Chapter 5
Data Analysis and Interpretation

5.1. Introduction

In this chapter the researcher will discuss the analysis and interpretation of the quantitative research which is given as raw statistical data, as well as the qualitative data which was collected by means of interviews. Comparisons and links will be made between the analyses of the sets of data. A clear explanation of the researcher's interpretations and findings will be given to report on the findings of the analyses.

5.2. Quantitative Analysis

5.2.1. Factor analysis

A factor analysis was done of the quantitative data. According to Pietersen and Maree (2007b:219) as well as Leedy and Ormrod (2005:274), the purpose of this type of analysis is to identify and examine groups of key factors which form relationships within the quantitative set of data (*cf.* 4.2.4.3.1).

Pietersen and Maree (2007b:219) as well as Weisstein (2012) suggest that one must examine the eigenvalues to help in identifying how many important factors there are. These factors/themes will have an eigenvalue greater than 1. The following table indicates the eigenvalues for all components in this research study:

Table 5.1: Eigenvalues for the quantitative data

Factor	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.326	33.304	33.304	3.419	13.677	13.677
2	1.568	6.270	39.574	3.282	13.126	26.804
3	1.437	5.749	45.323	3.049	12.196	39.000
4	1.287	5.146	50.469	2.078	8.311	47.311
5	1.240	4.960	55.429	1.584	6.338	53.648
6	1.122	4.488	59.917	1.567	6.269	59.917
7	0.955	3.819	63.736			
8	0.878	3.512	67.248			
9	0.793	3.171	70.419			
10	0.734	2.936	73.355			

For the quantitative data in this research study, 6 important factors were identified, by means of the eigenvalues. These 6 factors were used to search for connections and relationships between the different questions on the questionnaire with regard to how these questions were answered by the participants. A Factor analysis was undertaken to group together variables in a questionnaire that address similar ideas (Cohen, Manion & Morrison, 2007:560). A factor analysis enabled the researcher to reduce the number of variables to a smaller number of factors that could count for as many of the variables as possible (Cohen *et al.,* 2007:560). Darlington (s.a.) as well as Pietersen and Maree (2007b:219) state that this procedure is better known as a common factor analysis. The following table shows the results of the factor analysis:

Table 5.2: Common factor analysis

	Factors					
	1	2	3	4	5	6
Q1	.633	.085	.485	.199	-.163	.000
Q2	.398	.219	.609	.076	-.038	-.083
Q3	.290	.414	.380	.300	-.002	-.202
Q4	.217	.517	-.018	.430	.025	.010
Q5	.169	.350	.403	.432	.193	.127
Q6	.438	.035	.024	.545	.224	.063
Q7	-.033	.012	.170	.772	-.247	.007
Q8	.051	-.030	.739	.192	.171	.382
Q9	-.007	.427	.705	.042	-.039	.155
Q10	.079	.178	.207	.266	-.721	.283
Q11	.128	.110	.250	.156	.697	.233
Q12	.595	.071	.538	.167	.004	.052
Q13	.691	.185	.079	.011	.022	.101
Q14	.417	.438	.224	.239	.289	.238
Q15	.104	.670	.127	.319	.052	.024
Q16	.217	.649	.251	.036	-.088	.158
Q17	-.013	.530	.102	-.044	-.086	.626
Q18	.366	.015	.078	.059	.062	.772
Q19	.096	.317	.333	.405	.274	-.030
Q20	.268	.605	.163	-.111	-.020	.040
Q21	.393	.403	.141	.190	.265	.172
Q22	.460	.403	.276	-.024	.204	.200
Q23	.348	.362	.519	.065	.122	-.088
Q24	.699	.249	.061	.069	.007	.145
Q25	.479	.267	.095	.357	.250	.100

Using these 6 factors and the connections between the different questions, four themes were identified. The reasoning for having only four themes within the six factors is that the researcher saw a very close link between factor 3 and factor 5; as well as factor 2

and factor 4; therefore decided to combine these two sets of factors into one theme each.

5.2.2. Statistical correlations

In this study the researcher made use of the Pearson correlation coefficient to determine whether any significant correlations existed between various factors. Tapson (2006:116) defines correlation as the measurement of the strength of the relationship between two variables (or sets of data). Pietersen and Maree (2007c:236) affirm that the Pearson correlation coefficient measures the strength and direction of the relationship between two factors (*cf.* 4.2.4.3.1). The properties of the correlation coefficient, as described by Pietersen and Maree (2007c:236), state that a positive sign for the correlation values indicates a positive relationship, as one variable increases, so does the other, (Tapson, 2006:116). Whereas a negative sign indicates a negative relationship, as one variable decreases the other value increases (Tapson, 2006:116). The closer these values are to one the stronger the relationship. According to Cohen *et al.* (2007:536), correlation values between 0.35 and 0.65 indicate statistical significance, whereas values between 0.20 and 0.35 only indicate a slight relationship that could also be statistically significant.

5.2.2.1. Relationships between the themes and performance

5.2.2.1.1. <u>Theme 1</u>: Attitudes towards own mathematical ability

Factor 1 focused on learners' feelings towards their own mathematical ability (*cf.* 5.2.1) and there was a general connection between six of the questions from the questionnaire (see Addendum H) as identified by means of the factor analyses.

Table 5.3: Questions that form factor 1

Question number	Question How confident do you feel:
FACTOR 1: Abilities within Mathematics	
1	about your ability to do Mathematics
12	about your own Mathematical abilities
13	about your Mathematical performances the past year
22	about producing your best in a Mathematics assessment
24	about the year-end exam you wrote for Mathematics this year
25	about doing Mathematics next year

Table 5.4: Correlation coefficients between CASS, exam, promotion marks and Theme 1 (Factor 1)

		CASS	Exam	Prom	Theme1
CASS	Pearson Correlation	1	.819**	.981**	.297**
	Sig. (2-tailed)		.000	.000	.000
	N	190	190	190	190
Exam	Pearson Correlation	.819**	1	.903**	.407**
	Sig. (2-tailed)	.000		.000	.000
	N	190	190	190	190
Prom	Pearson Correlation	.981**	.903**	1	.345**
	Sig. (2-tailed)	.000	.000		.000
	N	190	190	190	190
Theme_1	Pearson Correlation	.297**	.407**	.345**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	190	190	190	190

The focus within this theme is on the feelings learners have towards their own abilities in Mathematics. Within the six linked questions, the learners were asked to indicate how academically self-confident they felt about their abilities to do Mathematics and perform in it.

