Chapter 4
DATA ANALYSIS AND INTERPRETATION

4.0 INTRODUCTION

This chapter deals with the analysis and interpretation of the collected data. The data collected with the tool Cognitive Ability Test for Science (CATS) were quantitative in nature. Appropriate statistical techniques were employed for analyzing the data and interpretation were drawn from the analysis outputs. Moreover, hypotheses were tested and decisions regarding rejection of the hypotheses were taken. Another tool constructed for the present study was Creativity Test for Science (CTS) which included open ended questions. The data collected with CTS were analyzed through content analyzing students' responses. The analyzed content was presented in the form of description.

4.1 ACHIEVEMENT SCORES IN COGNITIVE ABILITY TEST FOR SCIENCE (CATS) OF STUDENTS

Table 4.1 shows students' Mean Achievement scores in CATS, standard deviation and total number of students with respect to each discontinuous variable namely gender, medium of instruction and type of school. There were 162 test items in CATS. Hence, the total score for CATS was 162. The values presented in the table 4.1 will be referred for making decisions regarding rejection of null hypotheses in the later part of the chapter.

Table 4.1: Mean, SD and N values of achievement in CATS of students

		M	**SD**	**N**
Gender	Male	52.08	20.26	1253
	Female	51.73	14.00	1190
Medium of Instruction	English	54.34	20.81	458
	Gujarati	51.35	16.57	1985
Type of School	Government	53.53	21.94	695
	Grant-in-aid	48.60	11.38	1043

	Private	55.22	19.10	705
	Total	51.91	17.49	2243

The present study is a normative survey. Central tendencies; mean, median and mode; Standard deviation were the norms established for CATS. The value of Mean, Median and Mode were found to be 51.91, 48 and 46 respectively. Reliability for CATS was calculated by Kuder – Richardson 21(KR 21) formula. The value of KR 21 Reliability coefficient was 0.89.

With reference to the values of mean, median and mode, it can be seen that the distribution of the scores of students in CATS is not a perfect normal distribution. However, the sampling technique employed for the present was probability sampling and randomization was followed in selecting sample of the study. Moreover, assumed equal variances in the test scores were realized for data analysis (refer table 4.2). Additionally, no outliers in the data set of students' scores in CATS were found. Therefore, parametric statistical techniques were employed for analysis.

4.2 EFFECT OF MEDIUM OF INSTRUCTION, GENDER, TYPE OF SCHOOL AND THEIR INTERACTIONS ON ACHIEVEMENT IN COGNITIVE ABILITY TEST FOR SCIENCE (CATS) OF CLASS IX STUDENTS

There were two levels of Gender – Male and Female, two levels of Medium of Instruction – English and Gujarati and three levels of Type of School – Government, Grant-in-aid and Private schools. Thus, the data were analyzed with the help of 2X2X3 Factorial design ANOVA.

Table 4.2: Levene's Test for Equality of Variances

Levene Statistics (F)	**df1**	**df2**	**Sig.**
120.40	7	2435	.000

From table 4.2, it can be seen that the F value is 120.40 with df= (7,2435) at significance level 0.000 which indicated $p<0.05$. Hence, the assumption of homogeneity of variances has been realized. Further, the results of 2X2X3 Factorial design ANOVA are given in table 4.3:

Table 4.3: Summary of 2X2X3 Factorial Design ANOVA of Achievement in CATS of Students

Source of Variance	df	SS	MSS	F-Value	Remarks
Gender (A)	1	36.72	36.72	0.133	ns
Medium of Instruction (B)	1	2544.94	2544.94	9.21	p<0.01
Type of School (C)	2	28779.34	14389.67	52.05	p<0.01
A X B	1	2310.23	2310.23	8.36	p<0.01
A X C	2	50840.95	25420.47	91.96	p<0.01
B X C	0	0*	-	-	
A X B X C	0	0*	-	-	
Error	2435	673133.87	276.44		
Total	2443	7329910.00			

* From table 4.3, it can be seen that interaction between Medium of Instruction and Type of School is zero. The underlying reason for this zero interaction is that there were no any English medium Government and Grant-in-aid secondary schools. Private schools were the only schools which had both English and Gujarati Medium. As a result, there cannot be any interaction between and beyond Medium of instruction and Type of School. Therefore, the interaction between Gender, Medium of Instruction and Type of School is also zero. These interactions will not be considered for further analysis in later part of this chapter.

4.2.1.Gender-wise Comparison of Mean Achievement Scores in CATS of Students

From Table 4.3, it can be seen that the F-value is 0.133 which is not significant at 0.01 level. It indicated that the mean scores of achievement in CATS of Male and Female students did not differ significantly. Thus the null hypothesis –**"$H_0$1: There will be no significant difference in the mean achievement scores in CATS of class IX students with respect to gender" is not rejected.**

4.2.2 Medium of Instruction-wise Comparison of Mean Achievement Scores in CATS of Students

From Table 4.3, it can be seen that the F-value is 9.21 which is significant at 0.01 level with df=1. It indicated that the mean scores of achievement in CATS of English and Gujarati medium students differed significantly. Thus the null hypothesis – **"$H_0$2: There will be no significant difference in the mean achievement scores in CATS of class IX students with respect to medium of instruction" is rejected.** Further, the mean score of Achievement in CATS of English medium students is 54.34 which is significantly higher than those of Gujarati medium students whose mean score of Achievement in CATS is 51.35 (Vide Table 4.1). It may, therefore, be said that English medium students were found to have significantly better Achievement in CATS as compared to Gujarati medium students.

4.2.3 Type of school-wise Comparison of Mean Achievement Scores in CATS of Students

From Table 4.3, it can be seen that the F-value is 52.05 which is significant at 0.01 level with df=2. It indicated that the mean scores of achievement in CATS of students studying in Government schools, Grant-in-aid schools and Private schools differed significantly. Thus the null hypothesis – **"$H_0$3: There will be no significant difference in the mean achievement scores in CATS of class IX students with respect to types of schools" is rejected.** In order to know which group's Achievement in CATS was significantly higher than others, the data were further analyzed with the help of Duncan's Multiple Range test and the results are given in Table 4.4.

Table 4.4: Duncan's Multiple Range Test for CATS

Type of schools	M	N	Grant-in-aid school	Private school
Government schools	53.53	695	6.12**	1.53**
Grant-in-aid schools	48.60	1043		9.06**
Private schools	55.22	705		

** Significant at 0.01 level

From Table 4.4, it can be seen that the mean score of Achievement in CATS of students studying in Private schools is 55.22 which is significantly higher than those of Government schools and Grant-in-aid schools whose mean score of Achievement CATS are 53.53 and 48.60 respectively. It may, therefore, be said that Private schools students were found to have significantly better Achievement in CATS as compared to Government schools students and Grant-in-aid schools students.

