CHAPTER 4 : ANALYSIS AND INTERPRETATION

This chapter offers a systematic investigation and explanation of the data collected for this research work. Analysis involves the calculation of suitable measurements and the identification of patterns of correlation among different data sets. Interpretation helps in deriving meaningful insights from statistical results. The statistical techniques adopted in this study for data analysis are percentages, means, standard deviations, chi-square test, independent samples t- test, ANOVA, Pearson's correlation and regression. The findings of the study are presented objective wise, along with the results of their corresponding hypotheses testing.

4.1 Findings related to Objective 1

Objective 1: ***To find out the Brain hemispheric dominance, Metacognitive awareness levels, Perceptual learning style preferences and Academic achievement levels in Biology of senior secondary school students.***

Brain hemispheric dominance of senior secondary Biology students

Table 4.1 Descriptive statistics on the Brain hemispheric dominance scores

N	*635*
Mean	-0.71
Skewness	-0.06
Kurtosis	-0.18

Table 4.2 Shapiro Wilk test of Normality for Brain hemispheric dominance scores

Statistic	**df**	**p-value**
0.99	635	0.094

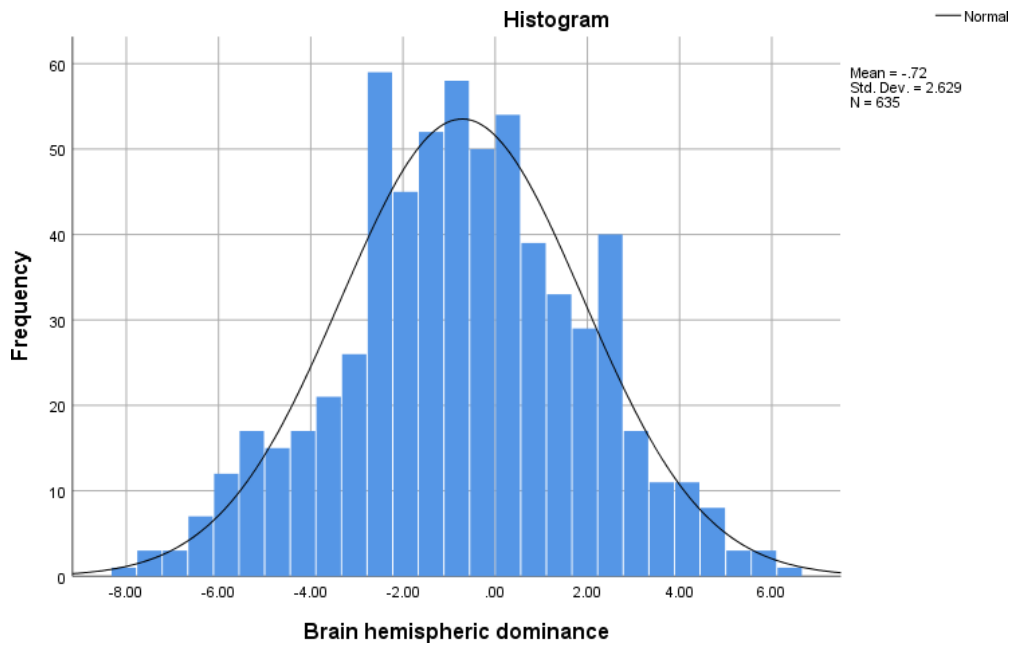


Figure 4.1 Normal probability curve for Brain dominance scores

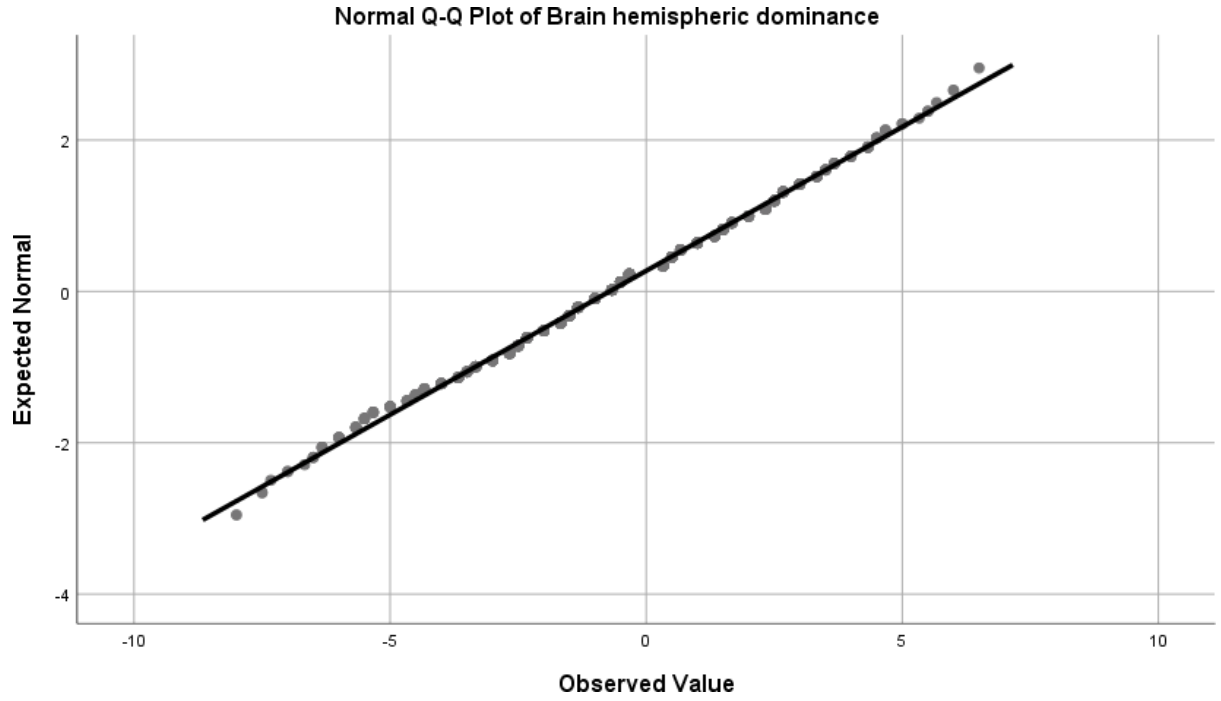


Figure 4.2 Normal Q-Q plot of Brain hemispheric dominance scores

Tables 4.1 and 4.2, Figures 4.1 and 4.2 show that the Brain hemispheric dominance scores of the students are normally distributed. According to Hair et al. (2010), data is considered to be normal if skewness is between -2 to +2 and kurtosis is between -7 to

+7. The skewness and kurtosis values of -0.06 and -0.18 fall within the acceptable range and depict normality. This is further confirmed by the Shapiro Wilk test which reveals a p-value of 0.094 that is greater than 0.05 and significant at the 0.05 level of significance. This implies that the scores are normally distributed.

Table 4.3 Percentages for left, right and whole brain dominance of the total sample

Type of Brain hemispheric dominance	**N**	**Percentage**
Left dominance (Left brainers)	386	60.78 %
Right dominance (Right brainers)	249	39.2 %
Whole dominance (Whole brainers)	0	0.0 %
Total	**635**	**100 %**

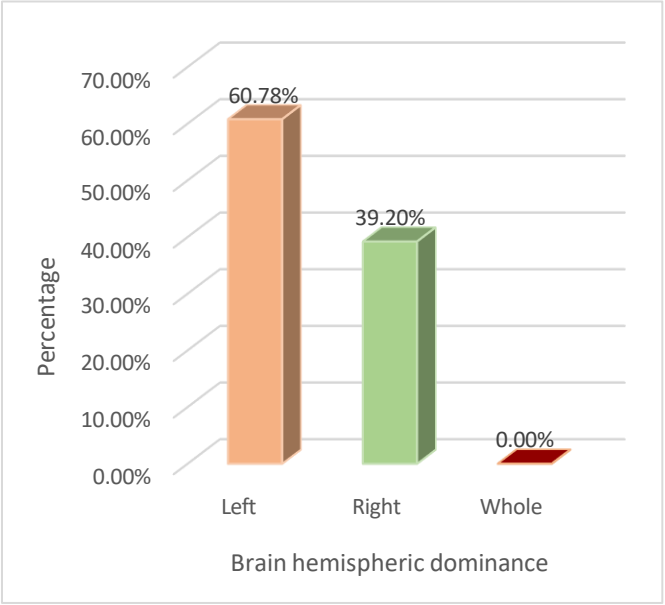


Figure 4.3 Bar graph representing the percentages of left, right and whole brain dominance of the total sample

Table 4.3 and Figure 4.3. reveal that majority of the total sample (60.78%) are left brainers, followed by right brainers (39.20%) and no whole brainers (0.0%).

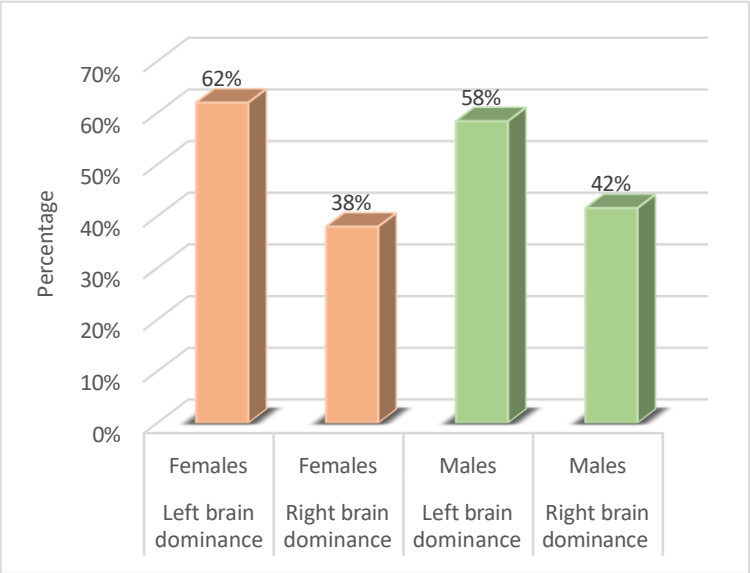


Figure 4.4 Percentages for left and right brain dominance of female and male students

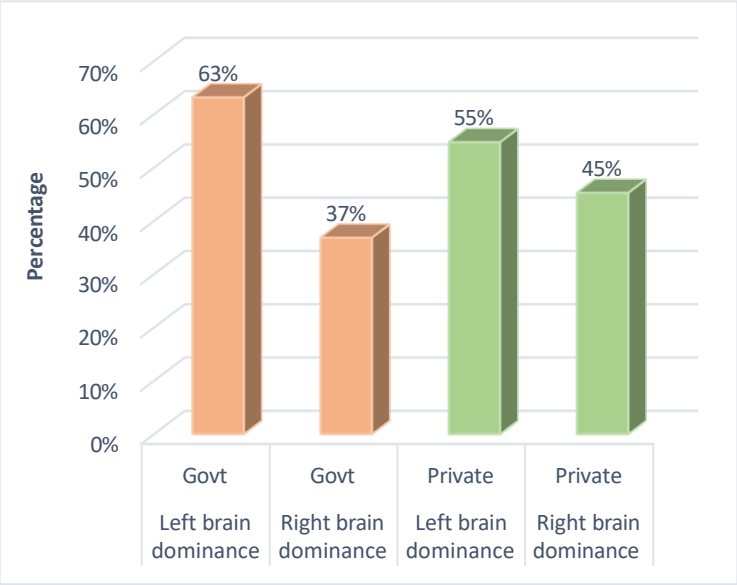


Figure 4.5 Percentages for left and right brain dominance of government and private school students

Figure 4.4 reveals that out of 421 females, 62% are left brained and 38% are right brained, and out of 214 males, 58% are left brained and 42% are right brained. Also, Figure 4.5 reveals that out of 456 government school students, 63% are left brained and 37% are right brained, and out of 179 private school students, 55% are left brained and 45% are right brained.

