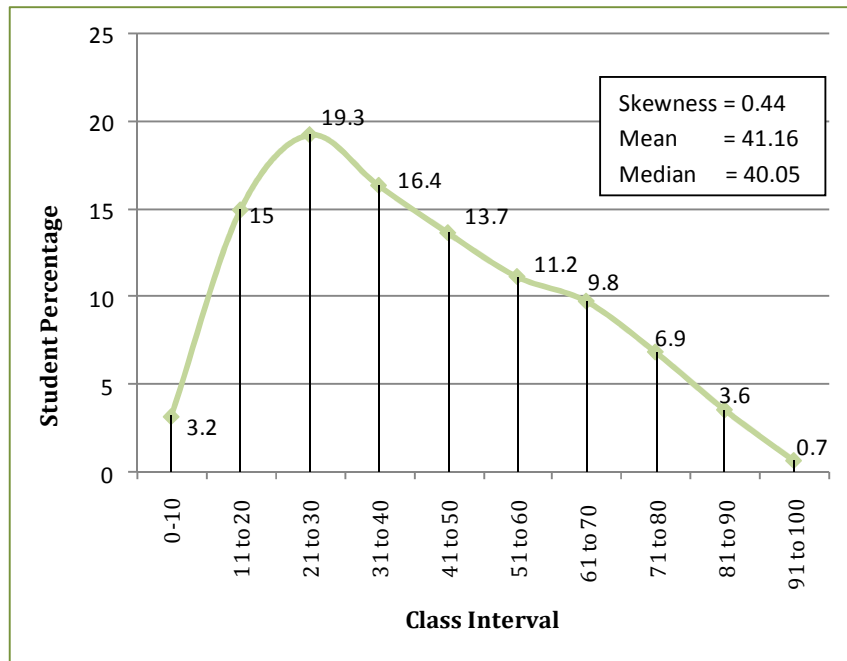The manner in which science test scores are distributed is shown by Figure 4.2.

Figure 4.2: All island achievement in science –distribution of marks

According to the graph, the distribution of marks is positively skewed. The value of the skewness is 0.44. This skewness is further illustrated by Table 4.2.

Table 4.2: Distribution of all island achievement marks of Science

Class Interval	Student %	Cumulative %
00 to10	3.2	3.2
11 to 20	15.0	18.3
21 to 30	19.3	37.6
31 to 40	16.4	54.0
41 to 50	13.7	67.8
51 to 60	11.2	79.0
61 to 70	9.8	88.8
71 to 80	6.9	95.7
81 to 90	3.6	99.3
91 to 100	0.7	100
Total	100.0	

According to Table 4.2, most of the students belong to low level mark categories. Nearly 38 percent of students have scored 30 or less than 30 marks and nearly 68 percent of the students have scored 50 or less than 50 marks. If the students have been able to display predicted learning outcomes, distribution of marks must be negatively skewed. However, that doesn't appear in the said distribution of marks of science. This negatively skewed distribution of marks can be seen in almost all the provinces. This is shown in Figure 4.3. According to this figure, Western and Sabaragamuwa Provinces do not seem to have a highly positively skewed mark distribution. Meanwhile, Northern and Central Provinces have a very high positively skewed distribution of marks.

Another important feature that can be seen in Figure 4.3 is that in most of the provinces distributions of science marks are bimodal. This indicates that there are two main groups of student in the population.

Figure 4.3: Provincial-wise distribution of marks – Science

Nature of the distribution of science marks is further elaborated by the box and whisker plots in Figure 4.4. One important thing is that a group of student who scored very high marks can be seen in Central and Northern provinces. These are the lowest performing provinces. This is a situation to be studied further.
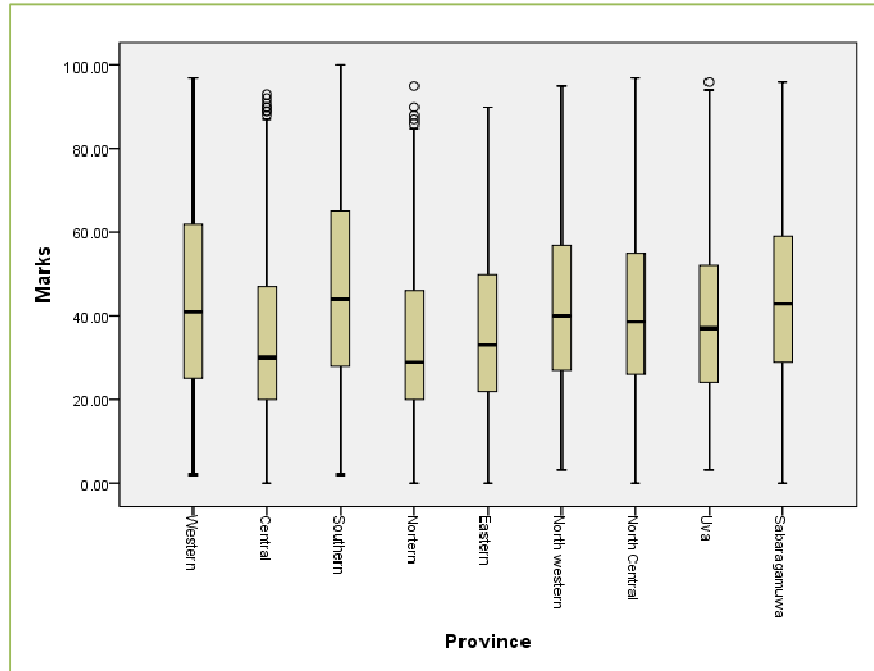

Figure 4.4: Science marks representation using boxplot and whisker plot

4.4   Disparities in Achievement in Science

Over the years various efforts have been made to provide equal opportunities for school education in Sri Lanka. Yet, disparities in achievement of students in science 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.