4.2.4 Effect of Interaction of Gender and Medium of Instruction on Mean Achievement Scores in CATS of Students

From Table 4.3, it can be seen that the F-value is 8.36 which is significant at 0.01 level with df=(1,2435). It indicates that there was a significant difference between the mean scores of Achievement in CATS of Male and Female students taught through English medium and Gujarati medium. Thus, the null hypothesis – **"$H_0$4: There will be no significant interaction between mean achievement scores in CATS of class IX students with respect to gender and medium of instruction" is rejected**. This indicates that the mean scores of Achievement in CATS of Male and Female students taught through English medium differed significantly from those taught through Gujarati medium. From table 4.5, it can be seen that both Male and Female students of English medium were found to have higher mean Achievement scores in CATS than Male and Female students of Gujarati medium. Further, Female students of English medium had higher mean Achievement scores in CATS than Male students of English medium.

Table 4.5: Gender-wise and Medium of Instruction-wise mean scores of Achievement in CATS

	M (English Medium)	**M (Gujarati Medium)**
Male	53.31	51.71
Female	56.13	51.01

4.2.5 Effect of Interaction of Gender and Type of School on Mean Achievement Scores in CATS of Students

From Table 4.3, it can be seen that the F-value is 91.96 which is significant at 0.01 level with df=(2,2435). It indicates that there was a significant difference between the mean scores of

Achievement in CATS of Male and Female students studying in Government schools, Grant-in-aid schools and Private schools. Thus, the null hypothesis – **"$H_0$5: There will be no significant interaction between mean achievement scores in CATS of class IX students with respect to gender and types of schools" is rejected.** This indicates that the mean scores of Achievement in CATS of Male and Female students studying in Government schools differed significantly from those studying in Grant-in-aid schools and Private schools. From table 4.6, it can be seen that Male students of Government schools were superior in CATS to those of Grant-in-aid schools and Private schools with mean value 62.40 whereas Female students of Private schools were superior in CATS to those of Grant-in-aid schools and Private schools with mean value 58.70. Further, Male students of Grant-in-aid schools and Female students of Government schools were found to be inferior in CATS.

Table 4.6: Gender-wise and Type of School-wise mean scores of Achievement in CATS

	M (Government schools)	**M (Grant-in-aid schools)**	**M (Private schools)**
Male	62.40	45.53	53.39
Female	47.85	51.64	58.70

4.3 EFFECT OF MEDIUM OF INSTRCUTION, GENDER, TYPE OF SCHOOL AND THEIR INTERACTIONS ON ACHIEVEMENT IN CHEMISTRY OF CLASS IX STUDENTS

There were two levels of Gender – Male and Female, two levels of Medium of Instruction – English and Gujarati and three levels of Type of School – Government, Grant-in-aid and Private schools. Thus, the data were analyzed with the help of 2X2X3 Factorial design ANOVA.

Table 4.7: Levene's Test for Equality of Variances

Levene Statistics (F)	**df1**	**df2**	**Sig.**
53.414	7	2435	.000

From table 4.7, it can be seen that the F value is 53.414 with df= (7,2435) at significance level 0.000 which indicated p<0.05. Hence, the assumption of homogeneity of variances has been realized. Further, the results of 2X2X3 Factorial design ANOVA are given in table 4.8:

Table 4.8: Summary of 2X2X3 Factorial Design ANOVA of Achievement in Chemistry of Students

Source of Variance	df	SS	MSS	F-Value	Remarks
Gender (A)	1	1.44	1.44	0.36	ns
Medium of Instruction (B)	1	0.168	0.168	0.04	ns
Type of School (C)	2	2673.69	1336.84	33.41	p<0.01
A X B	1	195.84	195.84	4.89	p<0.01
A X C	2	4552.27	2276.13	56.89	p<0.01
Error	2435	97427.14	40.01		
Total	2443	911375.00			

4.3.1.Gender-wise Comparison of Mean Achievement Scores in Chemistry of Students

From Table 4.8, it can be seen that the F-value is 0.36 which is not significant at 0.01 level. It indicated that the mean scores of achievement in Chemistry of Male and Female students did not differ significantly. Thus the null hypothesis –**"$H_0$6: There will be no significant difference in the mean achievement scores in Chemistry of class IX students with respect to gender" is not rejected**.

4.3.2 Medium of Instruction-wise Comparison of Mean Achievement Scores in Chemistry of Students

From Table 4.8, it can be seen that the F-value is 0.04 which is not significant at 0.01 level. It indicated that the mean scores of achievement in Chemistry of English and Gujarati medium students did not differ significantly. Thus the null hypothesis –**"$H_0$7: There will be no significant difference in the mean achievement scores in Chemistry of class IX students with respect to medium of instruction" is not rejected.**

4.3.3 Type of school-wise Comparison of Mean Achievement Scores in Chemistry of Students

From Table 4.8, it can be seen that the F-value is 33.41 which is significant at 0.01 level with df=2. It indicated that the mean scores of achievement in Chemistry of students studying in Government schools, Grant-in-aid schools and Private schools differed significantly. Thus the null hypothesis – **"$H_0$8: There will be no significant difference in the mean achievement scores in Chemistry of class IX students with respect to types of schools" is rejected**. In order to know which group's Achievement in Chemistry was significantly higher than others, the data were further analyzed with the help of Duncan's Multiple Range test and the results are given in Table 4.9.

Table 4.9: Duncan's Multiple Range Test for Chemistry

Type of schools	M	N	Grant-in-aid school	Private school
Government schools	18.37	695	4.75**	3.67**
Grant-in-aid schools	16.91	1043		9.96**
Private schools	19.80	705		

** Significant at 0.01 level

From Table 4.9, it can be seen that the mean score of Achievement in Chemistry of students studying in Private schools is 19.80 which is significantly higher than those of Government schools and Grant-in-aid schools whose mean score of Achievement Chemistry are 18.37 and 16.91 respectively. It may, therefore, be said that Private schools students were found to have significantly better Achievement in Chemistry as compared to Government schools students and Grant-in-aid schools students.

4.3.4 Effect of Interaction of Gender and Medium of Instruction on Mean Achievement Scores in Chemistry of Students

From Table 4.8, it can be seen that the F-value is 4.89 which is significant at 0.01 level with df=(1,2435). It indicates that there was a significant difference between the mean scores of Achievement in Chemistry of Male and Female students taught through English medium and Gujarati medium. Thus, the null hypothesis – **"$H_0$9: There will be no significant interaction between mean achievement scores in Chemistry of class IX students with respect to gender and medium of instruction" is rejected.** This indicates that the mean scores of Achievement in Chemistry of Male and Female students taught through English medium differed significantly from those taught through Gujarati medium. From table 4.10, it can be seen that both Male and Female students of English medium were found to have higher mean Achievement scores in Chemistry than Male and Female students of Gujarati medium. Further, Female students of English medium had higher mean Achievement scores in Chemistry than Male students of English medium.