Metacognitive awareness levels of senior secondary Biology students

Table 4.4 Descriptive statistics on the Metacognitive awareness scores

N	*635*
Mean	34.06
Skewness	0.088
Kurtosis	-0.175

Table 4.5 Shapiro Wilk test of Normality for Metacognitive awareness scores

Statistic	**df**	**p-value**
0.986	635	0.087

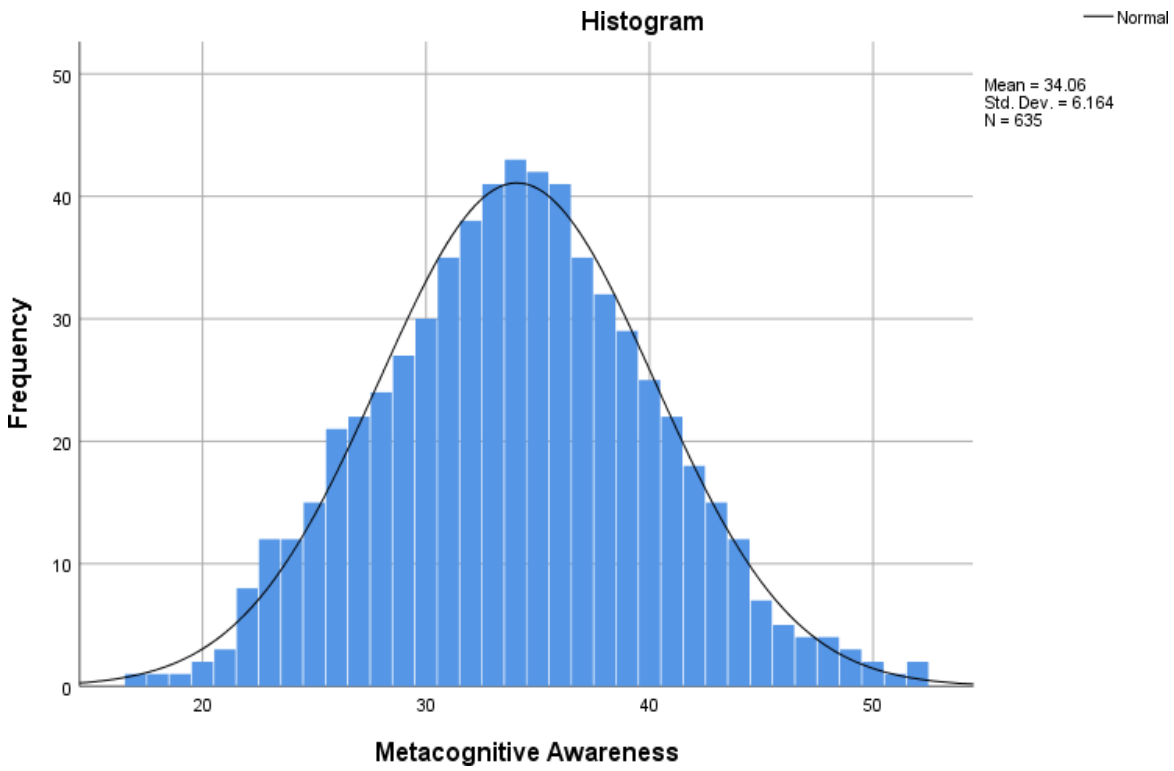


Figure 4.6 Normal probability curve for Metacognitive awareness scores

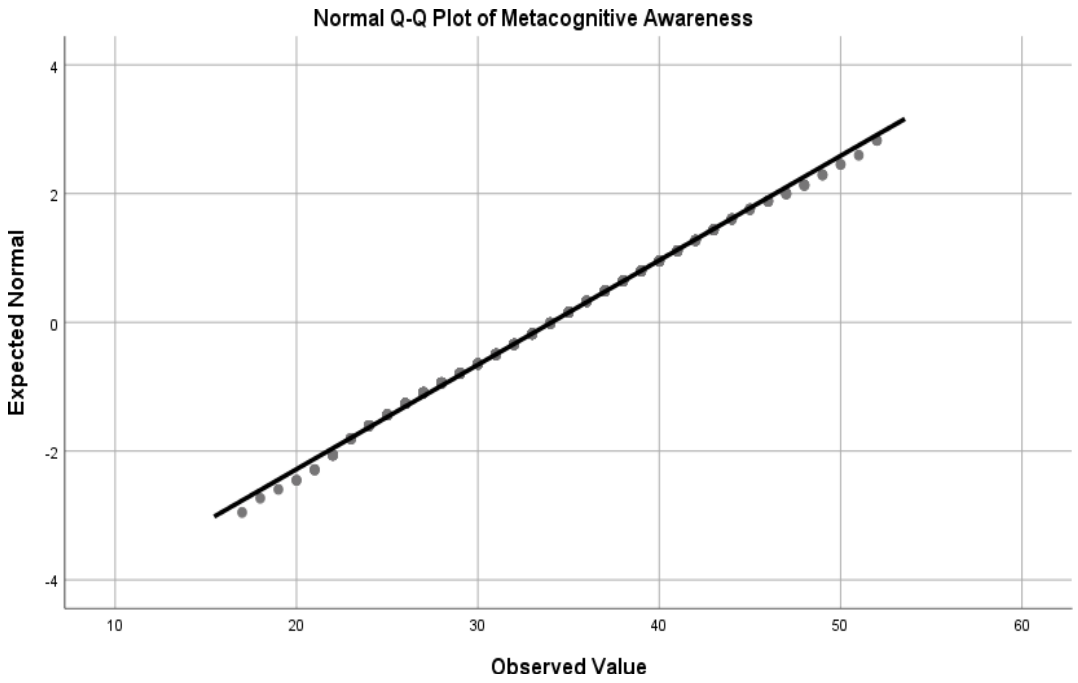


Figure 4.7 Normal Q-Q plot of Metacognitive awareness scores

Tables 4.4 and 4.5, Figures 4.6 and 4.7 show that the Metacognitive awareness scores of the students are normally distributed. According to Hair et al. (2010), data is considered to be normal if skewness is between -2 to +2 and kurtosis is between -7 to +7. The skewness and kurtosis values of 0.088 and -0.175 fall within the acceptable range and depict normality. This is further confirmed by the Shapiro Wilk test which reveals a p-value of 0.087 that is greater than 0.05 and significant at the 0.05 level of significance. This implies that the scores are normally distributed.

Table 4.6 Percentage count for Metacognitive awareness levels of the total sample

Metacognitive awareness levels	**N**	**Percentage**
Very high	28	4.4%
High	229	36.1%
Average	378	59.5%
Low	0	0
Very low	0	0
Total	**635**	**100 %**

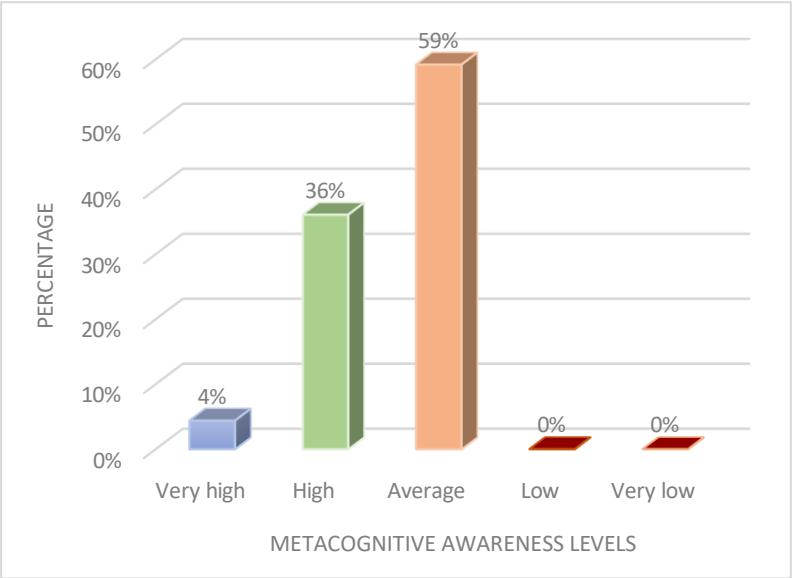


Figure 4.8 Bar graph representing the percentages for Metacognitive awareness levels of the total sample

Table 4.6 and Figure 4.8 reveal that majority of the students have average metacognitive awareness (59%). 36% of the students have high and 4% have very high levels of metacognitive awareness respectively. There were no students who had low and very low levels of metacognitive awareness.