4.4.1 Disparities in Achievement in Science in Relation to School Type

Indicators of achievement levels of science according to the school type are given in Table 4.3 which is given below.

Table 4.3: Science achievement marks according to school type

School Type	Mean	Standard Deviation	Median	Skewness	F	P
1AB	49.18	20.99	49.01	0.07	30,719	.000
1C	32.95	16.74	30.22	0.74		
Type 2	31.24	17.05	28.53	0.86		
All Island	41.16	20.92	40.05	0.44		

According to this table, lowest performance can be seen in Type 2 schools. Mean and median values of these schools are 31.24 and 28.53 respectively. Meanwhile 1AB schools show the highest performance levels. According to the F test, differences in performance levels in three types of schools are statistically significant (p=0.00). However, the difference between the achievement levels of students in Type 2 schools and those of 1C schools is not so high. This is an indication of the commonality of factors affecting achievement of students attending these two types of schools. This is illustrated by both mean and median values. Mean values for 1C and Type 2 schools are 32.95 and 31.24 while median values are 30.22 and 28.53 for the same two types of schools. Nevertheless, mean and median values of 1AB schools are respectively 49.18 and 49.01. These differences are further illustrated by Figure 4.5 below.
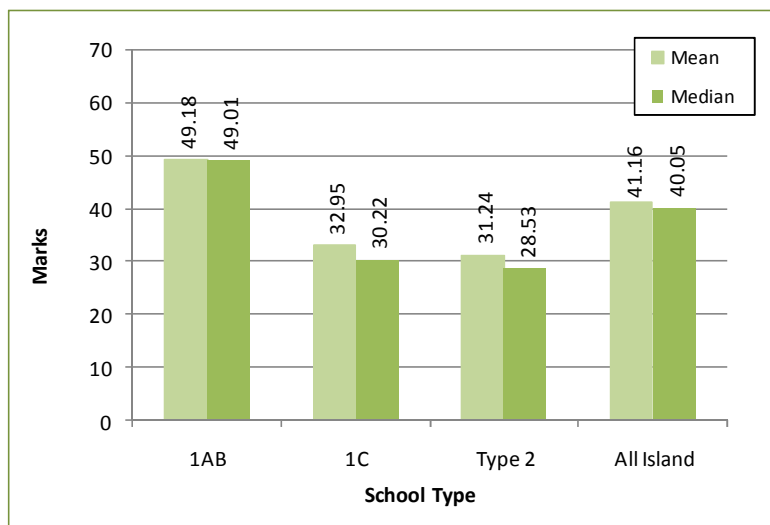

Figure 4.5: Mean values of science marks according to school type

Distribution of marks in achievement in science was analyzed in relation to school type. This is given in Table 4.4 below and further illustrated by Figure 4.6. Both the table and the figure show a highly positively skewed distribution of scores in 1C and Type 2 schools. Concerning 1AB schools scores are distributed with a positive skewness.

However this skewness is very low when compared with 1C and Type 2 schools. This indicates that the majority of students belonging to 1C and Type 2 schools have shown a poor performance.

Table 4.4: Distribution of science achievement marks according to school type

Class Interval	1AB Student %	Cumulative %	1C Student %	Cumulative %	Type 2 Student %	Cumulative %
00-10	1.29	1.29	4.78	4.78	6.43	6.43
11-20	8.04	9.33	21.06	25.84	25.61	32.03
21-30	13.75	23.08	26.01	51.85	24.71	56.74
31-40	14.63	37.71	19.48	71.33	16.64	73.38
41-50	14.84	52.55	12.82	84.15	12.06	85.44
51-60	14.32	66.87	7.91	92.06	7.37	92.81
61-70	14.59	81.46	4.90	96.96	3.86	96.67
71-80	11.02	92.48	2.34	99.30	2.60	99.27
81-90	6.29	98.77	0.70	100.00	0.62	99.89
91-100	1.23	100.00	0.00	100.00	0.11	100.00
Total	100.00		100.00		100.00	
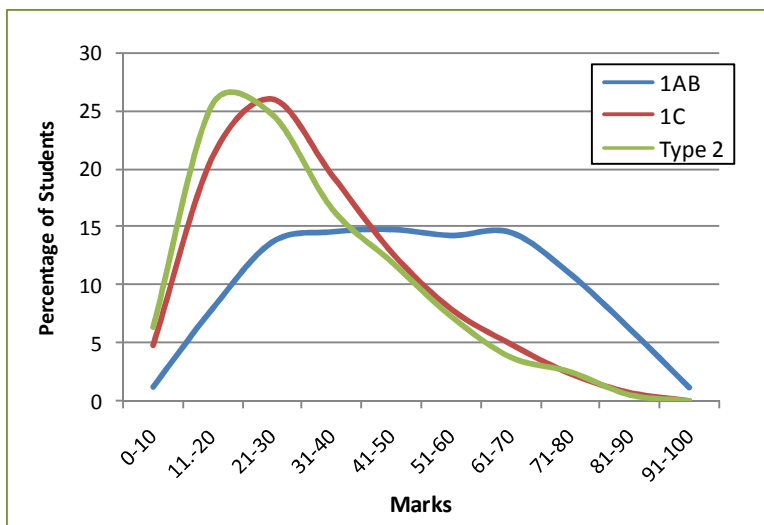
Figure 4.6: Distribution of science achievement marks according to school type

## 4.4.2 Disparities in Achievement in Science in Relation to Gender

Gender has been an important area of disparities in the achievement levels of students according to previous national assessment studies (Grade 4 and Grade 8) conducted by NEREC. Table 4.5 shows indicators of achievement levels of boys and girls separately.