Within the correlation coefficients, it was found that there is a strong positive correlation, r =0.819 with a statistically significant relationship between the learners' CASS (Continuous Assessment) and Examination mark (summative assessment), $p < 0.05$ =0.000. This relationship consequently verifies that when learners continuously perform well throughout the year in various assessment tasks, it could be expected that they would also

perform well in the year-end examination. Ley (2007) corroborates this statement by pointing out that learners who tend to work hard continuously are more inclined to achieve higher marks in the examinations.

There is also a significant relationship between Theme 1 (learners' feelings towards their own mathematical abilities) and the learners' performance measured by means of their marks for CASS and the year-end examination; consequently also their final promotion mark which is the CASS and Exam mark combined in a ratio of 3:1 (the CASS mark carrying the most weight). This relationship is substantiated by Dednam (2011:215) who is of the opinion that positive feelings towards Mathematics result in satisfactory mathematical performances (*cf.* 3.5.4). The correlation coefficient between Theme 1 and the learners' CASS mark indicates a slight positive relationship between these two variables, $r = 0.297$, with a statistical significance of $p = 0.000$. An even stronger positive relationship is suggested between Theme 1 and the learners' exam marks, $r = 0.0407$ with a statistical significance of $p = 0.000$. This indicates that learners' feelings could have a stronger influence on their performance during the exam than during continuous assessment throughout the year. Goetz, Preckel, Pekrun and Hall (2007:4) emphasize that learners' emotions have a significant influence on their performances within tests and exams. Moreover, Cassady and Johnson (2001:271) assert that negative emotions, such as anxiety (*cf.* 3.10.1.3), have negative effects on learners' performances, while positive emotions and higher levels of academic self-confidence positively influence learners' exam performances.

5.2.2.1.2. Theme 2: Comprehension and application of mathematical concepts

Within this theme, two factors (factors 2 and 4) (*cf.* 5.2.1) were used, in which there was a general connection between four of the questions from the first factor and two questions from the second factor, as they were identified by means of the factor analyses.

Table 5.5: Questions that form factors 2 and 4

Question number	Question How confident do you feel:
FACTOR 2: Comprehension of Mathematical Concepts	
4	in your understanding of the unique mathematical language
15	accurately explaining complicated mathematical concept to a friend
16	about answering questions posed by the teacher, in front of your peers
20	about doing revision every day on the day's work in Mathematics
FACTOR 4: Application of Mathematical Concepts	
6	when applying mathematical concepts that you grasp
7	when applying mathematical concepts that do not make sense to you

Table 5.6: Correlation coefficients between factors 2 and 4 and Theme 2

		Factor_2	Factor_4	Theme_2
Factor_2	Pearson Correlation	1	.298**	.840**
	Sig. (2-tailed)		.000	.000
	N	190	190	190
Factor_4	Pearson Correlation	.298**	1	.627**
	Sig. (2-tailed)	.000		.000
	N	190	190	190s
Theme_2	Pearson Correlation	.840**	.627**	1
	Sig. (2-tailed)	.000	.000	
	N	190	190	190

Table 5.7: Correlation coefficients between CASS, exam, promotion mark and Theme 2

		CASS	Exam	Prom	Theme_2
CASS	Pearson Correlation	1	.819**	.981**	.198
	Sig. (2-tailed)		.000	.000	.006
	N	190	190	190	190
Exam	Pearson Correlation	.819**	1	.903**	.270**
	Sig. (2-tailed)	.000		.000	.000
	N	190	190	190	190
Prom	Pearson Correlation	.981**	.903**	1	.239**
	Sig. (2-tailed)	.000	.000		.001
	N	190	190	190	190
Theme_2	Pearson Correlation	.198**	.270**	.239**	1**
	Sig. (2-tailed)	.006	.000	.001	
	N	190	190	190	190

In this theme the focus is on the learners' academic self-confidence in comprehending certain mathematical concepts such as the unique mathematical language, patterns, calculations and arithmetic, problem solving (*cf.* 3.2), and there after using the knowledge to apply it to different mathematical problems. Questions posed to the learners varied from how learners understand Mathematics and their own ability to apply their understanding thereof to answer questions and properly explain these concepts to their peers who might find it difficult to comprehend.

Strong, positive correlation coefficients, r = 0.840 and r = 0.627 were obtained between factor 2 and Theme 2, and between factor 4 and theme 2 respectively. Both correlation coefficients indicated statistically significant relationships of $p < 0.05 = 0.000$ and $p < 0.05 = 0.000$ respectively.

A statistically significant and meaningful relationship is indicated between Theme 2 (the learners' comprehension and application of mathematical concepts) with their exam and promotion marks. A slight positive correlation of r = 0.239 was noted for the relationship between theme 2 and the learners' promotion marks, with a statistically significant relationship, p = 0.001. A slight positive correlation, r = 0.270, with a statistical significant relationship, p = 0.000, was obtained between theme 2 and the learners' exam marks. This indicates that although there is a positive but small relationship between how confident learners feel in their comprehension and application, also known as the contextual level of learning in Mathematics (*cf.* 3.5.5), and their ability to perform in Mathematics, this relationship is statistically significant. It appears therefore that as learners' academic self-confidence in their understanding and application of Mathematics increases their mathematical performance also increases.

5.2.2.1.3. Theme 3: Solving mathematical problems

In this theme, two factors (factors 3 and 5) (*cf.* 5.2.1) were used within which there was a general connection between four of the questions from the first factor and two questions from the second factor, as they were identified by means of the factor analyses.