Table 4.10: Gender-wise and Medium of Instruction-wise mean scores of Achievement in Chemistry

	M (English Medium)	**M (Gujarati Medium)**
Male	19.55	17.86
Female	20.76	17.61

4.3.5 Effect of Interaction of Gender and Type of School on Mean Achievement Scores in Chemistry of Students

From Table 4.8, it can be seen that the F-value is 56.89 which is significant at 0.01 level with df=(2,2435). It indicates that there was a significant difference between the mean scores of Achievement in Chemistry of Male and Female students studying in Government schools, Grant-in-aid schools and Private schools. Thus, the null hypothesis – **"$H_0$10: There will be no significant interaction between mean achievement scores in Chemistry of class IX students with respect to gender and types of schools" is rejected**. This indicates that the mean scores of Achievement in Chemistry of Male and Female students studying in Government schools differed

significantly from those studying in Grant-in-aid schools and Private schools. From table 4.11, it can be seen that Male students of Government schools were superior in Chemistry to those of Grant-in-aid schools and Private schools with mean value 21.03 whereas Female students of Private schools were superior in Chemistry to those of Grant-in-aid schools and Private schools with mean value 21.14. Further, Male students of Grant-in-aid schools and Female students of Government schools were found to be inferior in Chemistry.

Table 4.11: Gender-wise and Type of School-wise mean scores of Achievement in Chemistry

	M (Government schools)	**M (Grant-in-aid schools)**	**M (Private schools)**
Male	21.03	16.05	19.09
Female	16.68	17.76	21.14

4.4 EFFECT OF MEDIUM OF INSTRUCTION, GENDER, TYPE OF SCHOOL AND THEIR INTERACTIONS ON ACHIEVEMENT IN PHYSICS OF CLASS IX STUDENTS

There were two levels of Gender – Male and Female, two levels of Medium of Instruction – English and Gujarati and three levels of Type of School – Government, Grant-in-aid and Private schools. Thus, the data were analyzed with the help of 2X2X3 Factorial design ANOVA.

Table 4.12: Levene's Test for Equality of Variances

Levene Statistics (F)	**df1**	**df2**	**Sig.**
78.33	7	2435	.000

From table 4.12, it can be seen that the F value is 78.33 with df= (7,2435) at significance level 0.000 which indicated $p<0.05$. Hence, the assumption of homogeneity of variances has been realized. Further, the results of 2X2X3 Factorial design ANOVA are given in table 4.13:

Table 4.13: Summary of 2X2X3 Factorial Design ANOVA of Achievement in Physics of Students

Source of Variance	df	SS	MSS	F-Value	Remarks
Gender (A)	1	1.44	1.44	0.33	ns
Medium of Instruction (B)	1	491.13	491.13	11.09	p<0.01
Type of School (C)	2	3969.54	1984.77	44.81	p<0.01
A X B	1	563.50	563.50	12.72	p<0.01
A X C	2	6407.04	3203.52	72.33	p<0.01
Error	2435	107850.71	44.29		
Total	2443	911375.00			

4.4.1.Gender-wise Comparison of Mean Achievement Scores in Physics of Students

From Table 4.13, it can be seen that the F-value is 0.33 which is not significant at 0.01 level. It indicated that the mean scores of achievement in Physics of Male and Female students did not differ significantly. Thus the null hypothesis –**"$H_0$11: There will be no significant difference in the mean achievement scores in Physics of class IX students with respect to gender" is not rejected.**

4.4.2 Medium of Instruction-wise Comparison of Mean Achievement Scores in Physics of Students

From Table 4.13, it can be seen that the F-value is 11.09 which is t significant at 0.01 level with df=(1,2435). It indicated that the mean scores of achievement in Physics of English and Gujarati medium students differed significantly. Thus the null hypothesis –**"$H_0$12: There will be no significant difference in the mean achievement scores in Physics of class IX students with respect to medium of instruction" is rejected.** Further, the mean score of Achievement in Physics of English medium students is 18.41 which is significantly higher than those of Gujarati medium students whose mean score of Achievement Physics is 17.19 (Vide Table 4.14). It may, therefore, be said that English medium students were found to have significantly better Achievement in Physics as compared to Gujarati medium students.

Table 4.14: Medium of Instruction-wise Mean Achievement Scores in Physics

Medium of Instruction	M
English	18.41
Gujarati	17.19

4.4.3 Type of school-wise Comparison of Mean Achievement Scores in Physics of Students

From Table 4.13, it can be seen that the F-value is 44.81 which is significant at 0.01 level with df=2. It indicated that the mean scores of achievement in Physics of students studying in Government schools, Grant-in-aid schools and Private schools differed significantly. Thus the null hypothesis – **"$H_0$13: There will be no significant difference in the mean achievement scores in Physics of class IX students with respect to types of schools" is rejected.** In order to know which group's Achievement in Physics was significantly higher than others, the data were further analyzed with the help of Duncan's Multiple Range test and the results are given in Table 4.15.

Table 4.15: Duncan's Multiple Range Test for Physics

Type of schools	M	N	Grant-in-aid school	Private school
Government schools	17.86	695	5.36**	2.13**
Grant-in-aid schools	16.21	1043		8.20**
Private schools	18.77	705		

** Significant at 0.01 level

From Table 4.15, it can be seen that the mean score of Achievement in Physics of students studying in Private schools is 18.77 which is significantly higher than those of Government schools and Grant-in-aid schools whose mean score of Achievement in Physics are 17.86 and 16.21 respectively. It may, therefore, be said that Private schools students were found to have significantly better Achievement in Physics as compared to Government schools students and Grant-in-aid schools students.

4.4.4 Effect of Interaction of Gender and Medium of Instruction on Mean Achievement Scores in Physics of Students

From Table 4.13, it can be seen that the F-value is 12.72 which is significant at 0.01 level with df=(1,2435). It indicates that there was a significant difference between the mean scores of Achievement in Physics of Male and Female students taught through English medium and Gujarati medium. Thus, the null hypothesis – **"$H_0$14: There will be no significant interaction between mean achievement scores in Physics of class IX students with respect to gender and medium of instruction" is rejected.** This indicates that the mean scores of Achievement in Physics of Male and Female students taught through English medium differed significantly from those taught through Gujarati medium. From table 4.16, it can be seen that both Male and Female students of English medium were found to have higher mean Achievement scores in Physics than Male and Female students of Gujarati medium. Further, Female students of English medium had higher mean Achievement scores in Physics than Male students of English medium.