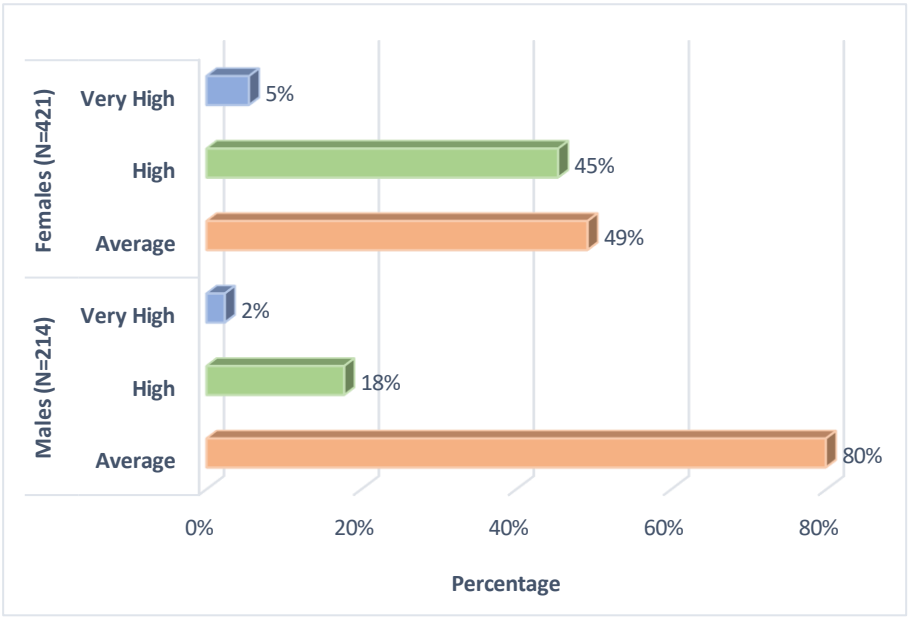


Figure 4.9 Percentages for Metacognitive awareness levels of female and male students

In case of both female and male students, majority have average level of metacognitive awareness, followed by high and very high levels. Also, in case of government and

private school students also, majority are having average level of metacognitive awareness, followed by high and very high levels.

Perceptual learning style preferences of Biology students

Table 4.7 Descriptive statistics on the Perceptual learning style scores

N	*635*
Mean	108.61
Skewness	-0.076
Kurtosis	-0.170

Table 4.8 Shapiro Wilk test of Normality for Perceptual learning style scores

Statistic	df	p-value
0.986	635	0.108

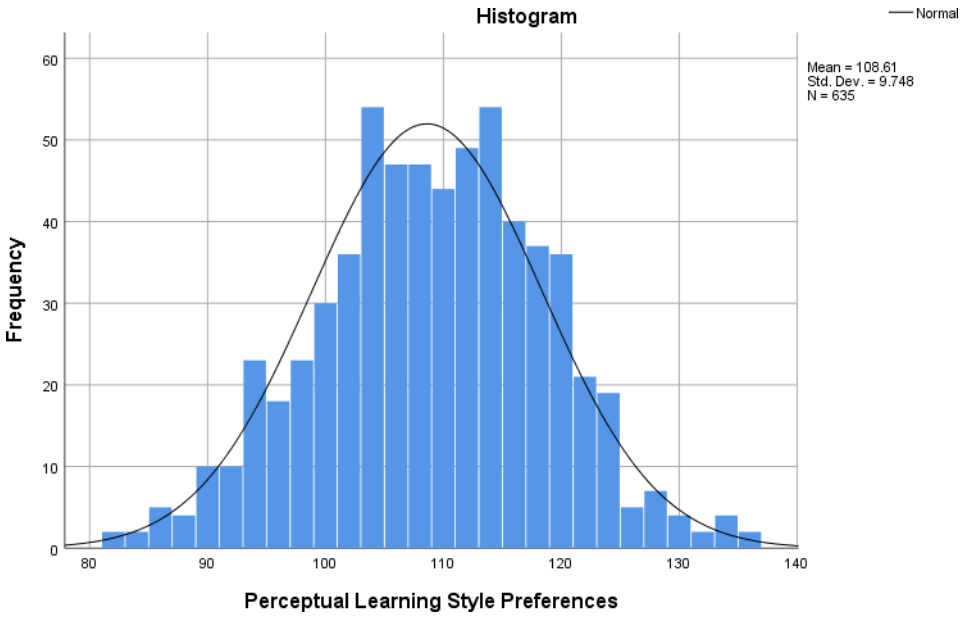


Figure 4.10 Normal probability curve for Perceptual learning style preference scores

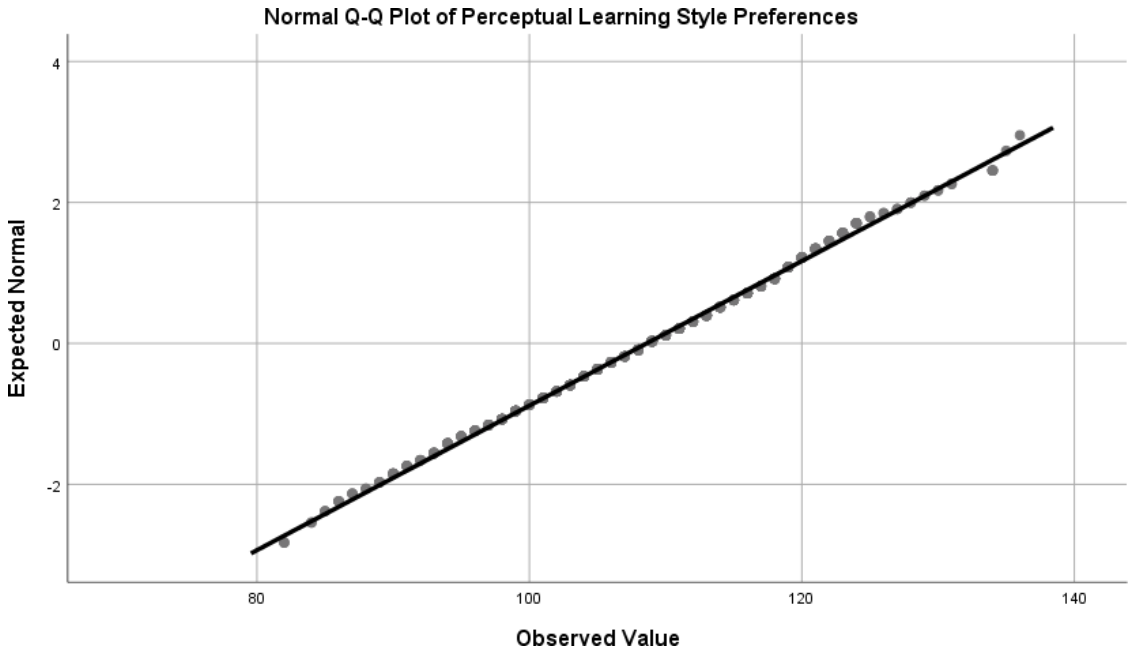


Figure 4.11 Normal Q-Q plot of Perceptual learning style preference scores

Tables 4.7 and 4.8, Figures 4.10 and 4.11 show that the Perceptual learning style preference scores of the students are normally distributed. According to Hair et al. (2010), data is considered to be normal if skewness is between -2 to +2 and kurtosis is between -7 to +7. The skewness and kurtosis values of -0.076 and -0.170 fall within the acceptable range and depict normality. This is further confirmed by the Shapiro Wilk test which reveals a p-value of 0.108 that is greater than 0.05 and significant at the 0.05 level of significance. This implies that the scores are normally distributed.

Table 4.9 Percentage count for each type of Perceptual learning style

Perceptual learning style	***N***	***Percentage***
Visual	19	2.99 %
Auditory	14	2.20 %
Kinesthetic	35	5.51%
Visual-Auditory	171	26.93%
Visual-Kinesthetic	96	15.12%
Auditory-Kinesthetic	13	2.05%
Visual-Auditory-Kinesthetic	262	41.26%
No major preference	25	3.94%
Total	**635**	**100%**

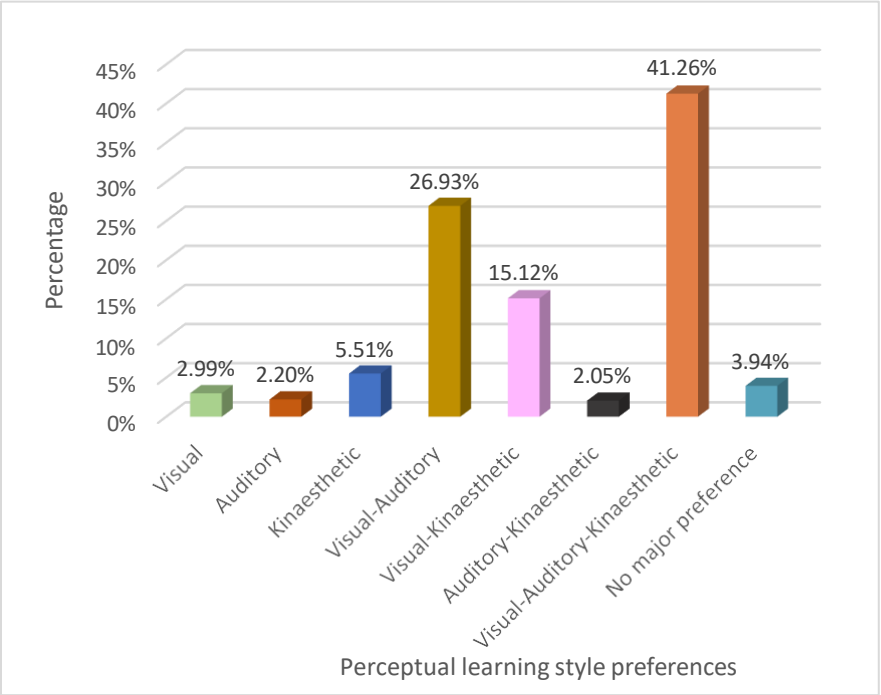


Figure 4.12 Percentages for Perceptual learning style preferences

Table 4.9 and Figure 4.12 shows the major learning styles of Biology students. The findings revealed that less percentage of students showed unimodal preference, with 2.99% of students utilizing visual learning style, 2.20% utilizing auditory learning style and 5.51% utilizing kinesthetic learning style. However, it was found that the highest preference was seen among 41.26% of students who preferred VAK, which was followed by 26.93% of students who preferred VA and 15.12% who preferred VK.