Table 5.8: Questions that form factors 3 and 5

Question number	Question How confident do you feel:
FACTOR 3: Performance in Solving Mathematical Problems	
2	about your ability to do well in Mathematics
8	when attempting to solve a general mathematical problem
9	when doing a more advanced mathematical problem
23	in your ability to pass a Mathematics assessment on your first attempt
FACTOR 5: Solving Mathematical Problems	
10	when you fail to solve a mathematical problem
11	when you successfully solve a mathematical problem

Table 5.9: Correlation coefficients between factors 3, 5 and Theme 3

		Factor_3	Factor_5	Theme_3
Factor_3	Pearson Correlation	1	.008	.836**
	Sig. (2-tailed)		.917	.000
	N	190	190	190
Factor_5	Pearson Correlation	.008	1	.342**
	Sig. (2-tailed)	.917		.000
	N	190	190	190
Theme_3	Pearson Correlation	.836**	.342**	1
	Sig. (2-tailed)	.000	.000	
	N	190	190	190

Table 5.10: Correlation coefficients between the CASS, exam, promotion marks and Theme 3

		CASS	Exam	Prom	Theme_3
CASS	Pearson Correlation	1	.819**	.981**	.161**
	Sig. (2-tailed)		.000	.000	.026
	N	190	190	190	190
Exam	Pearson Correlation	.819**	1	.903**	.225
	Sig. (2-tailed)	.000		.000	.002
	N	190	190	190	190
Prom	Pearson Correlation	.981**	.903**	1	.190**
	Sig. (2-tailed)	.000	.000		.009
	N	190	190	190	190
Theme_3	Pearson Correlation	.161*	.225**	.190**	1**
	Sig. (2-tailed)	.026	.002	.009	
	N	190	190	190	190

After learners start to comprehend certain mathematical ideas and apply their knowledge to the different concepts it is also important for them to successfully solve mathematical problems (*cf.* 3.6.2). Two factors identified links between questions posed to the learners regarding their academic self-confidence to do and solve different types of mathematical problems.

A very strong positive relationship between factor 3 and theme 3, exists, which is indicated by the correlation coefficient, r=0.836, and a statistically significant relationship of p = 0.000. Even though factor 5 also has a significant positive relationship with theme 3, this relationship is radically weaker, indicated by a correlation coefficient, r=0.342, and a statistically significant relationship of p = 0.000.

Considering the correlation coefficients between the learners' marks and theme 3, it is evident that positive but weak relationships exist between how confident the learners feel about solving a mathematical problem and performing in Mathematics. The strongest relationship exists between theme 3 and the exam mark with a coefficient of r = 0.225, and a statistically significant relationship of p = 0.002. This suggests the possibility that the more confident learners feel in their ability to solve mathematical problems, the greater the chances are of performing well in the examination. Nicolaidou and Philippou (s.a.:4) validate this by affirming that learners' academic self-confidence in solving problems has a strong influence on their mathematical performance. In addition it is reasoned that mathematically resilient learners, who are motivated, often solve problems successfully; therefore indirectly influencing their mathematical performances positively (*cf.* 3.9). There is also a significant positive correlation between the continuous assessment and promotion mark and Theme 3. However, these values are particularly low with coefficient values of r = 0.161 and r = 0.190, and statistically significant relationships of p = 0.026 and p =0.009 respectively.

5.2.2.1.4. Theme 4: Educator assistance

In this theme one factor (factor 6) (*cf.* 5.2.1) was used within which there was a general connection between four of the questions from the questionnaire as identified through the factor analyses.

Table 5.11: Questions that form factor 6

Question number	Question How confident do you feel:
FACTOR 6: Requesting Assistance from Educator	
17	about asking your teacher to re-explain work that you did not understanding, in front of your peers
18	about asking your teacher to re-explain work that you did not understand, after class

Table 5.12: Correlation coefficients between the CASS, exam, promotion mark and Theme 4

		CASS	Exam	Prom	Theme_4
CASS	Pearson Correlation	1	.819**	.981**	.179**
	Sig. (2-tailed)		.000	.000	.013
	N	190	190	190	190
Exam	Pearson Correlation	.819**	1	.903**	.193**
	Sig. (2-tailed)	.000		.000	.008
	N	190	190	190	190
Prom	Pearson Correlation	.981**	.903**	1	.200
	Sig. (2-tailed)	.000	.000		.006
	N	190	190	190	190
Theme_4	Pearson Correlation	.179*	.193**	.200**	1**
	Sig. (2-tailed)	.013	.008	.006	
	N	190	190	190	190

The focus of this theme fell on how confident learners feel to ask their educator for assistance when they are struggling to comprehend and apply mathematical concepts.

A slight positive correlation coefficient value of $r = 0.200$, with a statistically significant relationship, $p < 0.05 = 0.006$, was obtained when the relationship between Theme 4, Educator Assistance, and the learners' promotion marks were considered.

This correlation coefficient confirms that the relationship exists but that it is weak. Therefore, it can be assumed that educator assistance only has a slightly significant influence on a learners' ability to perform in Mathematics. This, however, contradicts the opinion of researchers such as Dednam (2011:219) that educators who teach Mathematics poorly cause barriers to performing in Mathematics (*cf.* 3.10.2.2). This could be a result of the way the question is posed, where the focus was only on the learner approaching the educator for assistance, and not really on the broader sense of educator involvement and assistance through means of teaching strategies and effective communication. Hence these results could be an indication that learners prefer not to ask for assistance from the educator out of their own will when struggling with certain mathematical concepts. In the qualitative Research it became apparent that most learners feel more comfortable turning to their peers for assistance (*cf.* 5.3.3). Statistically significant positive correlation coefficients of $p < 0.05 = 0.013$ and $p < 0.05 = 0.008$ were obtained between the learners' performances in their CASS and Exam, and Theme 4 (educator assistance), respectively. However, the correlation coefficient values of 0.179 and 0.193 are so small that they cannot be taken into consideration for the analysis of this data.