Table 4.16: Gender-wise and Medium of Instruction-wise mean scores of Achievement in Physics

	M (English Medium)	**M (Gujarati Medium)**
Male	18.14	17.16
Female	18.87	17.22

4.4.5 Effect of Interaction of Gender and Type of School on Mean Achievement Scores in Physics of Students

From Table 4.13, it can be seen that the F-value is 72.33 which is significant at 0.01 level with df=(2,2435). It indicates that there was a significant difference between the mean scores of Achievement in Physics of Male and Female students studying in Government schools, Grant-in-aid schools and Private schools. Thus, the null hypothesis – **"$H_0$15: There will be no significant interaction between mean achievement scores in Physics of class IX students with respect to gender and types of schools" is rejected.** This indicates that the mean scores of Achievement in Physics of Male and Female students studying in Government schools differed significantly from those studying in Grant-in-aid schools and Private schools. From table 4.17, it can be seen that

Male students of Government schools were superior in Physics to those of Grant-in-aid schools and Private schools with mean value 20.76 whereas Female students of Private schools were superior in Physics to those of Grant-in-aid schools and Private schools with mean value 20.06. Further, Male students of Grant-in-aid schools and Female students of Government schools were found to be inferior in Physics.

Table 4.17: Gender-wise and Type of School-wise mean scores of Achievement in Physics

	M (Government schools)	**M (Grant-in-aid schools)**	**M (Private schools)**
Male	20.76	15.00	18.09
Female	16.00	17.41	20.06

4.5 EFFECT OF MEDIUM OF INSTRUCTION, GENDER, TYPE OF SCHOOL AND THEIR INTERACTIONS ON ACHIEVEMENT IN BIOLOGY OF CLASS IX STUDENTS

There were two levels of Gender – Male and Female, two levels of Medium of Instruction – English and Gujarati and three levels of Type of School – Government, Grant-in-aid and Private schools. Thus, the data were analyzed with the help of 2X2X3 Factorial design ANOVA.

Table 4.18: Levene's Test for Equality of Variances

Levene Statistics (F)	**df1**	**df2**	**Sig.**
84.74	7	2435	.000

From table 4.18, it can be seen that the F value is 84.74 with df= (7,2435) at significance level 0.000 which indicated $p<0.05$. Hence, the assumption of homogeneity of variances has been realized. Further, the results of 2X2X3 Factorial design ANOVA are given in table 4.19:

Table 4.19: Effect of Gender, Medium of Instruction, Type of School and Their Interactions on Scores in Biology of CATS

Source of Variance	df	SS	MSS	F-Value	Remarks
Gender (A)	1	71.59	71.59	1.75	ns
Medium of Instruction (B)	1	823.457	823.457	20.09	p<0.01
Type of School (C)	2	3149.07	1574.53	38.40	p<0.01
A X B	1	106.76	106.76	2.60	p<0.01
A X C	2	6155.09	3077.55	75.07	p<0.01
Error	2435	99830.05	41.00		
Total	2443	759749.00			

4.5.1.Gender-wise Comparison of Mean Achievement Scores in Biology of Students

From Table 4.19, it can be seen that the F-value is 1.75 which is not significant at 0.01 level. It indicated that the mean scores of achievement in Biology of Male and Female students did not differ significantly. Thus the null hypothesis –**"$H_0$16: There will be no significant difference in the mean achievement scores in Biology of class IX students with respect to gender" is not rejected**.

4.5.2 Medium of Instruction-wise Comparison of Mean Achievement Scores in Biology of Students

From Table 4.19, it can be seen that the F-value is 20.09 which is significant at 0.01 level with df=(1,2435). It indicated that the mean scores of achievement in Biology of English and Gujarati medium students differed significantly. Thus the null hypothesis –**"$H_0$17: There will be no significant difference in the mean achievement scores in Biology of class IX students with respect to medium of instruction" is rejected.** Further, the mean score of Achievement in Biology of Gujarati medium students is 16.42 which is significantly higher than those of English medium students whose mean score of Achievement Biology is 15.93 (Vide Table 4.20). It may, therefore, be said that Gujarati medium students were found to have significantly better Achievement in Biology as compared to English medium students.

Table 4.20: Medium of Instruction-wise Mean Achievement Scores in Biology

Medium of Instruction	M
English	15.93
Gujarati	16.42

4.5.3 Type of school-wise Comparison of Mean Achievement Scores in Biology of Students

From Table 4.19, it can be seen that the F-value is 38.40 which is significant at 0.01 level with df=2. It indicated that the mean scores of achievement in Biology of students studying in Government schools, Grant-in-aid schools and Private schools differed significantly. Thus the null hypothesis – **"$H_0$18: There will be no significant difference in the mean achievement scores in Biology of class IX students with respect to types of schools" is rejected**. In order to know which group's Achievement in Biology was significantly higher than others, the data were further analyzed with the help of Duncan's Multiple Range test and the results are given in Table 4.21.

Table 4.21: Duncan's Multiple Range Test for Biology

Type of schools	M	N	Grant-in-aid school	Private school
Government schools	17.29	695	5.88**	1.55**
Grant-in-aid schools	15.48	1043		4.07**
Private schools	16.64	705		

** Significant at 0.01 level

From Table 4.21, it can be seen that the mean score of Achievement in Biology of students studying in Government schools is 17.29 which is significantly higher than those of Grant-in-aid schools and Private schools whose mean score of Achievement in Biology were 15.48 and 16.64 respectively. It may, therefore, be said that Government schools students were found to have significantly better Achievement in Biology as compared to Grant-in-aid schools and Private schools students.

4.5.4 Effect of Interaction of Gender and Medium of Instruction on Mean Achievement Scores in Biology of Students

From Table 4.19, it can be seen that the F-value is 2.60 which is significant at 0.01 level with df=(1,2435). It indicates that there was a significant difference between the mean scores of Achievement in Biology of Male and Female students taught through English medium and Gujarati medium. Thus, the null hypothesis – **"$H_0$19: There will be no significant interaction between mean achievement scores in Biology of class IX students with respect to gender and medium of instruction" is rejected.** This indicates that the mean scores of Achievement in Biology of Male and Female students taught through English medium differed significantly from those taught through Gujarati medium. From table 4.22, it can be seen that both Male students of Gujarati medium were found to have higher mean Achievement scores in Biology than Male students of English medium. Further, Female students of English medium had higher mean Achievement scores in Biology than Female students of Gujarati medium.