Academic achievement levels of Biology students

Table 4.10 Descriptive statistics on the Academic achievement scores

N	*635*
Mean	29.33
Skewness	-0.085
Kurtosis	-0.229

Table 4.11 Shapiro Wilk test of Normality for Academic achievement scores

Statistic	**df**	**p-value**
0.995	635	0.061

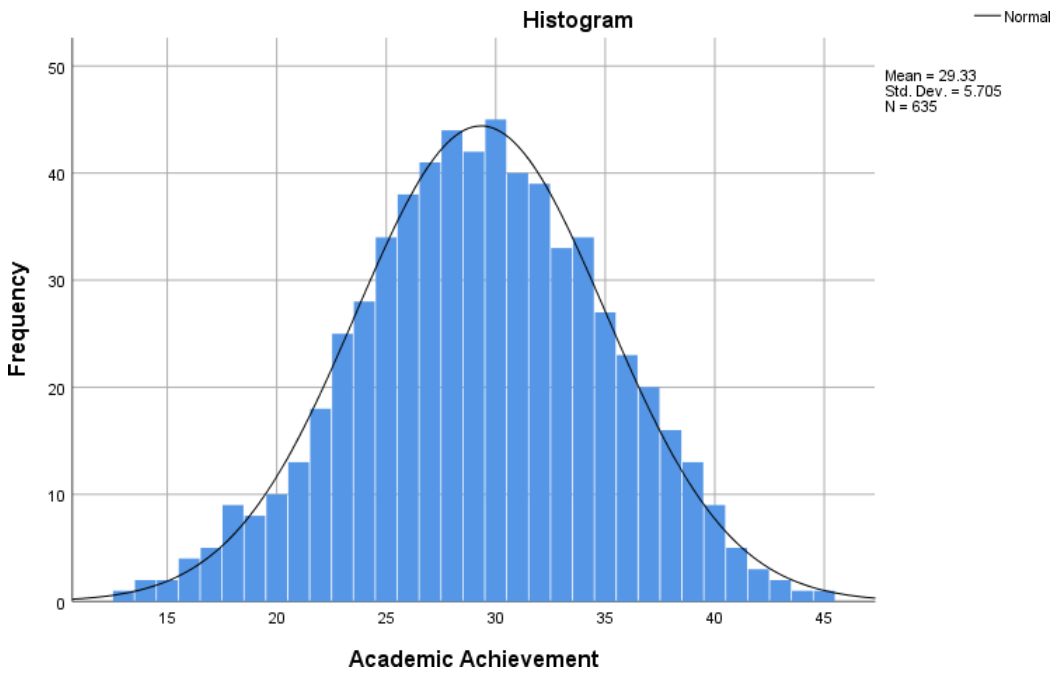


Figure 4.13 Normal probability curve for Academic achievement scores

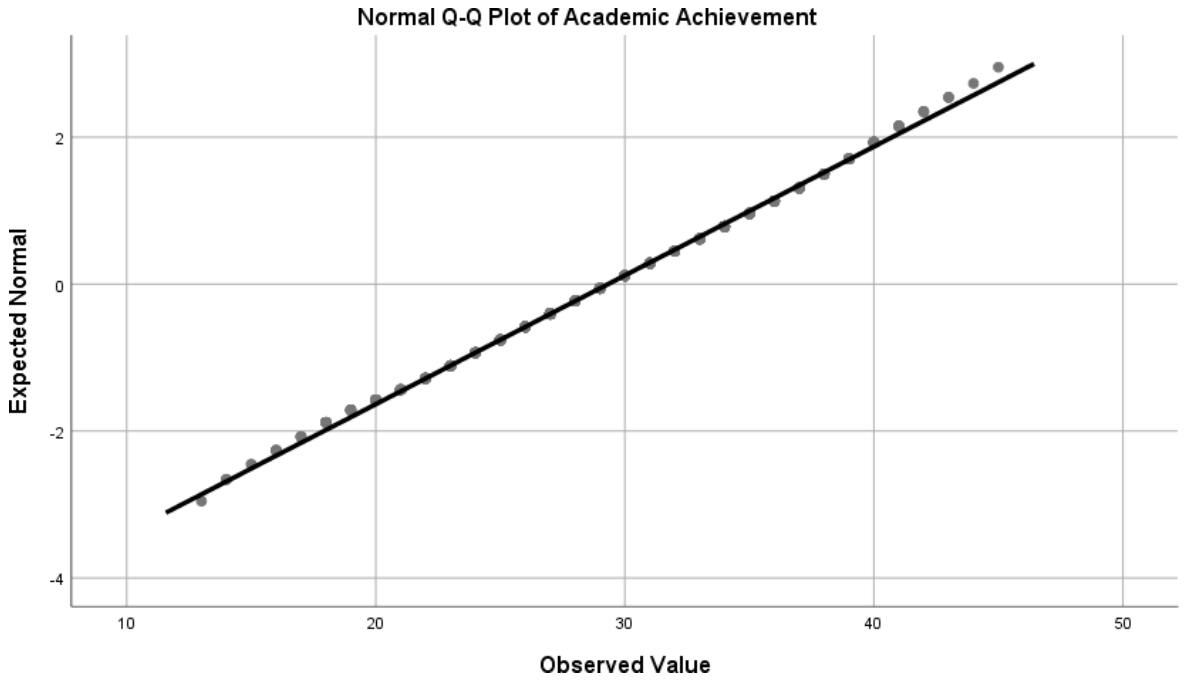


Figure 4.14 Normal Q-Q plot of Academic achievement scores

Tables 4.10 and 4.11, Figures 4.13 and 4.14 show that the Academic achievement scores of the students are normally distributed. According to Hair et al. (2010), data is considered to be normal if skewness is between -2 to +2 and kurtosis is between -7 to +7. The skewness and kurtosis values of -0.085 and -0.229 fall within the acceptable range and depict normality. This

is further confirmed by the Shapiro Wilk test which reveals a p-value of 0.061 that is greater than 0.05 and significant at the 0.05 level of significance. This implies that the scores are normally distributed.

Table 4.12 Percentage count for Academic achievement levels of the total sample

Academic achievement levels	**N**	**Percentage**
Very high	7	1.10%
High	147	23.15%
Average	472	74.33%
Low	9	1.42%
Very low	0	0%
Total	635	100%

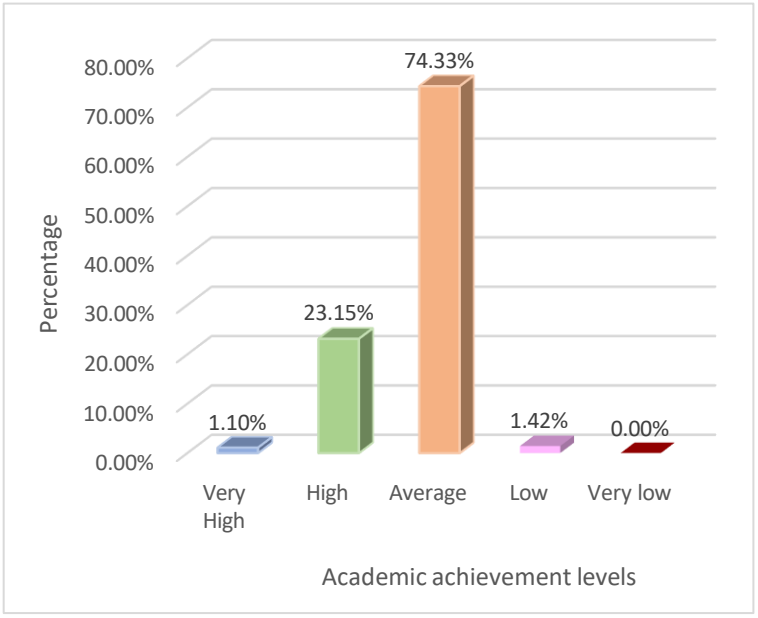


Figure 4.15 Bar graph representing the percentages of Academic achievement levels of the total sample

Table 4.12 and Figure 4.15 show that majority of the students were average achievers (74.33%), 23.15% were high achievers and 1.10% were very high achievers. There were 1.42% of low achievers and there were no students in the very low category.

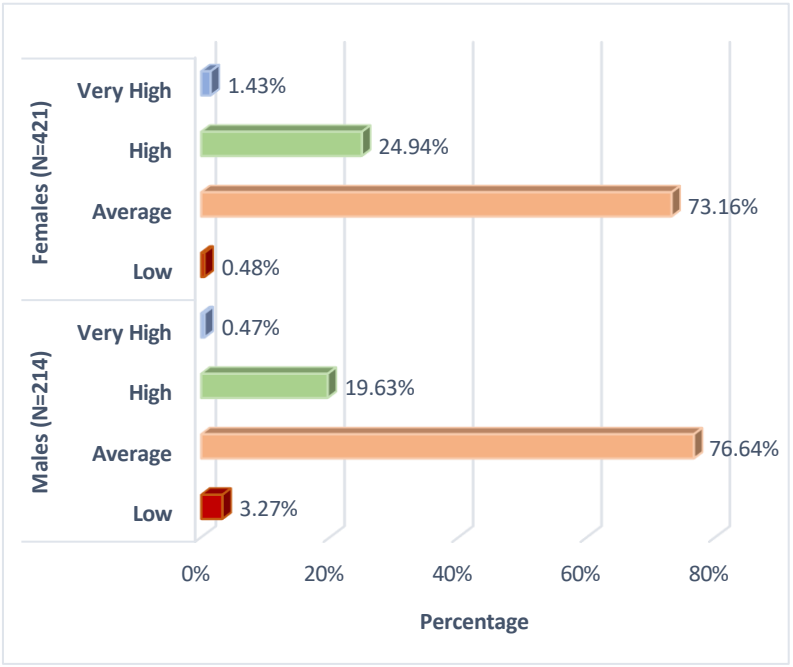


Figure 4.16 Percentages for Academic achievement levels of female and male students

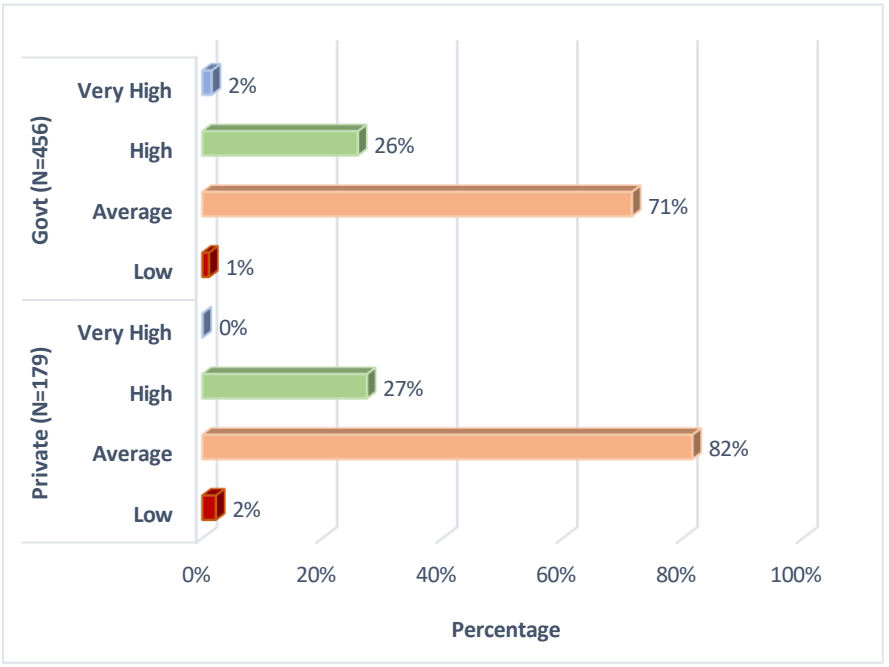


Figure 4.17 Percentages for Academic achievement levels of government and private school students