Table 4.5: Science achievement marks according to gender

Gender	Mean	Standard Deviation	Median	Skewness	F	P
Male	39.41	21.14	36.61	0.49	2,087	.000
Female	42.80	20.58	40.52	0.41		
All Island	41.16	20.92	40.05	0.44		

It is clear that achievement levels of girls is slightly higher than that of boys. The mean value is 42.80 while the mean value of boys 39.41. This difference is further illustrated by Figure 4.7.
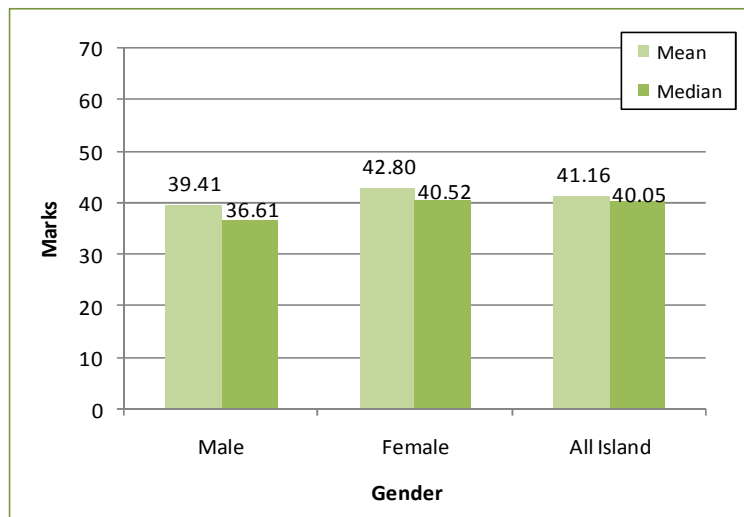

Figure 4.7: Mean values of science marks according to gender

Further to the mean value, values of the median show this. The value of the median for girls is 40.52 while the median value for boys is 36.61. However, this difference is not very high compared with the differences related to school type, location of school and medium of instruction.

The analysis of distribution of marks in science in relation to gender is given in Table 4.6 and further more it is shown in Figure 4.8. This analysis does not show a considerable difference with regard to the distribution of marks in relation to male and female. Both distributions are positively skewed. This indicates that the majority of students in both groups belongs to lower level mark categories.

Table 4.6: Distribution of science achievement marks according to gender

Class Interval	Male %	Cumulative %	Female %	Cumulative %
00-10	4.59	4.59	1.99	1.99
11-20	17.71	22.30	12.55	14.54
21-30	19.44	41.73	19.25	33.79
31-40	15.34	57.08	17.43	51.22
41-50	13.15	70.23	14.30	65.52
51-60	10.31	80.54	11.99	77.51
61-70	9.28	89.83	10.28	87.79
71-80	6.21	96.03	7.63	95.42
81-90	3.42	99.45	3.81	99.22
91-100	0.55	100.00	0.78	100.00
Total	100.00		100.00	
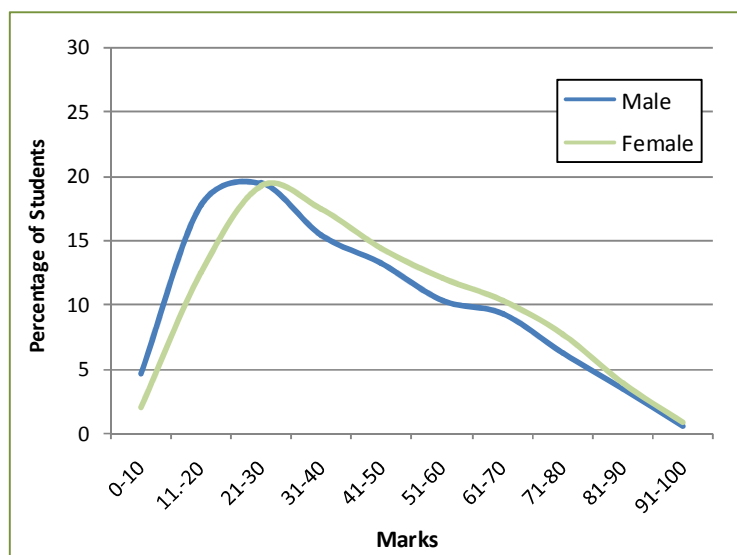
***Figure 4.8: Distribution of science achievement marks according to gender***

4.4.3 Disparities in Achievement in Science in Relation to Medium of Instruction

In the present study, medium of instruction was taken into consideration as a factor that apparently affect the achievement levels of students in science. Relevant statistics are displayed in Table 4.7.