Table 4.22: Gender-wise and Medium of Instruction-wise mean scores of Achievement in Biology

	M (English Medium)	**M (Gujarati Medium)**
Male	15.61	16.68
Female	16.48	16.17

4.5.5 Effect of Interaction of Gender and Type of School on Mean Achievement Scores in Biology of Students

From Table 4.19, it can be seen that the F-value is 75.07 which is significant at 0.01 level with df=(2,2435). It indicates that there was a significant difference between the mean scores of Achievement in Biology of Male and Female students studying in Government schools, Grant-in-aid schools and Private schools. Thus, the null hypothesis – **"$H_0$20: There will be no significant interaction between mean achievement scores in Biology of class IX students with respect to gender and types of schools" is rejected.** This indicates that the mean scores of Achievement in Biology of Male and Female students studying in Government schools differed significantly from those studying in Grant-in-aid schools and Private schools. From table 4.23, it can be seen that

Male students of Government schools were superior in Biology to those of Grant-in-aid schools and Private schools with mean value 20.60 whereas Female students of Private schools were superior in Biology to those of Government and Grant-in-aid schools with mean value 19.77. Further, Male students of Grant-in-aid schools and Female students of Government schools were found to be inferior in Biology.

Table 4.23: Gender-wise and Type of School-wise mean scores of Achievement in Biology

	M (Government schools)	**M (Grant-in-aid schools)**	**M (Private schools)**
Male	20.60	14.48	16.19
Female	15.17	16.47	19.77

4.6 ACHIEVEMENT OF STUDENTS IN COGNITIVE ABILITY TEST FOR SCIENCE (CATS) WITH RESPECT TO LEVEL OF TEST ITEMS

Students mean Achievement score in CATS were analyzed for each level of Bloom taxonomy (1956) with respect to Gender, Medium of Instruction and Type of School. Analysis was done with the help of three way ANOVA since there were three discontinuous variables and one continuous variable. Interaction effects were not included in the analysis due to feasibility and complexity concerns. Table 4.24 shows students' Mean Achievement scores for each level. The mean values were obtained as a result of analysis done at 0.01 and 0.05 levels of significance. Detailed description along with SS, MSS, df and F -values for each level are presented in the succeeding tables.

Table 4.24: Mean Achievement scores of students for each level of CATS

		Remember	Understand	Apply	Analyze	Evaluate
Gender	**Male**	23.11	13.22	8.53	4.19	3.04
	Female	23.77	13.07	8.34	3.70	2.85
Medium of Instruction	**English**	24.65	13.87	8.96	3.82	3.04
	Gujarati	23.14	12.98	8.32	3.98	2.92
Type of School	**Government**	23.60	13.60	8.75	4.43	3.13
	Grant-in-aid	21.99	12.23	7.91	3.70	2.79
	Private	25.36	14.05	8.92	3.86	3.02

The following part of the chapter shows significance of differences based on ANOVA for each level.

4.6.1 Achievement of Students for Remember level of CATS

Table 4.25 presents the results of ANOVA of gender, medium of instruction and type of school and; Achievement of students for Remember level of CATS.

Table 4.25: Achievement of Students for Remember level

Source of Variance	df	SS	MSS	F-value	Remarks
Gender	1	247.06	247.06	3.68	ns
Medium of Instruction	1	1173.81	1173.81	17.49	$p<0.01$
Types of School	2	6382.63	3191.32	47.56	$p<0.01$

ns: not significant

From table 4.25 it can be seen that the F-value for gender is 3.68 which is not significant. It indicated that the mean scores of achievement for Remember level of CATS of Male and Female students did not differ significantly. Thus the null hypothesis –**"$H_0$21: There will be no significant difference in the mean achievement scores for Remember level of CATS of class IX students with respect to gender" is not rejected.**

From table 4.25 it can be seen that the F-value for medium of instruction is 17.49 significant at 0.01 level with df=1. It indicated that the mean scores of achievement for Remember level of

CATS of English and Gujarati students differed significantly. Thus the null hypothesis –**"$H_0$22: There will be no significant difference in the mean achievement scores for Remember level of CATS of class IX students with respect to medium of instruction" is rejected.** Further, the mean achievement score of English medium school students was 24.65 which is significantly higher than Gujarati medium school students (Vide Table 4.24).

From table 4.25 it can be seen that the F-value for type of school is 47.56 significant at 0.01 level with df=2. It indicated that the mean scores of achievement for Remember level of CATS of Government, Grant-in-aid and Private school students differed significantly. Thus the null hypothesis –**"$H_0$23: There will be no significant difference in the mean achievement scores for Remember level of CATS of class IX students with respect to type of school" is rejected**. Further, the mean achievement score of Private school students was 25.36 which is significantly higher than Government and Grant-in-aid school students (Vide Table 4.30). It may, therefore, be said that Private school students were superior at Remember level of CATS than Government and Grant-in-aid school students.

4.6.2 Achievement of Students for Understand level of CATS

Table 4.26 presents the results of ANOVA of gender, medium of instruction and type of school and; Achievement of students for Understand level of CATS.

Table 4.26: Achievement of Students for Understand level

Source of Variance	df	SS	MSS	F-value	Remarks
Gender	1	0.807	0.807	0.33	ns
Medium of Instruction	1	101.75	101.75	4.20	$p<0.05$
Types of School	2	1956.96	978.48	40.37	$p<0.01$

ns: not significant

From table 4.26 it can be seen that the F-value for gender is 0.33 which is not significant. It indicated that the mean scores of achievement for Understand level of CATS of Male and Female students did not differ significantly. Thus the null hypothesis –**"$H_0$24: There will be no**

significant difference in the mean achievement scores for Understand level of CATS of class IX students with respect to gender" is not rejected.

From table 4.26 it can be seen that the F-value for medium of instruction is 4.20 which not significant at 0.01 level but significant at 0.05 level with df=1. It indicated that the mean scores of achievement for Understand level of CATS of English and Gujarati students differed significantly. Thus the null hypothesis –**"$H_0$25: There will be no significant difference in the mean achievement scores for Understand level of CATS of class IX students with respect to medium of instruction" is rejected**. Further, the mean achievement score of English medium school students was 13.87 which is significantly higher than Gujarati medium school students (Vide Table 4.24). It may, therefore, be said that English medium students were significantly better at Understand level of CATS than Gujarati medium students.

From table 4.26 it can be seen that the F-value for type of school is 40.37 significant at 0.01 level with df=2. It indicated that the mean scores of achievement for Understand level of CATS of Government, Grant-in-aid and Private school students differed significantly. Thus the null hypothesis –**"$H_0$26: There will be no significant difference in the mean achievement scores for Understand level of CATS of class IX students with respect to type of school" is rejected.** Further, the mean achievement score of Private school students was 14.05 which is significantly higher than Grant-in-aid and Private school students (Vide Table 4.30). It may, therefore, be said that Private school students were superior at Understand level of CATS than Government and Grant-in-aid school students.