5.2.2.2. Relationships between the themes

Table 5.13: Correlations between the different themes.

		Theme 1	Theme 2	Theme 3	Theme 4
Theme 1	Pearson Correlation	1	.609**	.578**	.421**
	Sig. (2-tailed)		.000	.000	.000
	N	190	190	190	190
Theme 2	Pearson Correlation	.609**	1**	.475**	.415**
	Sig. (2-tailed)	.000		.000	.000
	N	190	190	190	190
Theme 3	Pearson Correlation	.578**	.475*	1**	.303**
	Sig. (2-tailed)	.000	.000		.000
	N	190	190	190	190
Theme 4	Pearson Correlation	.421**	.415*	.303**	1**
	Sig. (2-tailed)	.000	.000	.000	
	N	190	190	190	190

When comparing the themes with one another, various relationships were found. There is a significant positive correlation between all the different themes.

It seems that the strongest correlations can be drawn between theme 1 (learners' attitude), as a central theme, and the other themes, confirming the importance of a positive attitude towards

Mathematics. Furner and Berman (2004:1) corroborate that learners with positive attitudes towards Mathematics are more likely to achieve success in Mathematics. (*cf.* 2.8). Likewise Dednam (2011:215) is of the opinion that for learners to perform in Mathematics, they should also have a positive attitude towards Mathematics as a subject (*cf.* 3.5.4). The strongest relationship exists between theme 1 and theme 2 with a correlation coefficient of $r = 0.60$, and a statistically significant relationship, $p < 0.05 = 0.000$. This demonstrates a strong positive relationship, which in turn could mean that as a learner's attitude towards their own mathematical abilities improve so does their ability to understand and apply these mathematical concepts increase, and vice-versa. Boekaest (1997:6) affirms that motivation to understand and do Mathematics depends on the learners' attitude towards the subject (*cf.* 3.8). Another relatively strong relationship exists between theme 1 and theme 3, with a coefficient value of $r = 0.578$, with a statistically significant relationship of $p < 0.05 = 0.000$. Once again it seems that the learners' attitude improve more positively, and so does their ability to solve mathematical problems. Bernard (2006:108) postulates that emotional resilience, the learner's ability to rise through difficulty (*cf.* 3.9), enables a learner to successfully solve a mathematical problem. In support of this, Woolfolk (2010:409) also affirms that learners who are good at problem solving often contemplate the reasonableness of their answers, and consequently they are more likely to have stronger academic self-confidence and better performance (*cf.* 2.11.6).

A statistically significant positive relationship also exists between themes 2 and 3, with a correlation coefficient of $r = 0.475$, and $p < 0.05 = 0.000$. This could illustrate that, as learners' ability to comprehend mathematical concepts increase, and so does their ability to apply this knowledge to solve mathematical problems improve. Miller (2003) maintains that learners should comprehend

mathematical concepts and knowledge in order to solve mathematical problems (*cf.* 3.11.1.7).

Lastly, it seems that even though theme 4, Educator Assistance, has positive correlations with all the other themes, these correlations are the weakest of all. The most significant positive relationship educator assistance has is with learners' attitude (theme 1). In this case a correlation coefficient of $r = 0.421$ with a statistically significant relationship, $p < 0.05 = 0.000$, was found between theme 4 and theme 1, informing us that as teacher assistance increases it could have a direct positive influence on learners' emotional attitude towards Mathematics. DeRoche (2011) affirms that educators can improve learners' attitude in Mathematics, and Donald *et al.* (2002:130) believe that when educators help improve learners' attitude by building a positive sense of academic self-confidence it also encourages successful learning (*cf.* 2.8). The correlation coefficient between educator assistance, theme 4, and themes 2 and 3, which deals with the comprehension, application and solving of mathematical concepts, is respectively, $r = 0.415$ and $r = 0.303$, with statistically significant relationships of $p < 0.05 = 0.000$ and $p < 0.05 = 0.000$. There is a positive relationship between these themes, meaning that educator assistance seems to have a slight positive influence on a learner's ability to comprehend, apply and solve mathematical ideas. The fact that there are weaker correlations between theme 4 and the other themes compared to the correlations between theme 1 and the other themes could indicate that learners' emotional attitudes have a stronger influence on their mathematical abilities than educator assistance. However, both these factors do have a statistically significant relationship and can therefore not be separated from the other themes. In contradiction to the "weakness" of the relationship, however, the quantitative data indicated a stronger relationship between theme

4 and the other three themes (*cf.* 5.3.4). These will be discussed in more detail in the following paragraphs.

5.3. Qualitative Analysis

The qualitative data collected by means of semi-structured individual interviews (*cf.* 4.2.8) was analysed by dividing it into the four themes derived from the factor analyses in the quantitative analysis, and after which subthemes were allocated for each theme.

Before discussing the themes in more depth it is important to highlight the fact that one of the interviews with a weaker learner was not used for the purpose of analysing the qualitative data, since this learner constantly contradicted herself in the interview:

"*I will be able to know if I am doing the right thing, even if it's wrong, I'll still be able to do it because I know I'm doing it right*"

And

"Uhm…not my…I'm maybe not confident, it might become a bit low. But I still have that confidence in me that I'll be able to do it, but yeah I do have the confidence it just goes a bit low at that time, but I still do it."

This could be an indication of self-deception where the learner's contradictory statements are a misrepresentation of the real truth to support what she would want to be true. According to Diamond (2008), the moment the truth threatens a learner's self-esteem and academic self-confidence, some learners may experience 'confirmatory bias', where the learner would rather dismiss selected truths that contradict in order to confirm their own perceptions, which might be less intimidating to them.

Consequently one cannot consider this learner's answers for the analysis of the qualitative data.

5.3.1. Theme 1: Attitude towards own mathematical ability

Table 5.14: Subthemes for Theme 1

Theme 1	Subtheme
Attitude towards Mathematics	Positive Emotions (Mostly from the high and average performing learners)
	Negative emotions (Mostly from the poor performing learners)

All 5 learners who perform well in Mathematics describe positive feelings towards the subject.