Table 4.7: Science achievement marks according to medium of instruction

Medium	Mean	Standard Deviation	Median	Skewness	F	P
Sinhala	44.30	20.98	42.73	0.30	21,188	.000
Tamil	32.38	10.09	28.11	0.87		
All Island	41.16	20.92	40.05	0.44		

According to the above table the performance level of students who study in Sinhala is considerably higher than that of the students whose medium of instruction is Tamil. While the mean value of Sinhala medium students is 44.30, the mean value of Tamil medium students is 32.38. Furthermore, the median value of the Sinhala medium students is 42.73 and the median value of the Tamil medium students is 28.11. This difference is further shown by Figure 4.9 given below.
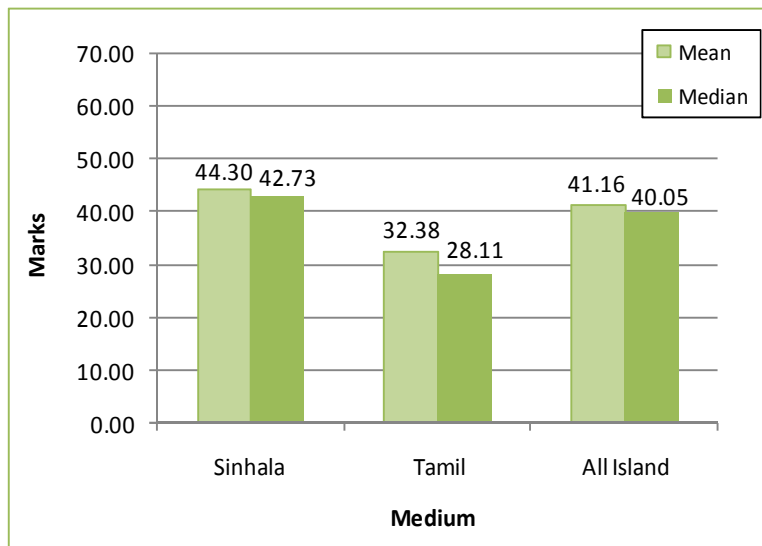

Figure 4.9: Mean values of science marks according to medium of instruction

One important thing is that though the medium of instruction for the two groups is different, more often the two languages in which they study are their mother tongues. When compared with the differences of achievement levels related to school type, gender and the location of school, the difference concerning the medium of instruction seems to be the highest. However, this can be due to some other factors associated with these two different kinds of schools where the medium of instruction is different.

Distribution of marks of student achievement was analyzed for both Sinhala and Tamil medium students. Such data are given in Table 4.8 below. For both groups, the distributions of marks show a positive skewness. This skewness is very high for Tamil medium students when compared with that of Sinhala medium students. This difference in skewness in marks is once again illustrated in Figure 4.10. This indicates that the majority of Tamil medium students who are in lower mark categories are higher than those of Sinhala medium.

Table 4.8: Distribution of science achievement marks according to medium of instruction

Class Interval	Sinhala %	Cumulative %	Tamil %	Cumulative %
00-10	2.25	2.25	6.00	6.00
11-20	11.58	13.83	24.74	30.74
21-30	17.42	31.25	24.73	55.46
31-40	16.43	47.68	16.42	71.89
41-50	14.62	62.30	11.29	83.18
51-60	12.62	74.92	7.14	90.32
61-70	11.42	86.34	5.26	95.58
71-80	8.31	94.65	3.11	98.69
81-90	4.45	99.10	1.29	99.98
91-100	0.90	100.00	0.02	100.00
Total	100.00		100.00	
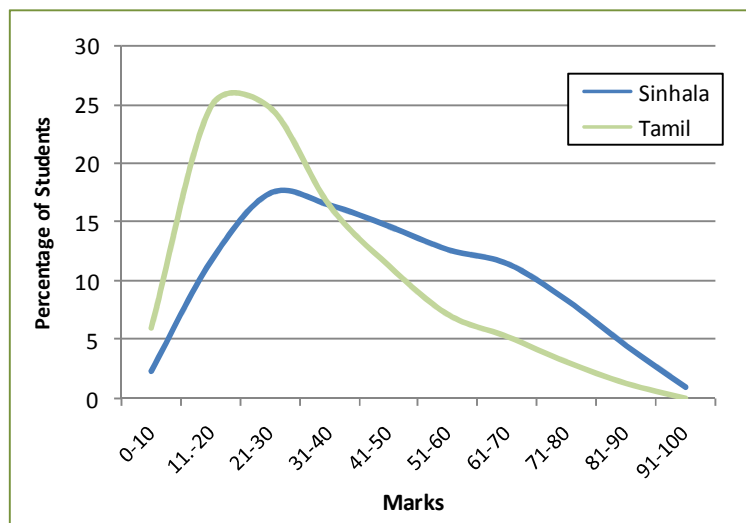
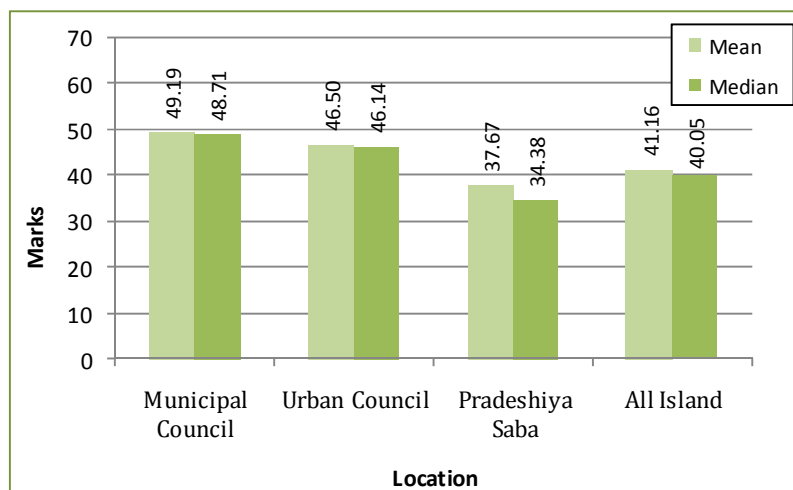*Figure 4.10: Distribution of science achievement marks according to medium of instruction*