4.6.3 Achievement of Students for Apply level of CATS

Table 4.27 presents the results of ANOVA of gender, medium of instruction and type of school and; Achievement of students for Apply level of CATS.

Table 4.27: Achievement of Students for Apply level

Source of Variance	df	SS	MSS	F-value	Remarks
Gender	1	14.25	14.25	1.24	ns
Medium of Instruction	1	16.12	16.12	1.40	ns
Types of School	2	726.69	363.34	31.59	p<0.01

ns: not significant

From table 4.27 it can be seen that the F-value for gender is 1.24 which is not significant. It indicated that the mean scores of achievement for Apply level of CATS of Male and Female students did not differ significantly. Thus the null hypothesis –**"$H_0$27: There will be no significant difference in the mean achievement scores for Apply level of CATS of class IX students with respect to gender" is not rejected.**

From table 4.27 it can be seen that the F-value for medium of instruction is 1.40 which not significant. It indicated that the mean scores of achievement for Apply level of CATS of English and Gujarati students did not differ significantly. Thus the null hypothesis –**"$H_0$28: There will be no significant difference in the mean achievement scores for Apply level of CATS of class IX students with respect to medium of instruction" is not rejected.**

From table 4.27 it can be seen that the F-value for type of school is 31.59 significant at 0.01 level with df=2. It indicated that the mean scores of achievement for Apply level of CATS of Government, Grant-in-aid and Private school students differed significantly. Thus the null hypothesis –**"$H_0$29: There will be no significant difference in the mean achievement scores for Apply level of CATS of class IX students with respect to type of school" is rejected.** Further, the mean achievement score of Private school students was 8.92 which is significantly higher than Grant-in-aid and Private school students (Vide Table 4.30). It may, therefore, be said that Private school students were superior at Apply level of CATS than Government and Grant-in-aid school students.

4.6.4 Achievement of Students for Analyze level of CATS

Table 4.28 presents the results of ANOVA of gender, medium of instruction and type of school and; Achievement of students for Analyze level of CATS.

Table 4.28: Achievement of Students for Analyze level

Source of Variance	df	SS	MSS	F-value	Remarks
Gender	1	155.96	155.96	35.66	p<0.01
Medium of Instruction	1	1.52	1.52	0.35	ns
Types of School	2	367.68	183.84	42.04	p<0.01

ns: not significant

From table 4.28 it can be seen that the F-value for gender is 35.66 significant at 0.01 level with df=1. It indicated that the mean scores of achievement for Analyze level of CATS of Male and Female students differed significantly. Thus the null hypothesis –**"$H_0$30: There will be no significant difference in the mean achievement scores for Analyze level of CATS of class IX students with respect to gender" is rejected.** Further, the mean achievement score of Males was 4.19 which is significantly higher than Females (Vide Table 4.24). It may, therefore, be said that Male students were significantly better at Analyze level of CATS than Female students.

From table 4.28 it can be seen that the F-value for medium of instruction is 0.35 which not significant. It indicated that the mean scores of achievement for Analyze level of CATS of English and Gujarati students did not differ significantly. Thus the null hypothesis –**"$H_0$31: There will be no significant difference in the mean achievement scores for Analyze level of CATS of class IX students with respect to medium of instruction" is not rejected.**

From table 4.28 it can be seen that the F-value for type of school is 42.04 significant at 0.01 level with df=2. It indicated that the mean scores of achievement for Analyze level of CATS of Government, Grant-in-aid and Private school students differed significantly. Thus the null hypothesis –**"$H_0$32:There will be no significant difference in the mean achievement scores for Analyze level of CATS of class IX students with respect to type of school" is rejected.** Further,

the mean achievement score of Government school students was 4.43 which is significantly higher than Grant-in-aid and Private school students (Vide Table 4.30). It may, therefore, be said that Government school students were superior at Analyze level of CATS than Grant-in-aid and Private school students.

4.6.5 Achievement of Students for Evaluate level of CATS

Table 4.29 presents the results of ANOVA of gender, medium of instruction and type of school and; Achievement of students for Evaluate level of CATS.

Table 4.29: Achievement of Students for Evaluate level

Source of Variance	df	SS	MSS	F-value	Remarks
Gender	1	21.31	21.31	7.89	p<0.01
Medium of Instruction	1	0.721	0.721	0.27	ns
Types of School	2	107.28	53.64	19.85	p<0.01

ns: not significant

From table 4.29 it can be seen that the F-value for gender is 7.89 significant at 0.01 level with df=1. It indicated that the mean scores of achievement for Evaluate level of CATS of Male and Female students differed significantly. Thus the null hypothesis –**"$H_0$33: There will be no significant difference in the mean achievement scores for Evaluate level of CATS of class IX students with respect to gender" is rejected.** Further, the mean achievement score of Males was 3.04 which is significantly higher than Females (Vide Table 4.24). It may, therefore, be said that Male students were significantly better at Evaluate level of CATS than Female students.

From table 4.29 it can be seen that the F-value for medium of instruction is 0.27 which not significant. It indicated that the mean scores of achievement for Evaluate level of CATS of English and Gujarati students did not differ significantly. Thus the null hypothesis –**"$H_0$34: There will be no significant difference in the mean achievement scores for Evaluate level of CATS of class IX students with respect to medium of instruction" is not rejected.**

From table 4.29 it can be seen that the F-value for type of school is 19.85 significant at 0.01 level with df=2. It indicated that the mean scores of achievement for Evaluate level of CATS of Government, Grant-in-aid and Private school students differed significantly. Thus the null hypothesis –**"$H_0$35: There will be no significant difference in the mean achievement scores for Evaluate level of CATS of class IX students with respect to type of school" is rejected**. Further, the mean achievement score of Government school students was 3.13 which is significantly higher than Grant-in-aid and Private school students (Vide Table 4.30). It may, therefore, be said that Government school students were superior at Evaluate level of CATS than Grant-in-aid and Private school students.

Following table 4.30 presents Type of school-wise Significance of Differences for each level of CATS:

Table 4.30 Summary of Type of school-wise Significance of Differences

Level	Type of School	M	N	Grant-in-aid	Private
Remember	Government	23.60	695	1.6*	1.76*
	Grant-in-aid	22.00	1043		3.36*
	Private	25.36	705		
Understand	Government	13.60	695	1.37*	0.45*
	Grant-in-aid	12.23	1043		1.82*
	Private	14.05	705		
Apply	Government	8.75	695	0.84*	0.17*
	Grant-in-aid	7.91	1043		1.01*
	Private	8.92	705		
Analyze	Government	4.43	695	0.74*	0.57*
	Grant-in-aid	3.69	1043		0.17*
	Private	3.86	705		
Evaluate	Government	3.13	695	0.36*	0.11*
	Grant-in-aid	2.77	1043		0.25*
	Private	3.02	705		

*Significant at 0.01 level

Following Table 4.31 presents summary of significance of differences for each level of CATS.