"I enjoy Maths."

"I think it is an interesting subject and I do like it."

"Maths is really fun"

Conversely learners who have average and poor academic performances in Mathematics appear to have mixed emotions towards the subject. Out of the 5 average performing learners 3 describe positive feelings, while the other 2 learners describe impartial (neither positive nor negative) feelings towards Mathematics. However, 3 of the 4 learners, who perform academically poorly in Mathematics, express quite negative feelings towards Mathematics, with the remaining learner expressing neutral emotions:

"It's a challenging subject, uhhh, I enjoy it when I understand the solutions" (Average performing learner)

“I actually do like Maths. It’s quite interesting.” (Average performing learner)

“I love Maths” (Average performing learner)

“It’s okay. Sometimes it can be difficult and stuff.” (Poor performing learner)

“I don’t really like working with numbers.” (Average performing learner)

“I don’t really like it, like....uhm...like it is just impossible.” (Poor performing learner)

“At the moment I dislike it” (Poor performing learner)

I don’t like Maths” (Poor performing learner)

This seems to indicate that performance in Mathematics has an obvious influence on the way learners perceive and experience the subject, which corroborates the findings within the quantitative research analyses (*cf.* 5.2.2.1.1). Learners who perform and do well have a more positive attitude towards the subject, whereas learners who don’t perform well tend to have more negative attitudes towards the subject (*cf.* 3.10.1.4). This is substantiated by Legg and Locker (2009:480) and Beckmann *et al.* (2008:278) who are of the opinion that meta-cognition and performance have a positive correlation with learners’ academic self-confidence and emotional attitude towards a subject (*cf.* 2.8). Hence learners who perform academically well in Mathematics and achieve higher marks seem to be more likely to academically feel more self-confident and positive about the subject. Similarly, it also appears that learners who are positive about their mathematical abilities perform well in the subject.

When all the participants (which includes all three the academically performing groups) were asked whether, in their opinion, academic self-confidence influences their academic performances, 10 of the 14 learners responded with a resounding yes:

“Yes I do, if I don’t believe I can do something I don’t do well.”

“Yes, because I realize if I’m confident about writing my paper with my answers I and then it does help in resolving them.”

Additionally, 4 of the 14 learners also described that their academic performances have an influence on their academic self-confidence, instead of only seeing it as academic self-confidence influencing their performances, therefore making it a cycle of influence between academic self-confidence and performance (*cf.* 6.2.3):

“When you become better at Maths and boost your confidence in it.”

“Yes, uhm, I think if you know you are able to do something and you understand it you do better in that subject, coz I feel good about Mathematics, because I know I am able to do it”

“…the more I did get to know about Maths, the more my confidence in Maths started to decreased cause I thought uhm, my goodness how am I supposed to do those.”

“I get a sum and I look at it and I think it is so difficult that I doubt myself if I can get the right answer or whether I’m actually going to do it.”

This could be a possible sign that, according to the learners' opinions, there is a significant relationship between academic self-confidence and their own ability to learn Mathematics successfully in order to achieve good grades. In agreement with this statement, one can take into consideration that Woolfolk (2010:90) also stated that there is a link between academic self-confidence and academic performances (*cf.* 2.10). In addition this once again confirms the results from the quantitative research (*cf.* 5.2.2.1.1).

Throughout the interviews it became apparent that learners expressed words, such as "*love",* "ecstatic", "*stressed*", "*frustrated"* and "*panic stricken*", to describe very 'intense' emotions, when talking about Mathematics, their performances and their own abilities to solve mathematical problems. It seems that learners' experience of and attitude towards Mathematics include a sincere emotional aspect. It appears that when learners are academically more self-confident and sure about their abilities they use words such as 'love' and 'excitement' describing 'strong' positive emotions. Alternatively learners who seem to be academically less self-confident and afraid of Mathematics use words such as 'stress' and 'frustration' to describe 'strong' negative feelings. Allen (2010:3) asserts that learners who have negative attitudes towards Mathematics tend to also lack academic self-confidence in the subject. Sander and Sanders (s.a.:4) as well as Dednam (2011:215) affirm that learners who feel academically self-confident believe that they can perform well in Mathematics and consequently also do so (*cf.* 3.5.4). This academic self-confidence can be positively influenced by affirmative emotional and social development (*cf.* 2.3). Moreover, if one looks at Dr Eric Ericson's Theory (*cf.* 2.4.2), one would recognize that when he describes the development of positive emotions (e.g. trust, independence, initiative, diligence etc.) a stronger sense of academic self-confidence is envisioned. In

contrast, when he discusses the development of negative emotions (e.g. mistrust, shame, doubt, guilt etc.), it becomes apparent that these types of emotions result in a lack of academic self-confidence.

In short, it truly seems that a learner's attitudes and beliefs concerning Mathematics have either a positive or negative significant influence on their academic self-confidence as well as on their ability to comprehend the subject and perform in it.

5.3.2. Theme 2: Comprehension and application of mathematical concepts

Table 5.15: Subthemes for Theme 2

Theme 2	Subthemes
Comprehension and Application of Mathematical Concepts	Comprehension influences attitude
	Comprehension promotes application
	Practice promotes comprehension and performance
	Cooperative Learning and willingness to explain work to peers

A factor that seems to have an influence on the learners' attitude towards Mathematics is whether learners find the work easy or difficult and whether they actually comprehend the work, which is directly linked to the second theme (comprehension and application of mathematical concepts). *"I am coping with the work and I enjoy it (Maths)"; and "If you say it's (Maths) difficult, then I don't like it (Maths)".* This confirms the strong positive relationship found in the quantitative research analysis (*cf.* 5.2.2.2) between themes 1 and 2. This phenomenon (namely the relationship between theme 1 and theme 2) can probably be explained by the fact that learners who comprehend mathematical

concepts, calculations, arithmetic, problem solving and applications better, perform academically better than those learners who do not comprehend the same mathematical concepts, calculations, arithmetic, problem solving and applications. According to Zan and Martino (2007:165), Legg and Locker (2009:480), Allen (2010:13) as well as Jennison and Beswick (s.a.:285),learners, in most cases, tend to have positive attitudes towards Mathematics when they find it easy to carry out and comprehend, compared to learners who have low levels of academic self-confidence towards Mathematics and dislike the subject as a result of it being 'difficult' for them to execute and understand the unique mathematical language, concepts, calculations etc. Learners with a good comprehension of mathematical concepts appear to have higher academic self-confidence and more positive attitudes towards the subject. These learners then tend to be more motivated to perform better and achieve higher marks. Zan and Martino (2007:165) also affirm that it is only in extremely rare cases that learners do express positive attitudes towards Mathematics despite the fact they are finding it difficult to comprehend and execute.