4.4.4 Disparities in Achievement in Science in Relation to Location of School

Location of the school is considered as one significant factor that could be influential for the achievement levels of students in science. Table 4.9 show the differences in such achievement levels of students in schools located in Municipal Council area, Urban Council areas and Pradeshiya Saba areas.

Table 4.9: Science achievement marks according to location

Location	Mean	Standard Deviation	Median	Skewness	F	P
Municipal Council	49.19	23.24	48.71	0.09	9,486	.000
Urban Council	46.50	21.34	46.14	0.07		
Pradeshiya Saba	37.67	19.13	34.38	0.55		
All Island	41.16	20.92	40.05	0.44		

According to the indicators of achievement level given in Table 4.9, the highest achievement level can be seen in schools located in Municipal Council areas. The mean value of the achievement marks of students in schools that come under Municipal council areas is 49.19. Meanwhile, the lowest achievement level recorded by schools that come under Pradesiya Sabas shows a mean value of 37.67. The gap between these mean values is noticeably high. Nonetheless, the difference between the achievement levels of schools located in Municipal and Urban Council areas is not so high. The mean value of achievement of students in science in schools located in Municipal Council areas is 49.19 while the mean value of achievement in science in schools located in Urban Council areas is 46.50. This is further shown by Figure 4.11.


Figure 4.11: Mean values of science marks according to location

An analysis of the distribution of marks based on the location of school relating to Municipal, Urban and Pradeshiya Saba areas were conducted. Data are presented in Table 4.10 and further illustrated by Figure 4.12. It shows that there is no significant difference between the distributions of marks in schools belonging to Municipal and Urban Council areas. Concerning the Paradeshiya Saba schools distribution of marks is highly positively skewed. One important finding according to this analysis is that that the skewness of the distribution of marks in Municipal and Urban Council areas is significantly lower than that of Pradeshiya Saba areas. This shows that the performance of students in schools located in Municipal and Urban Council areas is more satisfactory than that of Pardeshiya Saba areas.

Table 4.10: Distribution of science achievement marks according to location

| Class Interval	Municipal Council %	Cumulative %	Urban Council %	Cumulative %	Pradeshiya Saba %	Cumulative %
00-10	2.20	2.20	2.39	2.39	3.73	3.73
11-20	10.24	12.44	11.76	14.15	17.14	20.87
21-30	14.88	27.32	14.05	28.20	21.76	42.63
31-40	12.90	40.22	14.78	42.98	17.82	60.45
41-50	12.41	52.63	13.94	56.91	14.11	74.56
51-60	11.85	64.48	12.15	69.06	10.78	85.34
61-70	12.59	77.07	15.47	84.54	7.81	93.14
71-80	11.95	89.02	9.65	94.19	4.89	98.03
81-90	8.75	97.76	5.45	99.64	1.71	99.74
91-100	2.24	100.00	0.36	100.00	0.26	100.00
Total	100		100		100	
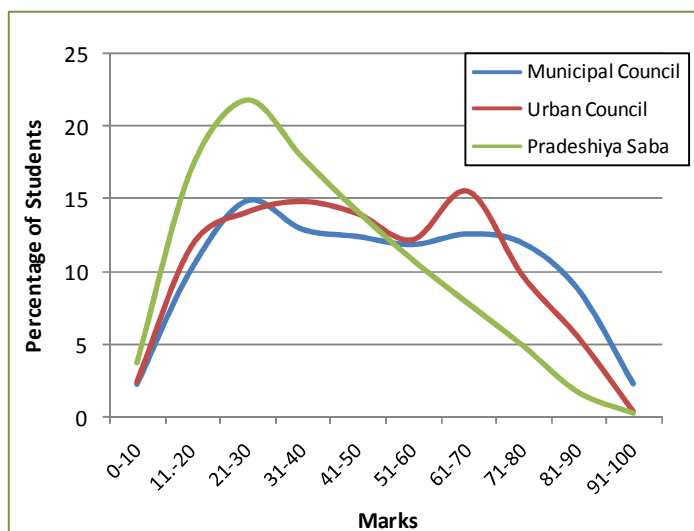
Figure 4.12: Distribution of science achievement marks according to location

Table 4.11 shows science performance of students who attends to schools located in urban areas and rural areas separately. It clearly shows that the performance level of the students in urban areas (Mean = 48.10) considerably higher than that of the students in rural areas (Mean = 37.67). This is further illustrated by Figure 4.13.