Table 4.31 Summary of Significance of Differences for each level of CATS

	Remember	Understand	Apply	Analyze	Evaluate
Gender	ns	ns	ns	sig.	sig.
Medium of Instruction	sig.	sig.	ns	ns	ns
Type of School	sig.	sig.	sig.	sig.	sig.

It can be concluded from the above table that as the complexity of the level of test items increases, the difference between gender wise performance becomes significant whereas medium of school wise difference becomes insignificant. The type of school wise performance of students remains unchanged across all the levels.

4.7 CORRELATION BETWEEN ACHIEVEMENT SCORES IN COGNITIVE ABILITY TEST FOR SCIENCE (CATS) AND ACADEMIC ACHIEVEMENT IN SCIENCE OF STUDENTS

The correlation between achievement scores in CATS and academic achievement in science was studies with the help of Product-moment correlation. For fifth objective, the sample size was 2285 students and the results are given in tables 4.32 to 4.39:

Table 4.32: Correlation coefficient between students Achievement in CATS and Academic Achievement in Science

	r	Remarks
Achievement in CATS	0.31	p<0.01
Academic Achievement in Science		

From Table 4.32, it can be seen that the correlation coefficient is 0.31 which is significant at 0.01 level with df=2283. It indicates that there is a positive significant correlation between achievement scores in CATS and academic achievement in science of students. Thus, the null hypothesis – **"$H_0$36: There will be no significant correlation between achievement scores in CATS and academic achievement in science of class IX students" is rejected.** Further, the percentage of commonness between achievement scores in CATS and academic achievement in science is 9.61 which is positive. It may, therefore, be said that both achievement scores in CATS and academic achievement in science of students were found to have positive correlation.

Table 4.33: Correlation coefficient between Achievement in CATS and Academic Achievement in Science of Male Students

	r	Remarks
Achievement in CATS	0.24	p<0.01
Academic Achievement in Science		

From Table 4.33, it can be seen that the correlation coefficient is 0.24 which is significant at 0.01 level with df=1140. It indicates that there is a positive significant correlation between achievement scores in CATS and academic achievement in science of Male students. Thus, the null hypothesis – **"$H_0$37: There will be no significant correlation between achievement scores in CATS and academic achievement in science of class IX Male students" is rejected.** Further, the percentage of commonness between achievement scores in CATS and academic achievement in science is 5.76 which is positive. It may, therefore, be said that both achievement scores in CATS and academic achievement in science of Male students were found to have positive correlation.

Table 4.34: Correlation coefficient between Achievement in CATS and Academic Achievement in Science of Female Students

	r	Remarks
Achievement in CATS	0.44	p<0.01
Academic Achievement in Science		

From Table 4.34, it can be seen that the correlation coefficient is 0.44 which is significant at 0.01 level with df=1141. It indicates that there is a positive significant correlation between achievement scores in CATS and academic achievement in science of Female students. Thus, the null hypothesis – **"$H_0$38: There will be no significant correlation between achievement scores in CATS and academic achievement in science of class IX Female students" is rejected**. Further, the percentage of commonness between achievement scores in CATS and academic achievement in science is 19.36 which is positive. It may, therefore, be said that both achievement scores in CATS and academic achievement in science of Female students were found to have positive correlation.

Table 4.35: Correlation coefficient between Achievement in CATS and Academic Achievement in Science of Students of English medium schools

	r	Remarks
Achievement in CATS	0.25	p<0.01
Academic Achievement in Science		

From Table 4.35, it can be seen that the correlation coefficient is 0.25 which is significant at 0.01 level with df=437. It indicates that there is a positive significant correlation between achievement scores in CATS and academic achievement in science of English medium students. Thus, the null hypothesis – **"$H_0$39: There will be no significant correlation between achievement scores in CATS and academic achievement in science of class IX English medium students" is rejected.** Further, the percentage of commonness between achievement scores in CATS and academic achievement in science is 6.25 which is positive. It may, therefore, be said that both achievement scores in CATS and academic achievement in science of English medium students were found to have positive correlation.

Table 4.36: Correlation coefficient between Achievement in CATS and Academic Achievement in Science of Students of Gujarati medium schools

	r	Remarks
Achievement in CATS	0.33	p<0.01
Academic Achievement in Science		

From Table 4.36, it can be seen that the correlation coefficient is 0.33 which is significant at 0.01 level with df=1844. It indicates that there is a positive significant correlation between achievement scores in CATS and academic achievement in science of Gujarati medium students. Thus, the null hypothesis – **"$H_0$40: There will be no significant correlation between achievement scores in CATS and academic achievement in science of class IX Gujarati medium students" is rejected**. Further, the percentage of commonness between achievement scores in CATS and academic achievement in science is 10.89 which is positive. It may, therefore, be said that both

achievement scores in CATS and academic achievement in science of Gujarati medium students were found to have positive correlation.

Table 4.37: Correlation coefficient between Achievement in CATS and Academic Achievement in Science of Students of Government schools

	r	Remarks
Achievement in CATS	0.12	p<0.01
Academic Achievement in Science		

From Table 4.37, it can be seen that the correlation coefficient is 0.12 which is significant at 0.01 level with df=631. It indicates that there is a positive significant correlation between achievement scores in CATS and academic achievement in science of students of Government schools. Thus, the null hypothesis – **"$H_0$41: There will be no significant correlation between achievement scores in CATS and academic achievement in science of class IX students of Government schools" is rejected.** Further, the percentage of commonness between achievement scores in CATS and academic achievement in science is 1.44 which is positive. It may, therefore, be said that both achievement scores in CATS and academic achievement in science of students of Government schools were found to have positive correlation.

Table 4.38: Correlation coefficient between Achievement in CATS and Academic Achievement in Science of Students of Grant-in-aid schools

	r	Remarks
Achievement in CATS	0.47	p<0.01
Academic Achievement in Science		

From Table 4.38, it can be seen that the correlation coefficient is 0.47 which is significant at 0.01 level with df=1000. It indicates that there is a positive significant correlation between achievement scores in CATS and academic achievement in science of students of Grant-in-aid schools. Thus, the null hypothesis – **"$H_0$42: There will be no significant correlation between achievement scores in CATS and academic achievement in science of class IX students of Grant-in-aid**

schools" is rejected. Further, the percentage of commonness between achievement scores in CATS and academic achievement in science is 22.09 which is positive. It may, therefore, be said that both achievement scores in CATS and academic achievement in science of students of Grant-in-aid schools were found to have positive correlation.