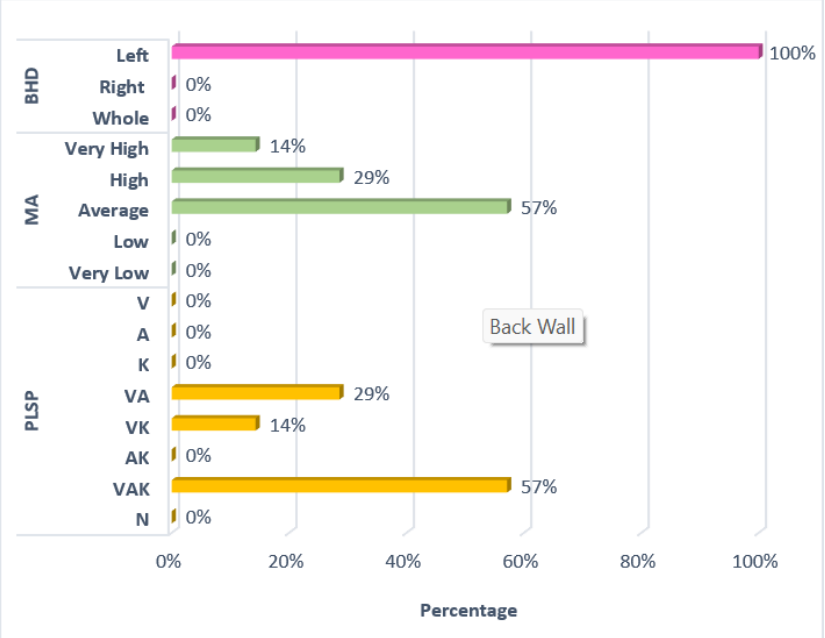
Figure 4.16 reveals that in case of females, majority have average level of academic achievement, followed by high, very high and low levels whereas in case of males, majority have average level of academic achievement, followed by high, low and very high levels. Also, Figure 4.17 reveals that in case of government school students also, majority have average level of academic achievement, followed by high, very high and

low levels whereas in case of private school students, majority have average level of academic achievement, followed by high, low and very high levels.

Table 4.13 MA and PLSP of senior secondary students according to their Academic Achievement levels

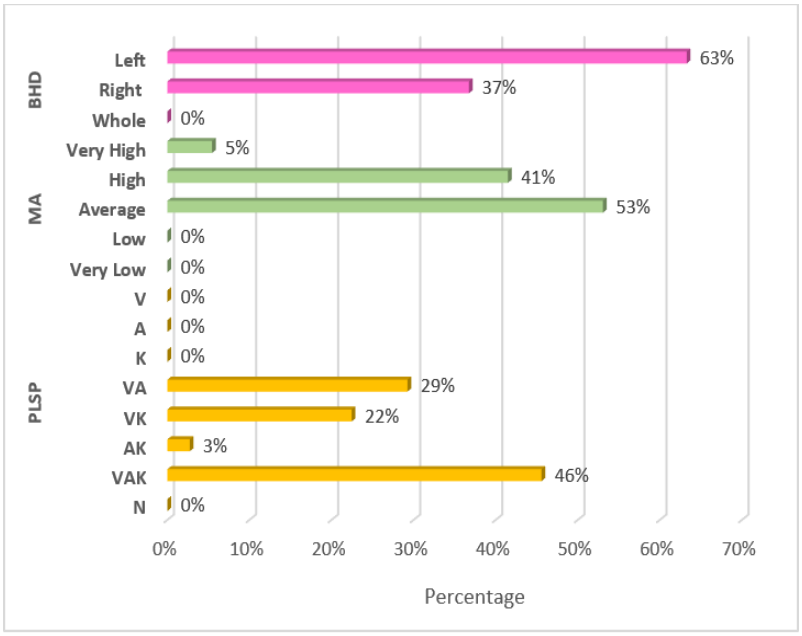
AA	BD	N	%	MA	N	%	PLSP	N	%
Very high (N=7)	Left Right Whole	7 0 0	100% 0% 0%	Very High High Average Low Very low	1 2 4 0 0	14% 29% 57% 0% 0%	V A K VA VK AK VAK N	0 0 0 2 1 0 4 0	0% 0% 0% 29% 14% 0% 57% 0%
High (N=147)	Left Right Whole	93 54 0	63% 37% 0%	Very high High Average Low Very low	8 61 78 0 0	5% 41% 53% 0% 0%	V A K VA VK AK VAK N	0 0 0 43 33 4 67 0	0% 0% 0% 29% 22% 3% 46% 0%
Average (N=472)	Left Right Whole	280 192 0	59% 41% 0%	Very high High Average Low Very low	19 163 290 0 0	4% 35% 61% 0% 0%	V A K VA VK AK VAK N	19 14 35 125 60 9 191 19	4% 3% 7% 26% 13% 2% 40% 4%
Low (N=9)	Left Right Whole	6 3 0	67% 33% 0%	Very high High Average Low Very low	0 3 6 0 0	0% 33% 67% 0% 0%	V A K VA VK AK VAK N	0 0 0 1 2 0 0 6	0% 0% 0% 11% 22% 0% 0% 67%
Very low	No students were found in this category								

Graphical representations of percentage for BHD, MA and PLSPS on the basis of Academic achievement levels (Very high, High, Average, Low, Very low)



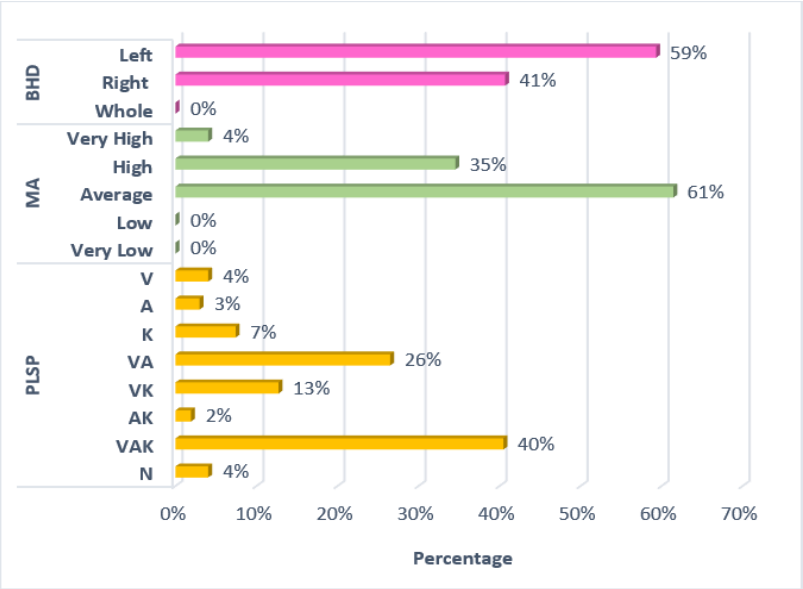
Very high achievers

Figure 4.18 BHD, MA and PLSPS for Very High achievers



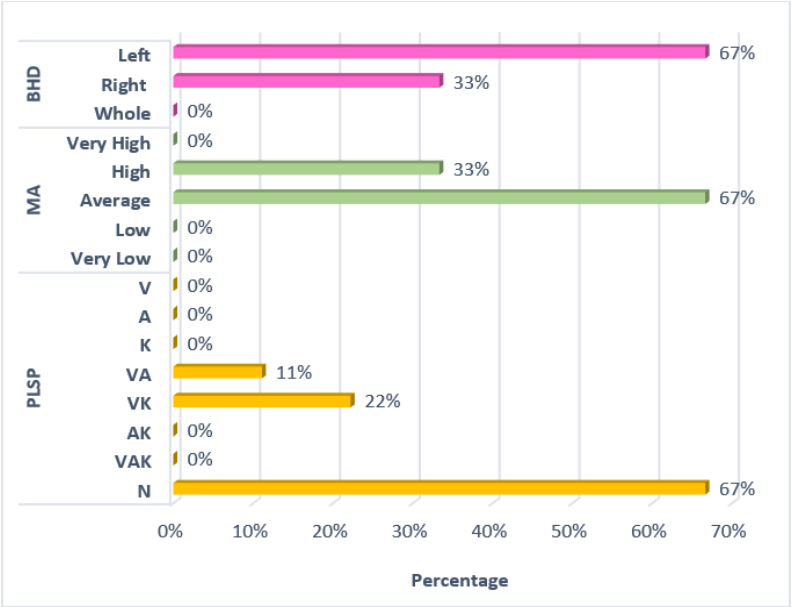
High achievers

Figure 4.19 BHD, MA and PLSPS for High achievers



Average achievers

Figure 4.20 BHD, MA and PLSPS for Average achievers



Low achievers

Figure 4.21 BHD, MA and PLSPS for Low achievers

The majority of pupils in all categories (Very high scorers, High achievers, Average achievers, Low achievers) exhibited left brain dominance, followed by right brain dominance. Very high achievers had very high, high and average levels of metacognitive awareness and maximum number of students preferred VAK. High achievers also had very high, high and average levels of metacognitive awareness and maximum number of

students preferred VAK, followed by VA and VK. highest number of students chose the VAK learning style, followed by VA and VK. Additionally, a small proportion of students, namely 4%, exhibited minimal inclinations towards either of the learning styles. In case of Low achievers, majority had average levels of metacognitive awareness and maximum number of students had negligible preferences for any learning style. Very few preferred VK and VA. None of the students had very low levels of academic achievement.

4.2 Findings related to Objective 2

Objective 2: ***To study the Brain hemispheric dominance, Metacognitive awareness, Perceptual learning style preferences and Academic achievement in Biology of senior secondary school students with respect to different demographic variables (gender and type of school).***

To test the corresponding hypotheses for fulfilling Objective 2, chi-square test and independent samples t-test were used.

Brain hemispheric dominance, Metacognitive awareness, Perceptual learning style preferences and Academic achievement in Biology with respect to gender

$H_0$1: Brain hemispheric dominance has no association with gender.

Table 4.14 Brain hemispheric dominance and Gender

			Brain Dominance			Pearson Chi-Square	p-value
			Left	Right	Total		
Gender	Females	Count	261	160	421	0.765	0.382
		Expected Count	255.9	165.1	421.0		
		% within Gender	62.0%	38.0%	100.0 %		
		% within Brain Dominance	67.6%	64.3%	66.3%		
		% of Total	41.1%	25.2%	66.3%		
	Males	Count	125	89	214		
		Expected Count	130.1	83.9	214.0		
		% within Gender	58.4%	41.6%	100.0 %		
		% within Brain Dominance	32.4%	35.7%	33.7%		
		% of Total	19.7%	14.0%	33.7%		

To test the association between brain hemispheric dominance and gender, chi-square test was conducted at 5% level of significance. Since the p-value obtained was 0.392, which is greater than 0.05, H01 was not rejected. This implies that gender does not have any significant association with brain hemispheric dominance.