Table 4.11: Science achievement marks according to location - Urban/Rural

| Location	Mean	Standard Deviation	Median	Skewness	F	P
Urban	48.10	22.54	47.41	0.10	18,500.96	.000
Rural	37.67	19.13	34.31	0.55		
All Island	41.16	20.92	40.05	0.44		
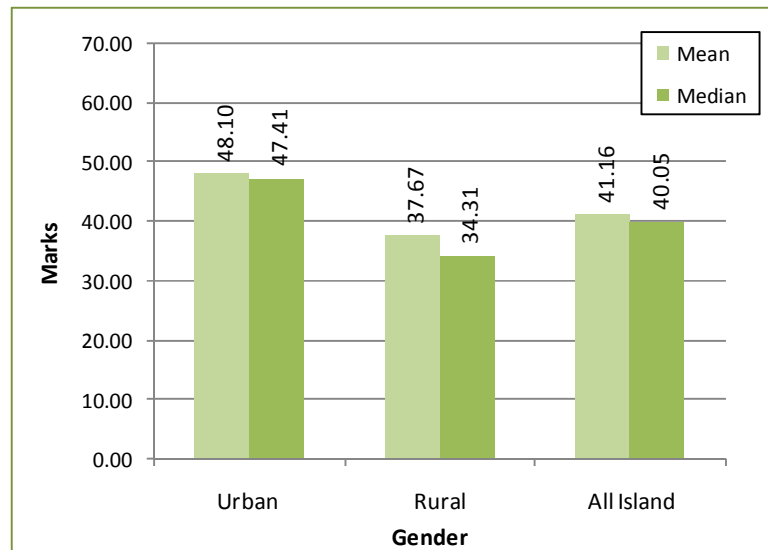
Figure 4.13: Mean values of science marks according to location – Urban/Rural

Further to the above analysis, distribution of scores was analyzed based on urban and rural categorizations. Analyzed data are given in Table 4.12 Findings show that the distribution of marks of students belonging to rural areas is highly positively skewed while the distribution marks of students in urban areas are slightly positively skewed. This again confirms the unsatisfactory achievement in rural areas.

Table 4.12: **Distribution of science achievement marks according to location –**
Urban/Rural

Class Interval	Urban %	Cumulative %	Rural %	Cumulative %
00-10	2.28	2.28	3.73	3.73
11-20	10.86	13.13	17.14	20.87
21-30	14.54	27.67	21.76	42.63
31-40	13.66	41.33	17.82	60.45
41-50	13.03	54.36	14.11	74.56
51-60	11.97	66.33	10.78	85.34
61-70	13.76	80.09	7.81	93.14
71-80	11.02	91.11	4.89	98.03
81-90	7.41	98.52	1.71	99.74
91-100	1.48	100.00	0.26	100.00
Total	100.00		100.00	
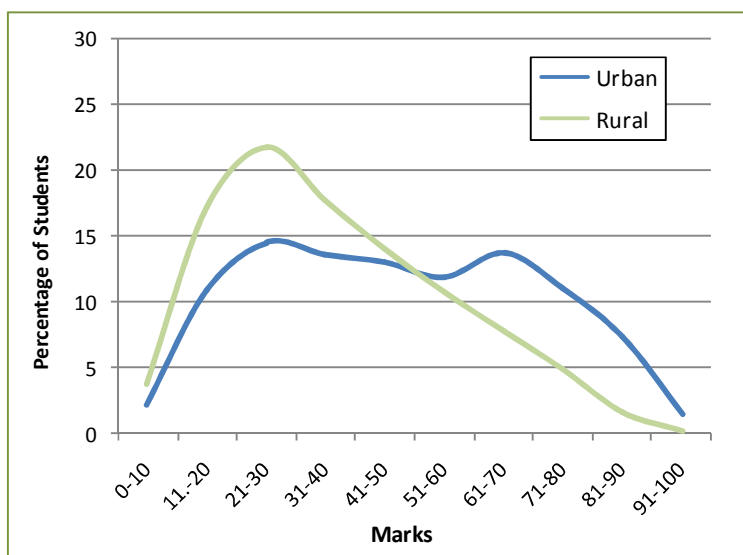
Figure 4.14: *Distribution of science achievement marks according to location – Urban/Rural*

4.5   Achievement of Science by Competency Levels

It is important to see to what extent, students have been able to achieve the expected competencies related to science in Grade 8. The test which was administered to assess the achievement level of science was principally based on competencies and competency levels in science. The percentage of students who achieved the expected competency levels according to the results of the test was analyzed. This was done for four areas in science separately. They are biology, chemestry, earth science and physics.

4.5.1 Achievement of Competency Levels Related to Biology

Percentages of students who achieved different competency levels related to biology ware analyzed and are given in Table 4.13 below.