There seems to be a strong link between learners' understanding and comprehension of the subject and their attitude towards Mathematics. According to Legg and Locker (2009:480) a learner's academic self-confidence and attitude is interlinked with comprehension and performance in Mathematics. The better learners comprehend mathematical concepts the more positive their attitude becomes and vice versa:

"If I don't understand it then I, then I just start to dislike it (Maths)."

"I enjoy it (Maths) when I understand the solutions"

"I am coping with the work and I enjoy it"

"I do well in the subject and that makes it a nice subject for me."

"I'm quite positive cause if you tend to love Mathematics it gets easier to understand, like I can do well"

Hannula *et al.* (2004:23) confirm that in their study a definite relationship was drawn between learners' academic self-confidence and mathematical achievement (*cf.* 2.10). The same results have been found in this study, where one learner, who performs well in Mathematics, describes feeling confident when getting mathematical problems right (*cf.* 2.9). This encourages the learner to engage further in the subject:

"when you get something right in Maths, you feel confident, and that makes you wanna go on doing Maths."

In contrast another learner describes feelings of low self-esteem when faced with difficult mathematical problems: *"if you cannot get the difficult problem and then you don't understand the thing properly, then you feel like, I fail this test because I don't know this"*. Allen (2010:13) explains that research in several countries substantiate the belief that learners with higher academic self-confidence perform better than learners with lower academic self-confidence. In his research Allen (2010:13) found that learners in countries with higher mathematical performances displayed a better comprehension of the subject and higher levels of academic self-confidence in their own abilities to learn Mathematics, compared to learners in countries who did not perform that well. Thus it is apparent that comprehension of mathematical concepts could have a major impact on the way learners experience the subject and consequently also their attitudes and academic self-confidence levels (*cf.* 3.5.4).

Five of the learners who performed better in Mathematics than the rest of the learners in the previous academic year felt that one can improve one's understanding of mathematical concepts through constant practice, diligence and hard work. Johnston-Wilder and Lee (2010:40) affirm that learners that work hard become better problem solvers and consequently perform better in Mathematics (*cf.* 3.9):

"I can say that Maths is not like particularly difficult or hard, it just needs you to be like focused and hard working."

"(I feel) Great about what I've achieved, but it takes a lot of hard work"

"...your base comes from where you study and how hard you work. So if you don't study and work hard I don't think you can accomplish the best that you can."

Four learners affirm that if they work hard and practise Mathematics they improve their understanding and consequently also their results. *"I would not understand any and I thought that if I just practise with myself I will eventually, I will get it."; "To work out problems in different ways so that you understand them better"; and "Maths is a subject where, it needs practice and yes with more practice you will do way better."* Upton (2012) asserts that practising Mathematics consistently is a key requirement to perform successfully in Mathematics. He also states that by revising Mathematics it improves learners' ability to think logically which then enables them to comprehend mathematical concepts and improve their mathematical learning, performance and academic self-confidence (Upton, 2012). Consequently it appears that frequent practice and hard work will improve learners' procedural knowledge (*cf.* 2.8.2). Rusinov (2012) supports this

theory by asserting that learners who work hard through studying and practising Mathematics improve their own knowledge and as a result become academically more self-confident in their own abilities. Some misconceptions identified in the literature review about learning Mathematics successfully were that one cannot study for it (*cf.* 3.13). However, this fallacy is contested by the opinion of these four learners and Upton (2012), who believe that through hard work and practice (study) they could enhance their mathematical performances.

When learners were asked about their willingness to explain mathematical concepts to their peers, 8 of the 14 learners expressed that they would only feel confident and willing to explain mathematical concepts to their peers if they themselves fully comprehended these concepts, indicating that learners themselves see the importance of feeling academically self-confident in their own abilities to comprehend Mathematics before they are willing to assist their peers:

“Only if I understand the work”

“If I understand it, I can explain it very well.”

“If I understand a problem very well I can explain it to anybody.”

“If you don’t understand something you can’t really explain it, and you get scared that you are giving that person the wrong answer.”

“If I know the problem, I will explain it, but if I don’t know I’ll refer them to someone else.”

“If I never know how to do it, then like I’d tell them to ask someone else.”

The response of one learner stood out when he/she unintentionally expressed an advantage (improve comprehension through working with one's peers) of co-operative learning, when helping fellow learners. *"Because if I help someone and I solve the problem then I will learn something when they tell me something that I might have missed."* La Fleur (2010:18) confirms that it is just as beneficial for learners who perform in Mathematics to explain mathematical concepts to their peers, as it helps to improve their own comprehension and academic self-confidence in Mathematics. According to Allen (2010:10), research proves that co-operative learning assists learners to build more academic self-confidence in their own abilities to do and learn Mathematics successfully.