$H_0$2: There exists no significant difference in the mean scores of Metacognitive knowledge with respect to gender.

$H_0$3: There exists no significant difference in the mean scores of Metacognitive regulation with respect to gender.

Table 4.15 Group statistics of Metacognitive awareness according to gender

Variable	Dimension	Gender	N	Mean	Std. Deviation
Metacognitive awareness	Metacognitive knowledge	Females	421	13.79	2.562
		Males	214	10.72	2.821
	Metacognitive regulation	Females	421	23.55	5.383
		Males	214	20.84	5.375

Table 4.16 Independent samples t-test for Metacognitive awareness and Gender

		t	df	p-value
Metacognitive awareness	Metacognitive knowledge	4.770	633	.000
	Metacognitive regulation	6.000	633	.000

Independent samples t-test was conducted at 5% level of significance to compare the mean scores of metacognitive awareness with respect to gender. Both H02 and H03 were rejected since the p-values obtained for both dimensions of metacognitive awareness (metacognitive knowledge and metacognitive regulation) with respect to gender are less than 0.05. This suggests that there exist significant differences between males and females for both Metacognitive knowledge and Metacognitive regulation, with the mean scores favouring the females for both dimensions.

$H_0$4: There exists no significant difference in the mean scores of Visual learning style preference with respect to gender.

$H_0$5: There exists no significant difference in the mean scores of Auditory learning style preference with respect to gender.

$H_0$6: There exists no significant difference in the mean scores of Kinaesthetic learning style preference with respect to gender.

Table 4.17 Group statistics of Perceptual learning style preferences according to gender

	Dimension	**Gender**	**N**	**Mean**	**Std. Deviation**
Perceptual learning style preferences	Visual	Females	421	43.18	3.034
		Males	214	42.48	3.266
	Auditory	Females	421	41.69	4.608
		Males	214	41.05	4.771
	Kinaesthetic	Females	421	40.80	5.816
		Males	214	39.32	6.169

Table 4.18 Independent samples t-test for Perceptual learning style preferences and Gender

		t	df	p-value
Perceptual learning style preferences	Visual learning	1.230	633	0.219
	Auditory learning	0.309	633	0.758
	Kinaesthetic learning	1.250	633	0.212

Independent samples t-test was conducted at 5% level of significance to compare the mean scores of perceptual learning style preferences with respect to gender. H04, H05 and H06 were not rejected since the p-values obtained for all three types of learning style preferences (visual, auditory and kinesthetic) with respect to gender are greater than 0.05. This suggests that there doesn't exist significant differences between males and females for perceptual learning style preferences.

$H_0$7: There exists no significant difference in the Academic achievement scores with respect to gender.

Table 4.19 Group statistics of Academic achievement according to gender

Variable	Gender	N	Mean	Std. Deviation
Academic achievement	Females	421	31.30	4.744
	Males	214	28.09	2.847

Table 4.20 Independent samples test for Academic achievement and Gender

	t	df	p-value
Academic achievement	3.349	633	0.001

Independent samples t-test was conducted at 5% level of significance to compare the academic achievement scores with respect to gender. H07 was rejected since the p-value obtained was less than 0.05. This suggests that females performed significantly better in the Achievement test in Biology than males.

Brain hemispheric dominance, Metacognitive awareness, Perceptual learning style preferences and Academic achievement in Biology with respect to type of school

$H_0$8: Brain hemispheric dominance has no association with the type of school students are studying in.

Table 4.21 Brain hemispheric dominance and type of school

			Brain Dominance			Pearson Chi-Square	p-value
			Left	Right	Total		
Type of school	Government	Count	288	168	456	3.813	0.063
		Expected Count	277.2	178.8	456.0		
		% within Gender	63.2%	36.8%	100.0 %		
		% within Brain Dominance	74.6%	67.5%	71.8%		
		% of Total	45.4%	26.5%	71.8%		
	Private	Count	98	81	179		
		Expected Count	108.8	70.2	179.0		
		% within Gender	54.7%	45.3%	100.0 %		
		% within Brain Dominance	25.4%	32.5%	28.2%		
		% of Total	15.4%	12.8%	28.2%		

To test the association between brain hemispheric dominance and type of school, chi-square test was conducted at the 5% level of significance. Since the p- value obtained was greater than 0.05, H08 was not rejected. This implies that the type of school students are studying in does not have any significant association with brain hemispheric dominance.

$H_0$9: There exists no significant difference in the mean scores of Metacognitive knowledge with respect to type of school.

$H_0$10: There exists no significant difference in the mean scores of Metacognitive regulation with respect to type of school.

Table 4.22 Group statistics of Metacognitive awareness according to type of school

Variable	Dimension	Type of school	N	Mean	Std. Deviation
Metacognitive awareness	Metacognitive knowledge	Government	456	11.49	2.636
		Private	179	11.27	2.848
	Metacognitive regulation	Government	456	25.73	5.318
		Private	179	22.60	6.039

Table 4.23 Independent samples t-test for Metacognitive awareness and type of school

		t	df	p-value
Metacognitive awareness	Metacognitive knowledge	0.905	633	0.366
	Metacognitive regulation	0.266	633	0.026

Independent samples t-test was conducted at 5% level of significance to compare the mean scores of metacognitive awareness with respect to type of school. H09 was not rejected and H010 was rejected since the p-values obtained for metacognitive knowledge with respect to type of school was greater than 0.05 but was lesser for metacognitive regulation. This suggests that there exist no significant differences between students from government and private schools for Metacognitive knowledge but significant differences do exist for Metacognitive regulation, with the scores favouring the private school students.

$H_0$11: There exists no significant difference in the mean scores of Visual learning style preference with respect to type of school.

$H_0$12: There exists no significant difference in the mean scores of Auditory learning style preference with respect to type of school.

$H_0$13: There exists no significant difference in the mean scores of Kinaesthetic learning style preference with respect to type of school.

Table 4.24 Group statistics of Perceptual learning style preferences according to type of school

	Dimension	**Type of school**	**N**	**Mean**	**Std. Deviation**
Perceptual learning style preferences	Visual	Government	456	37.61	5.904
		Private	179	37.23	6.001
	Auditory	Government	456	36.77	5.317
		Private	179	36.31	5.237
	Kinaesthetic	Government	456	34.14	6.396
		Private	179	35.29	6.543

Table 4.25 Independent samples t-test for Perceptual learning style preferences and type of school

		t	df	p-value
Perceptual learning style preferences	Visual learning	0.736	633	0.462
	Auditory learning	0.986	633	0.325
	Kinaesthetic learning	2.039	633	0.063

Independent samples t-test was conducted at 5% level of significance to compare the mean scores of perceptual learning style preferences with respect to type of school. H011, H012 and H013 were retained since the p-values obtained for all three types of learning style preferences (visual, auditory and kinesthetic) with respect to type of school are greater than 0.05. This suggests that there are no significant differences between government and private school students in their perceptual learning style preferences.

$H_0$14: There exists no significant difference in the Academic achievement scores with respect to type of school.

Table 4.26 Group statistics of Academic achievement according to type of school

Variable	**Type of school**	**N**	**Mean**	**Std. Deviation**
Academic achievement	Government	456	31.64	5.788
	Private	179	28.54	5.422

Table 4.27 Independent samples test for Academic achievement and type of school

	t	df	p-value
Academic achievement	2.192	633	.029

Independent samples t-test was conducted at 5% level of significance to compare the academic achievement scores with respect to type of school. H014 was rejected since the p-value obtained was less than 0.05. This suggests that private school students performed significantly better in the Achievement test in Biology than government school students.

4.3 Findings related to Objective 3

Objective 3: ***To study the Brain hemispheric dominance, Metacognitive awareness and Perceptual learning style preferences of senior secondary school students with respect to their Academic achievement levels.***

To test the corresponding hypotheses for fulfilling Objective 3, chi square test and one way ANOVA have been used.

Brain hemispheric dominance, Metacognitive awareness and Perceptual learning style preferences with respect to their Academic achievement levels (Very high, High, Average, Low and Very low)

$H_0$15: Brain hemispheric dominance has no association with Academic achievement levels.

*Table 4.28 Academic achievement levels * Brain hemispheric dominance cross tabulations*

Level of Achievement		Brain dominance			Pearson chi-square	p-value
		Left	Right	Total		
Very high	Count	7	0	7		
	% within Level of Achievement	4.3	2.7	7.0		
	% within Brain Dominance	100.0%	0.0%	100.0%		
	% of Total	1.8%	0.0%	1.1%		
High	Count	1.1%	0.0%	1.1%		
	% within Level of Achievement	93	54	147		
	% within Brain Dominance	89.4	57.6	147.0		
	% of Total	63.3%	36.7%	100.0%	5.450	0.142
Average	Count	24.1%	21.7%	23.1%		
	% within Level of Achievement	14.6%	8.5%	23.1%		
	% within Brain Dominance	280	192	472		
	% of Total	286.9	185.1	472.0		
Low	Count	6	3	9		
	% within Level of Achievement	5.5	3.5	9.0		
	% within Brain Dominance	66.7%	33.3%	100.0%		
	% of Total	1.6%	1.2%	1.4%		

To test the association between brain hemispheric dominance and academic achievement levels, chi-square test was conducted at 5% level of significance. Since the p-value obtained was greater than 0.05, H015 was not rejected. This implies that there is no association between Brain hemispheric dominance and the different levels of Academic achievement, i.e., whether a student is a left brainer or a right brainer has no association with what level of achiever he/she is.

$H_0$16: There are no significant differences among the mean scores of very high, high, average, low and very low achievers on metacognitive awareness.

Table 4.29 Descriptive of Metacognitive awareness according to Achievement levels

Metacognitive awareness	Achievement levels	N	Mean	Std. deviation
Metacognitive knowledge	Very high Achiever	7	15.71	1.496
	High Achiever	147	13.16	2.171
	Average Achiever	472	10.88	2.557
	Low Achiever	9	8.33	2.000
Metacognitive regulation	Very high Achiever	7	33.29	1.976
	High Achiever	147	25.16	4.476
	Average Achiever	472	21.85	5.383
	Low Achiever	9	14.33	3.937

Table 4.30 ANOVA table for Metacognitive awareness and Academic achievement levels

			Sum of Squares	*df*	*Mean Square*	*F*	*p-value*
Metacognitive awareness	Metacognitive knowledge	Between Groups	797.388	3	265.796	43.973	.000
		Within Groups	3814.101	631	6.045		
		Total	4611.490	634			
	Metacognitive regulation	Between Groups	2641.659	3	880.553	33.228	.000
		Within Groups	16721.847	631	26.501		
		Total	19363.506	634			

One-way ANOVA was conducted at 5% level of significance to compare the mean scores of metacognitive awareness among the academic achievement levels. H016 was rejected since the p-value obtained is less than 0.05. This implies that there exist significant differences in the metacognitive awareness scores among very high, high, average and low achievers.