Table 4.13: Achievement of competency levels related to biology

Content	Competency Level	Percentage
Biology	1.1 Discovers the diversity of the natural environments	42
	1.2 Investigates the advantages/disadvantages of the built environments	40
	1.3 Focuses attention on the venomous animals that are harmful to man	**68**
	1.4 Acquires the ability to use international scientific symbols	59
	3.1 Observes the interactions based on life cycles	36
	3.3 Explains the importance of use of cultivations under specific conditions	62
	3.4 Investigates the biotic factors affecting the perpetuation of the environment.	45
	6.1 Conducts explorations to identify the morphological diversity of leaves	**8**
	6.3 Investigates the functions related to the diversity of roots.	33
	6.4 Uses plant related products with a scientific attitude	40
	Average	43

According to the above Table, the competency level 1.3, ('focuses attention on the venomous animals that are harmful to the man') has been achieved by the highest percentage of students which is 68. On the other hand, competency level 6.1, ('Conducts explorations to identify the morphological diversity of leaves') has been achieved by eight percent of the students and it is the lowest percentage according to the Table. Another significant finding is that more than 50 percent of students have been able to achieve only 3 competency levels out of the 10 competency levels which were tested. As a whole, only 43 percent of students have been able to achieve expected competency levels. This is further illustrated by Figure 4.15.
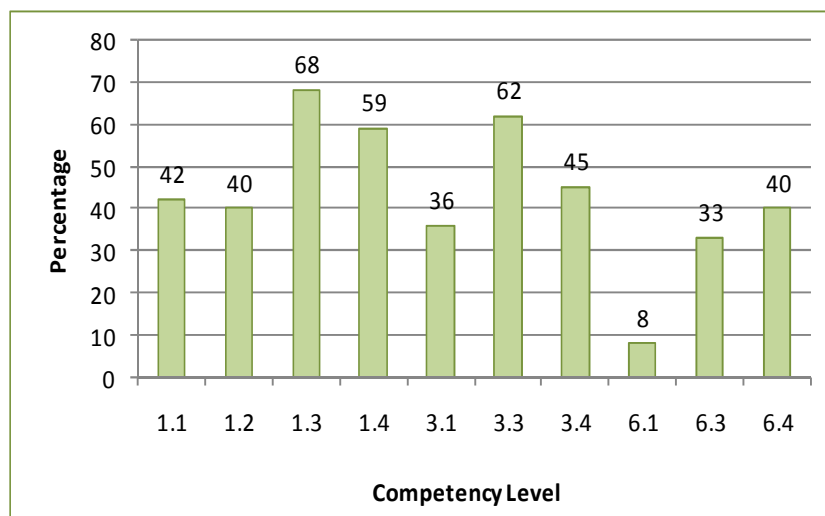
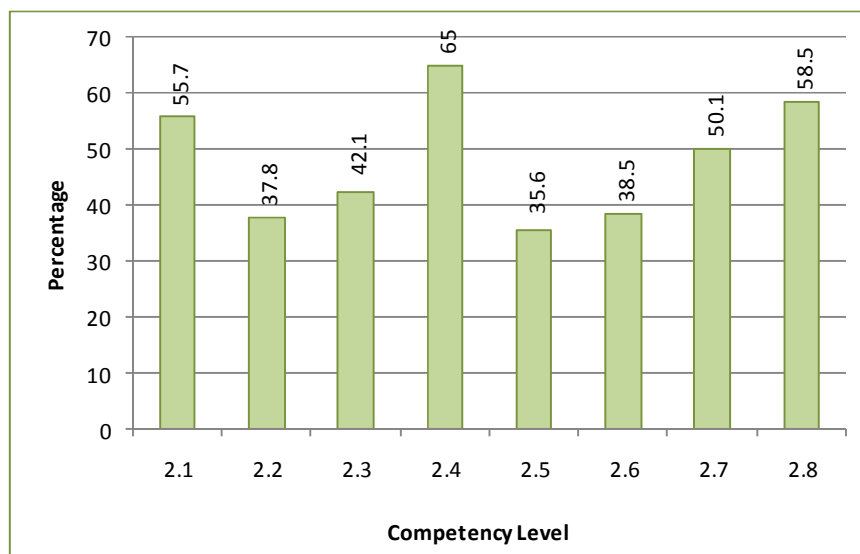*Figure 4.15: Achievement of competency levels related to biology*

4.5.2 Achievement of Competency Levels Related to Chemistry

Table 4.14: Achievement of competency levels related to chemistry

Content	Competency Level	Percentage
Chemistry	2.1 Inquires into the properties of matter	50
	2.2 Inquires into the standard symbols used for elements	47
	2.3 Display the ability to use the differences in density of substances in day today life.	41
	2.4 Uses the expansion of solids, liquids and gases in day today life effectively.	8
	2.5 Inquires into the usages of compounds according to their properties.	25
	2.6 Inquires into the domestic uses of chemicals	21
	2.7 Uses parallel and serial connections of electrical appliances in human needs.	44
	2.8 Uses magnets in day today life	53
	Average	36

Analysis related to chemistry shows that highest percentage of students (53) have been able to achieve the competency level 2.8, (Uses magnets in day today life). On the other hand, the lowest percentage of students (8) has achieved the competency level 2.4 (Uses the expansion of solids, liquids and gases in day today life effectively).

According to the above analysis, only 2 competency levels out of the tested 10 have been achieved by majority of students. These two, however, are related to knowledge. They are, 'inquiries into the properties of matter' and 'uses magnets in day today life'. In general, 36 percent of the students have been able to achieve the expected competencies which were tested in the study.