Table 4.39: Correlation coefficient between Achievement in CATS and Academic Achievement in Science of Students of Private schools

	r	Remarks
Achievement in CATS	0.32	p<0.01
Academic Achievement in Science		

From Table 4.39, it can be seen that the correlation coefficient is 0.32 which is significant at 0.01 level with df=648. It indicates that there is a positive significant correlation between achievement scores in CATS and academic achievement in science of students of Private schools. Thus, the null hypothesis – "**$H_0$43: There will be no significant correlation between achievement scores in CATS and academic achievement in science of class IX students of Private schools" is rejected.** Further, the percentage of commonness between achievement scores in CATS and academic achievement in science is 10.24 which is positive. It may, therefore, be said that both achievement scores in CATS and academic achievement in science of students of Private schools were found to have positive correlation.

Table 4.40: Values of Correlation coefficient between Achievement in CATS and Academic Achievement in Science of Students

	r	Remarks
Overall	0.31	p<0.01
Males	0.24	p<0.01
Females	0.44	p<0.01
English medium	0.25	p<0.01
Gujarati medium	0.33	p<0.01
Government	0.12	p<0.01

Grant-in-aid	0.47	p<0.01
Private	0.32	p<0.01

Table 4.40 comprehensively presents the correlation values with respect to different variables. It can be concluded that correlation between achievement scores in CATS and academic achievement in science of students with respect all the variable were found to be significantly positive.

4.8 CREATIVITY OF STUDENTS

The creativity of students was studied by Creativity Test for Science (CTS) which included three open ended questions each form Chemistry, Physics and Biology concepts. The data collected with CTS were analyzed through content analyzing students' responses. The analyzed content was presented in the form of description.

The question asked to study students' creativity in Chemistry was – Following is the set of elements and their atomic numbers. Frame as many compounds as possible by combining two or more of them. You can also make compounds of compounds.

H = 1, Be = 4, O = 8, Na = 11, Mg = 12, S = 16, Cl = 17.

The question asked to study students' creativity in Physics was –Design a compound machine using minimum four simple machines. Give it a name of your choice and also describe the purpose for which it can be used.

The question asked to study students' creativity in Biology was –Suppose 98 % of earth surface is covered with sea water and there does not exist any process called water cycle. What will be the consequences of it on the atmosphere and human life? write your answer in 10 sentences.

Following table 8 shows the frequency and percentage of students who attempted the questions of CTS:

Table 4.41: Frequency and Percentage of Respondents to CTS

	Chemistry	Physics	Biology	Total
English medium (458)	107 (23.36%)	59 (12.88%)	83 (18.12%)	249 (54.37%)
Gujarati medium (1985)	434 (21.86%)	267 (13.29%)	424 (21.36%)	1125 (56.67%)
Total (2443)	541 (22.14%)	326 (13.34%)	507 (20.75%)	1374 (56.24%)

From table 4.41, it is seen that almost equal percentage of both Gujarati and English medium students attempted the CTS. A prominent point to be noted that the lowest number of students of both English as well as Gujarati medium attempted question of Physics in CTS. Additionally, higher number of students attempted question of Chemistry and Biology. This indicates students' inclination towards written responses as the question of Physics required students response by drawing. The description of students responses to each question of CTS is presented in following part.

4.8.1 Creativity of Students in Chemistry

Students' responses to the question of Chemistry in CTS were analysed and are described below: Out of 541 students who attempted question of Chemistry, 283 students did not form any compound from the given elements in the question. Instead, they wrote the symbols of the elements given in the question or other than those. This indicates the students either did not understand the question or did not know how to form compounds. 147 students did form the compounds but those compounds were chemically incorrect such as HO, MgO, HCl_2. It implies that they are aware about the basics of elements and compounds but they lack conceptual understanding of valency and compound formation. This reveals their particle knowledge of compounds as they do know that compounds are formed by two or more elements but they lack understanding of valency. Though they attempted to apply the principles of compound formation, the output of their attempts did not yield correct compounds. As a result, they ended giving incorrect response. 111 students formed chemically correct compounds such as H_2O, HCl, NaCl. However, these compounds are frequently

mentioned in the textbooks. An important point to be noted here is that some of the students showed calculations of the atomic numbers while some drew diagrams of compounds, though it was not asked in the question. Those calculations and diagrams were chemically incorrect. Thus, it can be said that students revealed their bookish knowledge. This implies that students demonstrated 'Remember' level knowledge even for 'Create' level question. None of the students wrote about any such compound which is not given in the textbooks.

4.8.2 Creativity of Students in Physics

Students' responses to the question of Physics in CTS were analysed and are described below:
39 students drew the design of the fan as compound machine. There were 18 students who attempted to draw compound machine. However, they neither made use of four simple machines nor they showed appropriate connections among the simple machines. In other words, they drew diagrams of simple machines but not integrating them to make a compound machine out of them. In other words, their responses were incorrect responses. 269 students gave written responses to the question. 162 students wrote names of the machines such as washing machine, sewing machine, vacuum machine. 107 students wrote definition or brief explanation of simple machine and compound machine. It was observed that even for drawing type of required response, students preferred to provide written answer. This indicates that students had inclination towards written answers such as definitions, short notes, one line answers. This shows that for a 'Create' level question, students supplied 'Remember' or 'Understand' level answers.

4.8.3 Creativity of Students in Biology

Students' responses to the question of Biology in CTS were analysed and are described below:
None of the students wrote ten different sentences in their response. Students repeated the answer in order to complete the require limit of ten sentences. The most prominent response observed was "There will no life on Earth". This indicates that students thought of extreme consequences. They did not consider alternate ways or modes of life through adaptation or innovation by humans. Least number of students gave 'out of the box' kind of responses along with the above mentioned responses. To give an instance "humans will become mermaids", "transportation would take place by boats only", boat house will be the habitat of the humans", "humans will eat vegetables grown in sea water". There were also some responses given by students based on their imagination such

as “more and more water rides can be constructed”, “there is rain of fire in the absence of water cycle”, “ water animals will consume humans”. Though students gave multiple responses, the context of the question was missing in their responses. In other words, students’ responses were non-scientific responses in biology as the term scientific means something conducted in a logical and step by step manner but here students gave direct and imagination based responses which can be considered non-scientific responses.

To conclude, it can be inferred that creativity of students was poor as they provided lower level answers for questions asked in CTS.