Further, the Hochberg test was applied to know which groups specifically have significant differences among them.

Table 4.31 Hochberg test for multiple comparisons of Academic achievement levels with Metacognitive awareness

Metacognitive awareness	Level of Achievement	Level of Achievement	p-value
Metacognitive knowledge	Very high Achiever	High Achiever**	.044
		Average Achiever**	.000
		Low Achiever**	.000
	High Achiever	Very high Achiever	.044
		Average Achiever**	.000
		Low Achiever**	.000
	Average Achiever	Very high Achiever**	.000
		High Achiever**	.000

		Low Achiever**	.013
	Low Achiever	Very high Achiever**	.000
		High Achiever**	.000
		Average Achiever**	.013
Metacognitive regulation	Very high Achiever	High Achiever**	.000
		Average Achiever**	.000
		Low Achiever**	.000
	High Achiever	Very high Achiever	.000
		Average Achiever**	.000
		Low Achiever**	.000
	Average Achiever	Very high Achiever**	.000
		High Achiever**	.000
		Low Achiever**	.000
	Low Achiever	Very high Achiever**	.000
		High Achiever**	.000
		Average Achiever**	.000

** denotes significant difference

The Hochberg test is a post-hoc test that is used to find out which groups have significant differences. From Table 4.31, the result showed that:

In case of both metacognitive knowledge and metacognitive regulation, there are significant differences between very high achievers, high achievers, average achievers and low achievers, as shown by p-values that are lesser than 0.05.

This leads to the understanding that the mean scores of the students on metacognitive knowledge and metacognitive regulation increase as their academic levels increase, i.e., low achievers have low mean scores on metacognitive awareness as compared to average achievers, and so on.

$H_0$17: There are no significant differences among the mean scores of very high, high, average, low and very low achievers on perceptual learning style preferences.

Table 4.32 Descriptive of Perceptual learning style preferences according to Achievement levels

Perceptual learning style preferences	**Achievement levels**	**N**	**Mean**	**Std. deviation**
Visual	Very high Achiever	7	45.29	0.756
	High Achiever	147	41.89	3.619
	Average Achiever	472	36.18	5.769
	Low Achiever	9	29.56	2.242
Auditory	Very high Achiever	7	43.14	2.116
	High Achiever	147	39.65	3.977
	Average Achiever	472	36.56	5.275
	Low Achiever	9	33.61	4.978

Kinesthetic	Very high Achiever	7	44.43	1.134
	High Achiever	147	43.81	5.809
	Average Achiever	472	41.34	6.564
	Low Achiever	9	40.56	1.944

Table 4.33 ANOVA table for Perceptual learning style preferences and Academic achievement levels

			Sum of Squares	*df*	*Mean Square*	*F*	*p-value*
Perceptual learning style preferences	Visual	Between Groups	4654.417	3	1551.472	55.522	.000
		Within Groups	17632.314	631	27.943		
		Total	22286.731	634			
	Auditory	Between Groups	2129.305	3	709.768	28.633	.000
		Within Groups	15641.388	631	24.788		
		Total	17770.693	634			
	Kinesthetic	Between Groups	1149.514	3	383.171	9.572	.067
		Within Groups	25258.366	631	40.029		
		Total	26407.880	634			

One-way ANOVA was conducted at 5% level of significance to compare the mean scores of perceptual learning styles among them. H017 was rejected since the p-values obtained are less than 0.05. This implies that there exist significant differences in the perceptual learning style preference scores among very high, high, average and low achievers.

Further, the Hochberg test was applied to know which groups specifically have significant differences among them.

Table 4.34 Hochberg test for multiple comparisons of Academic achievement levels with Perceptual learning style preferences

Perceptual learning style	**Level of Achievement**	**Level of Achievement**	**p-value**
Visual	Very high Achiever	High Achiever	.458
		Average Achiever**	.000
		Low Achiever**	.000
	High Achiever	Very high Achiever	.458
		Average Achiever**	.000
		Low Achiever**	.000
	Average Achiever	Very high Achiever**	.000

		High Achiever**	.000
		Low Achiever**	.001
	Low Achiever	Very high Achiever**	.000
		High Achiever**	.000
		Average Achiever**	.001
Auditory	Very high Achiever	High Achiever	.352
		Average Achiever**	.000
		Low Achiever**	.050
	High Achiever	Very high Achiever	.352
		Average Achiever**	.000
		Low Achiever**	.357
	Average Achiever	Very high Achiever**	.000
		High Achiever**	.000
		Low Achiever**	.994
	Low Achiever	Very high Achiever**	.050
		High Achiever**	.357
		Average Achiever**	.994
Kinesthetic	Very high Achiever	High Achiever	.161
		Average Achiever	.359
		Low Achiever	.099
	High Achiever	Very high Achiever	.161
		Average Achiever	.843
		Low Achiever	.735
	Average Achiever	Very high Achiever	.359
		High Achiever	.843
		Low Achiever	.471
	Low Achiever	Very high Achiever	.099
		High Achiever	.735
		Average Achiever	.471

** denotes significant difference

The Hochberg test is a post-hoc test that is used to find out which groups have significant differences. From Table 4.34, the result showed that

In case of both visual and auditory learning styles, there are significant differences between the groups, wherein the mean scores of very high achievers, high achievers and average achievers are greater than that of low achievers, and the scores of high achievers are greater than average achievers, as shown by all the p-values that are lesser than 0.05. In case of kinesthetic learning style, no significant differences were found between the groups, implying that their preferences for kinesthetic learning are the same.

4.4 Findings related to Objective 4

Objective 4: ***To study the relationship between Metacognitive awareness, Perceptual learning style preferences and Academic achievement in Biology of left brained and right brained students.***

To test the corresponding hypotheses for fulfilling Objective 4, Pearson correlation was used.

Relationship between Metacognitive awareness, Perceptual learning style preferences and Academic achievement in Biology of Left brained and Right brained students

$H_0$18: There is no relationship between Metacognitive awareness, Perceptual learning style preferences and Academic achievement in Biology of Left brained students.

Table 4.35 Relationship between Metacognitive Awareness, Perceptual Learning Style preferences and Academic achievement of Left brainers

Correlations: Left brainers (N=386)							
		Metacognitive knowledge	Metacognitive regulation	V	A	K	VAK
Academic achievement	Pearson Correlation	0.523	0.577	0.498	0.105	0.419	0.649
	p-value	0.000**	0.000**	0.000**	0.040**	0.000**	0.000**
** Correlation is significant at the 0.05 level (2-tailed).							

To test the relationship between Metacognitive awareness, Perceptual learning style preferences and Academic achievement of Left brained students, Pearson Correlation was conducted at 5% level of significance. As all the p-values derived are less than 0.05, the null hypothesis H018 is rejected. According to Best & Kahn (2006), correlation coefficients between 0.2-0.4 are considered as low correlation, between 0.4-0.6 as moderate correlation and between 0.6-0.8 as substantial correlation. It is found that there exists significant moderate positive correlation between Metacognitive knowledge and Academic achievement and also between Metacognitive regulation and Academic achievement with correlation coefficients of 0.523 and 0.577 respectively. There also exist significant positive correlations between Visual learning and Academic

achievement, between Auditory learning and Academic achievement, between Kinesthetic learning and Academic achievement and between a combination of all three styles i.e. VAK and academic achievement, with correlation coefficients of 0.498 (moderate correlation), 0.105 (low correlation), 0.419 (moderate correlation) and 0.649 (substantial correlation) respectively.

$H_0$19: There is no relationship between Metacognitive awareness, Perceptual learning style preferences and Academic achievement in Biology of Right brained students.

Table 4.36 Relationship between Metacognitive Awareness, Perceptual Learning Style preferences and Academic achievement of Right brainers

Correlations: Right brainers (N=249)							
		Metacognitive knowledge	Metacognitive regulation	V	A	K	VAK
Academic achievement	Pearson Correlation	0.502	0.504	0.537	0.102	0.529	0.698
	p-value	0.000**	0.000**	0.000**	0.034**	0.000**	0.000**
** Correlation is significant at the 0.05 level (2-tailed).							

To test the relationship between Metacognitive awareness, Perceptual learning style preferences and Academic achievement of Right brained students, Pearson Correlation was conducted at 5% level of significance. As all the p-values derived are less than 0.05, the null hypothesis H019 is rejected. According to Best & Kahn (2006), correlation coefficients between 0.2-0.4 are considered as low correlation, between 0.4-0.6 as moderate correlation and between 0.6-0.8 as substantial correlation. It is found that there exists significant moderate positive correlation between Metacognitive knowledge and Academic achievement and between Metacognitive regulation and Academic achievement with coefficients of 0.502 and 0.504 respectively. There also exist significant positive correlations between Visual learning and Academic achievement, between Auditory learning and Academic achievement, between Kinesthetic learning and Academic achievement and between a combination of all three styles i.e. VAK and academic achievement, with correlation coefficients of 0.537 (moderate correlation), 0.102 (low correlation), 0.529 (moderate correlation) and 0.698 (substantial correlation) respectively..

4.5 Findings related to Objective 5

Objective 5: ***To investigate whether Metacognitive awareness and Perceptual learning style preferences would be significant predictors of Academic achievement in left brained and right brained students.***

4.5.1 Assumptions of Regression Analysis

Before conducting a regression analysis, the following assumptions need to be fulfilled:

(1) Normality of Data: The Normality of data have already been tested using the Shapiro Wilk test. The data are found to be normal (Tables 4.2, 4.5, 4.8 and 4.11).

(2) Homoscedasticity: The scatterplot of the residuals has been visualized to test the data for homoscedasticity. The data points lie between -3 and 3, suggesting that the data is not homoscedastic.