Learners seem to feel more confident in their abilities when they comprehend the mathematical concepts. Dednam (2011:216) states that once learners comprehend a mathematical concept (*cf.* 3.6.2), their academic self-confidence and their willingness to try new problems improve:

"I think if you know you are able to do something and you understand it, you do better in that subject, coz I feel good about Mathematics; because I know I am able to do it"

Finally, comprehension also appears to have an influence on the learners' abilities to apply mathematical concepts and solve mathematical problems, and consequently to perform in Mathematics. Learners cannot perform in Mathematics using only basic knowledge of the mathematical concepts. Instead, they need to have a deep comprehension of the concepts, methods and theories (*cf.* 3.5). Woolfolk (2010:270) confirms that in order for learners to improve their performance, they should be conscious of their higher-order thinking and comprehension (*cf.* 2.8), as this will enable them to make informed decisions when attempting a

mathematical problem, and thereafter reflect on the reasonableness of the answer. Having acquired these competencies will also have a positive influence on their academic self-concept.

5.3.3. Theme 3: Solving mathematical problems

Table 5.16: Subthemes for Theme 3

Theme 3	**Subthemes**
Solving Mathematical Problems	Emotions and attitudes towards difficult problems
	Emotions and attitude towards successfully solving a difficult problem
	Maths Anxiety
	Support

Learners were asked how they feel while trying to solve difficult mathematical Problems. Most of the responses were very similar in that difficult problems create negative feelings such as anxiety and uncertainty, which in turn lowers their academic self-confidence:

"Stressed and under pressure"

"Frustrated, like pulling all my hair out. I just feel like giving up and pulling my hair out. Urrrghh. It's irritating."

"If I struggle with a problem I do get frustrated and panic stricken and I feel like 'oh no I can't do this'."

"I feel like I'm literally stuck, I'm helpless"

"That kind of breaks your confidence in Maths, and it feels like, this is a solid wall you came to and you can't go on"

"If I struggle with a problem I get frustrated and panic stricken, and feel like 'oh no I can't do this'."

"I feel very small and mediocre that I can't solve a Maths problem."

"I get panicked, I am unable to think"

These negative feelings towards Mathematics can also be seen as Maths Anxiety (*cf.* 2.7). Hall (2003:185) points out that those learners with low levels of academic self-confidence combined with Maths Anxiety have a significantly negative impact on a learner's ability to perform in Mathematics. Learners who suffer from Maths anxiety experience low levels of academic self-confidence and negative emotions towards the subject as a result of their immense fear of making mistakes and/or failure to perform satisfactorily (*cf.* 3.10.1.3).

An interesting phenomenon, although not surprising, was the fact that learners who had performed better in Mathematics showed more resilience, motivation and willingness to try solving difficult mathematical problems. *"I feel frustrated but I'm like okay, breath, take one step at a time, do it over and over again. Until I find the right answer."; "I try to solve it"; and "I'd actually see it as a challenge and I would not stop until I get the correct answer."* This confirms that mathematical resilient (*cf.* 3.9) learners are more motivated to not give up when faced with challenging problems, and therefore perform better than their counterparts (Johnston-Wilder and Lee, 2010:38). Tavani and Losh (2003:141) also confirm that a positive relationship (*cf.* 3.8) between

motivation, resilience and academic self-confidence will in turn influence positive academic performances.

Learners who performed poorly in Mathematics tend to have a more casual 'don't care' attitude: *"It does not change how I feel; I just leave it out and move on." and "I am not able to do it and then I just like leave it out."* Learners who perform poorly tend to avoid doing Mathematics in order to limit their chances of making mistakes (*cf.* 3.10.1.2). These learners often believe they cannot do Mathematics and avoid even trying, due to a possible fear of failure. Dednam (2011:215) also affirms that learners who perform poorly and lack academic self-confidence often refuse to actively participate in their mathematical learning process (*cf.* 3.10s.1.5), which may come off as 'I don't care'.

Alternatively, when learners were asked how they felt about successfully solving problems, it became apparent, not only in their answers but also in their body language, with signs such as sighs of relief, excitement in their voices and smiles on their faces, that they felt more confident and positive about Mathematics. This signifies that the learners felt more confident, positive and eager to solve more mathematical problems, after successfully solving another problem:

"I feel more confident of doing the next sum."

"It makes me feel clever in a way, you know, I feel good, and I feel like I accomplished something."

"I think that boosts your self-esteem or your aspects of Maths, because you feel like if I can do this I can surely find a solution to all the problems and I can cope with them."

"It makes me feel very good about myself."

What stood out is the fact that quite a few of the learners who participated in the interviews said that they had a feeling of *"I can do it"* after having solved mathematical problems successfully, which improved their academic self-confidence by performing in Mathematics.

When learners struggle to understand and solve mathematical problems they tend to ask for help from various sources, especially their friends: *"I'll ask someone (peer) to help me, and if they can't help me I will leave it out"; "I ask my friends. We usually work together but if ever my friends and I can't work it out I go to a teacher and then I'll get the easiest solution to the problem"; and "I'll come for extra classes (offered by Gr. 11 tutors) or I'll ask my friends to explain the work".* LaFleur (2010:1, 16) affirms that learners seem more at ease when they are able to ask their peers for assistance when struggling to solve problems. Dednam (2011:211) is of the opinion that peer support plays an essential role in mastering mathematical learning (*cf.* 3.4).

However, there are learners who do not feel comfortable asking friends for help. One of the learners mentioned that she would preferably rely on educators (*cf.* 5.3.4) or her older sister, who is also very good in Mathematics, for help when she is struggling: *"It may be my teachers, and then I don't really rely on friends because I don't think that is a good thing, uhm, and then my sister."* When asked to explain why she feels that friends are not the best source of assistance she said: *"Sometimes they are also unsure themselves, and if they are uncertain, it makes you feel uncertain."* This learner brought up a justifiable concern about peer assistance, and therefore it is of great importance that one should point out that not all the learners' peers would be able to help them solve mathematical problems accurately, and it may confuse them even more. Positive educator assistance (*cf.* 5.3.4)

is therefore crucial, and peer assistance should merely be an additional support strategy.