Figure 4.16: Achievement of competency levels related to chemistry

4.5.3 Achievement of Competency Levels Related to Earth Science

Table 4.15: **Achievement of competency levels related to earth science**

Content	Competency Level	Percentage
Earth science	4.1 Investigates the constituents of the atmosphere	32
	4.2 Acts to maintain optimum composition of the atmosphere	38
	4.3 Uses natural resources obtained from the earth effectively	47
	Average	39

The highest percentage of students has achieved the competency 4.3 (uses of natural resources obtained from the earth effectively) while the least percentage (32%) has been able to achieve the competency level 4.1 (investigates the constituents of the atmosphere). Thus according to the above table, the majority of the students have not been successful in achieving any one of the competencies. The overall percentage of the students who achieved the expected competency levels is 39. This is also less than 50 and may be viewed as an undesirable situation.
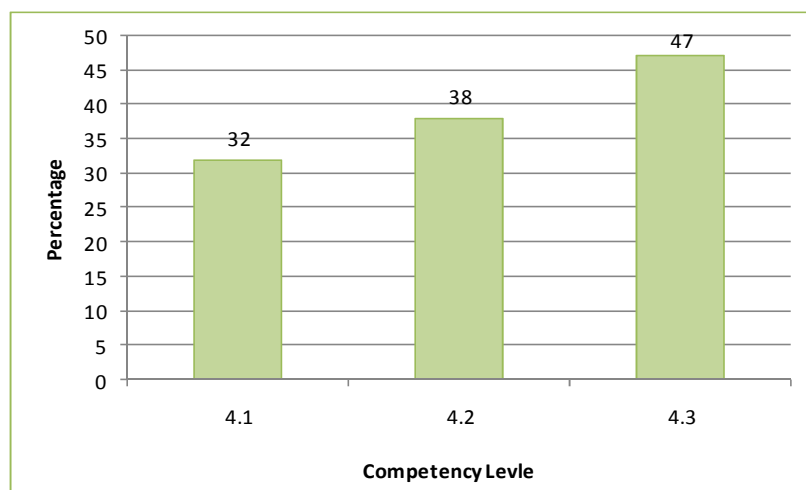
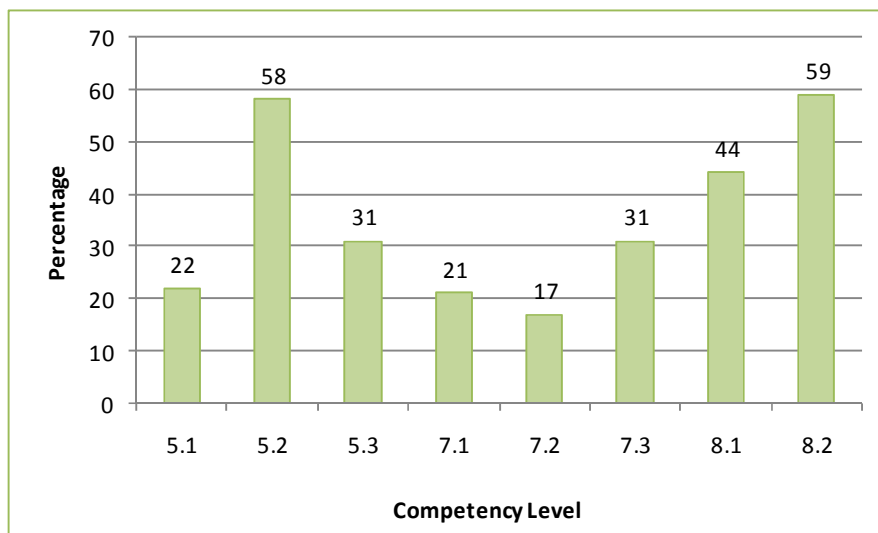*Figure 4.17: Achievement of competency levels related to earth science*

4.5.4 Achievement of Competency Levels Related to Physics

Table 4.16: Achievement of competency levels related to physics

Content	Competency Level	Percentage
Physics	5.1 Inquires into the application of the concept "pressure" in day today needs	22
	5.2 Inquires into the effect of Center of Gravity on the equilibrium of an object in relation to life experiences	58
	5.3 Uses work, energy and power in human concerns/needs	31
	7.1 Uses properties of light in human needs	21
	7.2 Uses generation and propagation of sound in musical instruments	17
	7.3 Explores the scientific basis of modern communication equipment	31
	8.1 Contribute to minimize the risks associated with cyclones	44
	8.2 Contribute to minimize the risks associated with lightning and thunder	59
	Average	35

Compared to the overall percentages of each branch in Science, students have achieved the lowest for Physics (35%). Analysis by competency level shows that highest percentage of the students possesses the required knowledge in minimizing the risks associated with lightning and thunder (59%) and effect of Center of Gravity on the equilibrium of an object in relation to life experiences (58%). Thirty percent of students have achieved the competency in applying scientific concepts of work; energy and power in human concerns/needs, while a similar percentage has the knowledge in relation to the scientific basis of modern communication equipment. However, the

above table indicates that the lowest percentage (17%) of students has achieved the competency in applying skill in relation to 'uses generation and propagation of sound in musical instruments'. It also reveals that applying scientific knowledge in real world situations in relation to pressure as well as properties of light is not satisfactory.

Figure 4.18: Achievement of competency levels related to physics

4.6   Summary

This chapter presented the achievement levels of science. The average achievement of science is 41.16. The majority of students belong to low marks category. There are disparities in achievement in science with regard to school type, gender, medium of instruction and location of school. Achievement level of the students of 1AB schools is higher than that of 1C and Type 2 schools. Girls' performance is higher than that of boys. Achievement level of Sinhala medium students is also higher than that of Tamil medium students. A significant disparity in the achievement level of competencies related to biology, chemistry, physics and earth sciences tested under the general term 'science' is not noticed.