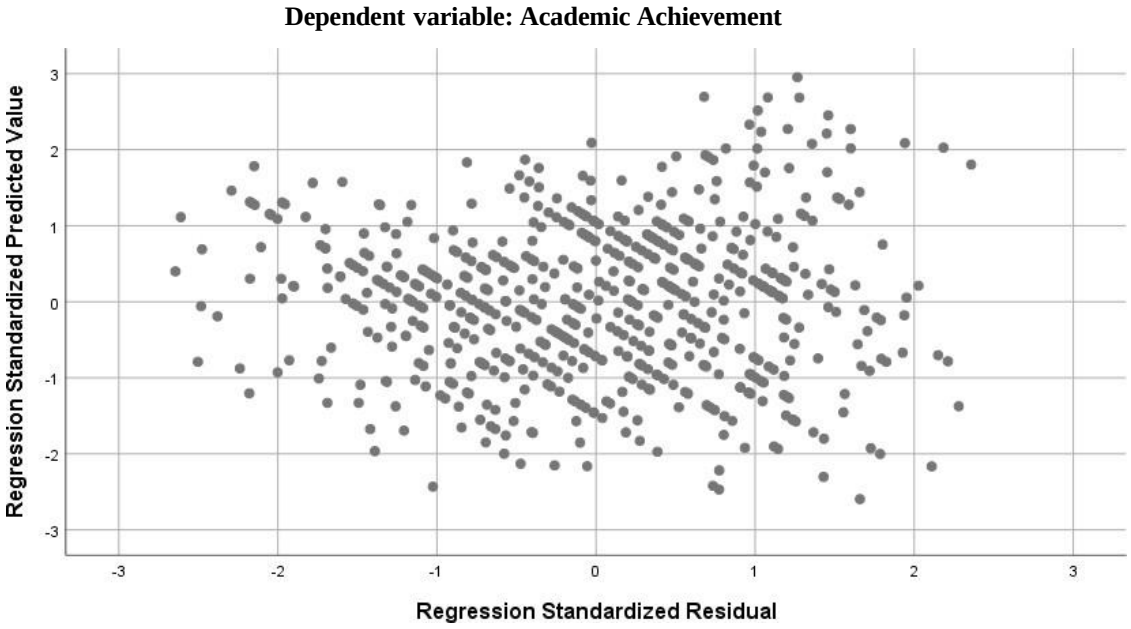


Figure 4.22 Scatterplot showing homoscedasticity of data

(3) Multicollinearity: Multicollinearity has been tested based on the Tolerance and VIF values. Tolerance values less than 0.1 and VIF (Variance inflation factor) values above 10 suggests multicollinearity, which can be problematic. In the

current study, tolerance values above 0.1 and VIF values below 10 indicate the absence of multicollinearity.

Table 4.37 VIF values testing Multicollinearity

	Collinearity Statistics	
	Tolerance	**VIF**
Metacognitive Knowledge	.807	1.239
Metacognitive Regulation	.803	1.246
Visual Learning	.735	1.360
Auditory Learning	.817	1.224
Kinesthetic Learning	.778	1.285

(4) Normality of Regression residuals: The Normal P-P plot has been visualized to check the approximate normality of the regression residuals. The graph shows that the data points of the residuals are normal.

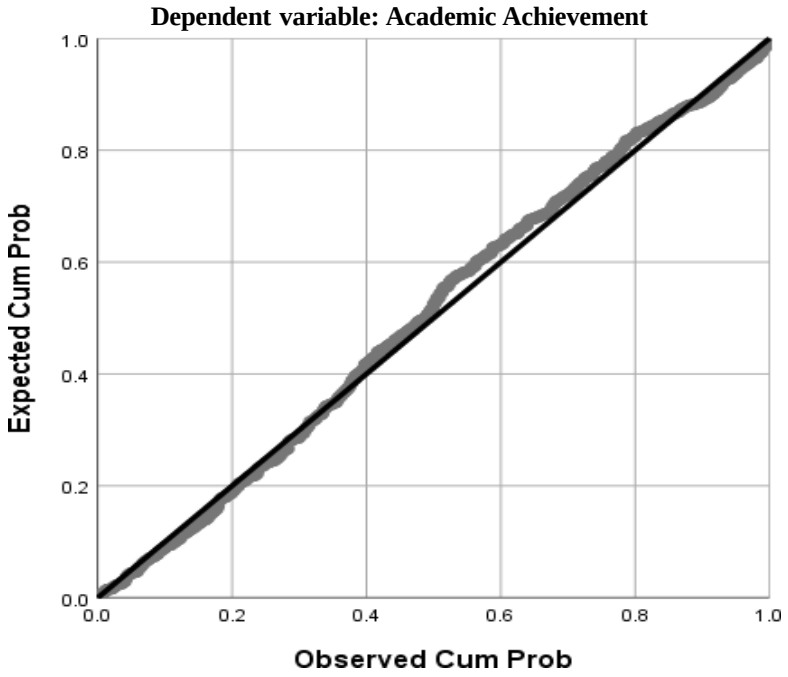


Figure 4.23 Normal P-P Plot of Regression Standardized Residuals

Since all the assumptions were fulfilled, the regression analysis was run in the next phase.

4.5.2 Hierarchical Regression Analysis

$H_0$20: Metacognitive awareness and Perceptual learning style preferences would not be significant predictors of Academic achievement in Biology of Left brained students.

Table 4.38 Regression model summary for left brained students

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	p-value
1	.477[a]	**.228**	.226	5.109	.000
2	.632[b]	**.400**	.397	4.511	.000
3	.690[c]	**.476**	.472	4.220	.000
4	.743[d]	**.552**	.547	3.906	.000
5	.791[e]	**.626**	.621	3.573	.000

a. Predictors: (Constant), Metacognitive knowledge
b. Predictors: (Constant), Metacognitive knowledge, Metacognitive regulation
c. Predictors: (Constant), Metacognitive knowledge, Metacognitive regulation, Visual learning
d. Predictors: (Constant), Metacognitive knowledge, Metacognitive regulation, Visual learning, Auditory Learning
e. Predictors: (Constant), Metacognitive knowledge, Metacognitive regulation, Visual learning, Auditory Learning, Kinaesthetic Learning

Table 4.39 Coefficients

Model		**Unstandardized B**	**Coefficients Std. Error**	**Standardized Coefficients Beta**	**p-value**
1	(Constant)	18.058	1.118		.000
	MK	1.015	.095	.477	.000
2	(Constant)	8.853	1.321		.000
	MK	.999	.084	.470	.000
	MR	.410	.039	.415	.000
3	(Constant)	1.682	1.566		.028
	MK	.830	.082	.390	.000
	MR	.328	.038	.332	.000
	VL	.286	.038	.299	.000
4	(Constant)	-16.315	2.665		.000
	MK	.705	.077	.331	.000
	MR	.254	.037	.257	.000
	VL	.480	.043	.502	.000
	AL	.370	.046	.334	.000
5	(Constant)	-17.898	2.444		.000
	MK	.511	.074	.240	.000
	MR	.177	.035	.180	.000
	VL	.384	.041	.402	.000
	AL	.350	.042	.316	.000
	KL	.296	.034	.327	.000

The regression analysis on Table 4.38 for left brained students indicates that Model 1 (Metacognitive knowledge) explains 22.8% of impact on Academic achievement, Model 2 (Metacognitive knowledge + Metacognitive regulation) explains 40% of impact on Academic achievement, Model 3 (Metacognitive knowledge + Metacognitive regulation + Visual learning) explains 47.6% of impact on Academic achievement, Model 4 (Metacognitive knowledge + Metacognitive regulation + Visual learning + Auditory learning) explains 55.2 % of impact on Academic achievement and Model 5 (Metacognitive knowledge + Metacognitive regulation + Visual learning + Auditory learning + Kinesthetic learning) explains 62.6 % of impact on Academic achievement, which is significant at the 0.05 level of significance. This leads us to understand that metacognitive awareness alone explains 40% of impact on academic achievement, but metacognitive awareness along with perceptual learning styles significantly explains 62.6% of the variance in Academic achievement. Hence, $H_0$20 is rejected since metacognitive awareness and perceptual learning styles have been found to be significant predictors of academic achievement in Biology in left brained students.

$H_0$21: Metacognitive awareness and Perceptual learning style preferences would not be significant predictors of Academic achievement in Biology of Right brained students.

Table 4.40 Regression model summary for right brained students

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	p-value
1	.502[a]	**.252**	.249	4.784	.000
2	.716[b]	**.413**	.409	3.867	.000
3	.743[c]	**.583**	.578	3.588	.000
4	.779[d]	**.607**	.600	3.490	.000
5	.803[e]	**.646**	.638	3.321	.000

a. Predictors: (Constant), Metacognitive knowledge
b. Predictors: (Constant), Metacognitive knowledge, Metacognitive regulation
c. Predictors: (Constant), Metacognitive knowledge, Metacognitive regulation, Visual learning
d. Predictors: (Constant), Metacognitive knowledge, Metacognitive regulation, Visual learning, Auditory Learning
e. Predictors: (Constant), Metacognitive knowledge, Metacognitive regulation, Visual learning, Auditory Learning, Kinaesthetic Learning

Table 4.41 Coefficients

Model		Unstandardized B	Coefficients Std. Error	Standardized Coefficients Beta	p-value
1	(Constant)	16.895	1.346		.000
	MK	1.043	.114	.502	.000
2	(Constant)	3.940	1.567		.013
	MK	1.059	.092	.510	.000
	MR	.576	.050	.511	.000
3	(Constant)	-1.972	1.723		.025
	MK	.877	.090	.422	.000
	MR	.482	.049	.427	.000
	VL	.270	.042	.290	.000
4	(Constant)	-11.586	2.995		.000
	MK	.822	.089	.396	.000
	MR	.433	.049	.384	.000
	VL	.369	.048	.397	.000
	AL	.202	.052	.184	.000
5	(Constant)	-15.451	2.947		.000
	MK	.690	.088	.332	.000
	MR	.375	.048	.333	.000
	VL	.324	.047	.348	.000
	AL	.239	.050	.218	.000
	KL	.211	.041	.231	.000

The above regression analysis for left brained students indicates that Model 1 (Metacognitive knowledge) explains 25.2% of impact on Academic achievement, Model 2 (Metacognitive knowledge + Metacognitive regulation) explains 41.2% of impact on Academic achievement, Model 3 (Metacognitive knowledge + Metacognitive regulation + Visual learning) explains 58.3% of impact on Academic achievement, Model 4 (Metacognitive knowledge + Metacognitive regulation + Visual learning + Auditory learning) explains 60.7 % of impact on Academic achievement and Model 5 (Metacognitive knowledge + Metacognitive regulation + Visual learning + Auditory learning + Kinesthetic learning) explains 64.6 % of impact on Academic achievement, which is significant at the 0.05 level of significance. This leads us to understand that metacognitive awareness alone explains 41.3% of impact on academic achievement, but metacognitive awareness along with perceptual learning styles significantly explains 64.6% of the variance in Academic achievement. Hence, $H_0$21 is rejected since metacognitive awareness and perceptual learning styles have been found to be significant predictors of academic achievement in Biology in left brained students. Hence, we see that Metacognitive awareness and Perceptual learning styles are significant predictors of Academic achievement in both left brained and right brained students, which means that both categories of students are at par with each other.