5.3.4. Theme 4: Educator assistance

Table 5.17: Subthemes for Theme 4

Theme 4	Subthemes
Educator Assistance	Acceptance of support from educators
	Educator Influence

Educator assistance can be linked to theme 3 (*cf.* 5.3.3), since educators should be an essential source for assistance when struggling with mathematical problems (*cf.* 3.11.1): *"I just go to a teacher and ask for help and then there on, after I've learned the strategy, I can do it as well."*

Kyriacou (2005:168) asserts that educators are responsible for motivating learners positively. However, it also became apparent that not all learners feel comfortable turning to educators for help. It seems that the weaker learners who perform poorly in Mathematics are much more hesitant to ask their educator for help. The reason for this could be a fear of disappointing the educator (*cf.* 2.7): *"I'm not so confident going to the teacher"*

In addition, educators also have an influence on a learner's ability to comprehend certain mathematical concepts (see Theme 2; *cf.* 5.3.2). Of the 14 learners, 8 explained that the ways in which educators explain mathematical concepts have a great influence on their understanding of the subject. This is consequently linked to the effectiveness of the educator's ability to communicate (*cf.* 3.11.1.1) as well as their teaching strategies (*cf.* 3.11). Sweeting (2011:23) emphasizes that educators have a responsibility to prepare well for Mathematics lessons. When educators are well

prepared it will keep them enthusiastic about Mathematics. Consequently also learners' enthusiasm and academic self-confidence in Mathematics will be stimulated:

"Teachers have a big influence because they practically, if they don't explain it properly then we will have difficulties."

"The teacher explained something in the way that even a person who is academic challenged could find an answer to"

"My teachers explain everything in a manner that you actually like Maths"

"I also think it is the way the teacher explained."

One learner pointed out how her performance and comprehension increased after a change in educators had taken place in the middle of the year: *"The difference is that at first we had another teacher and I didn't like the way she explained and then we got a new teacher and then I knew what she was teaching and I understood."* This indicates how important good teaching strategies (*cf.* 3.11.1) are in order to enhance learners' chances to fully comprehending mathematical concepts. Good teaching strategies encourage open communication and question asking, logical thinking, reflection, support and assistance as well as parental involvement.

Lastly, educators also seem to play a part in how learners feel about Mathematics (see Theme 1, *cf.* 5.2.2.2) as a subject, as well as their own mathematical abilities (*cf.* 3.11). *"I think the teachers also play a big part in how you feel about Maths, because if they're enthusiastic about the subject and if they are positive and sure about what they do, it also makes you feel like you can do Maths."*

It also appears that an educator's subject knowledge (*cf.* 3.11.1.7) has a great influence on how confident and motivated learners feel, not only about the educator but also about their own ability to do Mathematics: *"If the teacher knows what they are doing, it obviously makes you feel secure and you feel that, okay you're on the right path and that there is someone that you can rely on when you need help";* and *"There is always teachers there to help you, and uhm, there is always someone that's gonna push you up, and say you can do it, carry on going."*

The educator's role and assistance is an imperative part of learners' successful learning of Mathematics. Also, the educators' attitude towards their learners, their level of preparation, the manner of assistance, teaching strategies and the subject itself are fundamental elements in the learner's ability to perform and comprehend and successfully execute Mathematics and subsequently also to enhance their academic self-confidence in this subject.

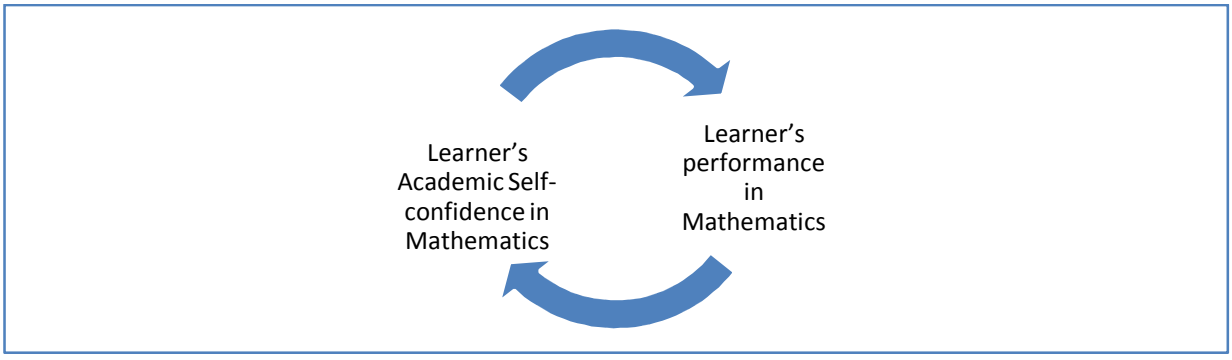
5.4. Conclusion

An essential observation during the interviews was the manner in which the learners answered the questions. Learners who performed well in the previous academic year (2011) seemed more at ease and confident in their answers compared to their counter parts that performed poorly and who seemed to be more stressed and unsure about their own abilities and their answers. It also became evident through observation of the sample group that most learners tend to associate themselves with peers with the same academic performance abilities. It seems therefore when learners turn to friends/peers or make use of co-operative learning strategies when attempting to solve mathematical problems, those performing well have the most advantage, since

their ‘friends’ are also learners who perform well, and consequently have a better comprehension of the subject, whereas the weaker performing learners carry on struggling within their own group of struggling ‘friends’, unless they get additional ‘outside’ assistance, from other learners who perform better in Mathematics, tutors or educators.

It appears that there are various factors, such as comprehension, abilities to execute and solve mathematical problems, continuous hard work and educator assistance, that play an active role in learners’ abilities and consequent good academic self-confidence to perform well in Mathematics. However, it seems that the strongest influence on academic performance, as indicated by both the quantitative and qualitative research data, is the learners’ own emotions, attitude and academic confidence towards the subject. There also seems to be a cycle of self-confidence influencing performance and in turn performing well enhances a learner’s academic self-confidence in the subject, as indicated in the diagram below:

Diagram 5.1: Mathematical Cycle of Influence



In Chapter 6 the research questions will be answered and discussed, the limitations of the study will be identified and a brief summary of the most important factors found during the literature study and findings of this study will be given. Recommendations for further research will also be made.