CHAPTER 5

DATA ANALYSIS AND INTERPRETATION

CHAPTER 5

DATA ANALYSIS AND INTERPRETATION

5.0 INTRODUCTION

The present chapter attempts to convey the essential characteristics of the collected data by arranging the data into an interpretable form. The analysis and interpretation of the data is done objective wise pertaining to the respective hypothesis constructed. The analysis and interpretation of data from situational analysis in presented in chapter 4. The present chapter focuses on the analysis and interpretation of data from the implemented tools to study the effectiveness of the implemented intervention programme.

5.1 EFFECTIVENESS OF THE DEVELOPED INTERVENTION PROGRAMME

To study the effectiveness of the developed intervention programme three different tools were used. The data analysis for the objective number three was done and a detailed description of the analyzed and interpreted data is presented below in accordance to the tools of data collection.

5.1.1 Achievement of the students on the conceptual understanding of physics concepts

An entry level test constructed by the researcher and validated by the experts was administered on the experimental group and control group prior to the treatment. The tools for data collection were employed on the experimental group and control group after the implementation of the intervention programme on the experimental group.

To test the null hypothesis ' There will be no significant difference in the adjusted mean score of the control group and experimental group and experimental group when the scores of entry level test are considered as a covariate on the scores of achievement test', the statistical technique of ANCOVA was used. The entry level test scores were taken as a covariate to compute ANCOVA. According to Gay (2000), ANCOVA is a statistical technique used to equate groups on one or more variables. ANCOVA adjusts post test scores for initial differences on a variable and compares the adjusted scores; groups are equalized with respect to the control variable and then

compared. Secondly, ANCOVA also increases the power of a statistical test by reducing within group variance.

Before computing ANCOVA the basic assumptions underlying ANCOVA were tested. The assumptions that need to be supportive are

— The treatment group are selected randomly from the population

— Regression is linear and same from group to group

— The group are homogeneous in variability

The homogeneity of regression assumption was listed and then Levene's test was computed to verify the assumption of constant variance. The computed results are presented below.

Table 5.1
Test of Between Subject Effects

Source of Variance	Sum of Squares	df	Mean Square	F- value	p - value
Group	0.019	1	0.019	0.000	0.983
Entry test	2069.156	1	2069.156	50.190	0.000
Group* Entry test	84.565	1	84.565	2.051	0.156
Error	3050.731	74	41.226		
Total	34638.000	78			
Corrected Total	7159.846	77			

In the above table since the significance of group* entry test value which is 0.156 is greater than 0.05, the interaction is not significant and thus ANCOVA can be computed.

Table 5.2
Mean and Standard Deviation of achievement test

Group	Mean	SD	N
Control	13.95	7.299	40
Experimental	23.84	9.263	38
Total	18.77	9.643	78

Table 5.3
Levene's Test of Equality of Error Variances

F	df1	df2	p-value
0.150	1	76	0.700

From the above table it can be seen that since p>0.05, assumption of homogeneity of variance for ANCOVA has been met. Hence the basic assumptions were supportive and hence ANCOVA was computed. The output of the analyzed data is presented in the table below.

Table 5.4
ANCOVA Output

Source of Variance	Sum of Squares	df	Mean Square	F- value	p - value
Entry test	2117.656	1	2117.656	50.657	0.000
Group	1492.640	1	1492.640	35.706	<0.001
Error	3135.296	75	41.804		
Total	34638.00	78			
Corrected Total	7159.846	77			

From the table 5.4 it can be seen that F(1,75) equal to 35.706 , $p < 0.001$ and hence the null hypothesis is rejected. It implies that there was a significant difference in the adjusted mean score of the control group and the experimental group when the scores of entry level test was considered as a covariate on the scores of achievement test. The adjusted mean achievement scores suggest that experimental group performed better as compared to control group.

Table 5.5
The estimated marginal means of achievement test

Group	Mean	Standard Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Control	14.482	1.025	12.440	16.524
Experimental	23.282	1.052	21.187	25.377

The table 5.5 implies that the estimated marginal mean of the experimental group has a higher value than the control group. Adjusted mean scores of groups in achievement test suggest that the intervention has lead to a significant increase in the experimental group scores in comparison to the control group scores.

5.1.2 Interpretation of the physics concepts from the stories

To study the effectiveness of the intervention programme in terms of interpretation of physics concepts from the stories the techniques used were frequency, percentage,

contingency chi square and content analysis. The summarized table of the analysis is presented below in table no. 5.6

Table 5.6
Percentage of students' response on the interpretation of physics concepts from the stories

Question No.	Correct Response (%)		Incorrect Response (%)		Not Responded (%)	
	Experimental Group	Control Group	Experimental Group	Control Group	Experimental Group	Control Group
Story 1	**The Hare and the Tortoise**					
Q.1	100	55	-	37.5	-	7.5
Q.2	97.36	50	2.63	35	-	15
Q.3	92.10	80	7.89	5	-	15
Q.4	89.47	37.5	10.52	47.5	-	15
Q.5	78.94	42.5	21.05	40	-	17.5
Story 2	**The Thirsty Crow**					
Q.1	100	75	-	20	-	5
Q.2	92.10	40	7.89	55	-	5
Q.3	86.84	15	10.52	67.5	2.63	17.5
Q.4	86.84	50	2.63	20	10.52	30
Q.5	89.47	42.5	-	22.5	10.52	35
Story 3	**The Magical Lantern**					
Q.1	89.47	27.5	10.52	50	-	22.5
Q.2	86.84	25	10.52	52.5	2.63	22.5
Q.3	60.52	7.5	34.21	70	5.26	22.5
Q.4	55.26	5	39.47	70	5.26	25
Q.5	68.42	15	23.68	32.5	7.89	52.5
Story 4	**The Cricket Match**					
Q.1	97.36	40	2.63	47.5	-	12.5
Q.2	81.57	22.5	18.42	65	-	12.5
Q.3	78.94	22.5	21.05	57.5	-	20
Q.4	89.47	30	5.26	37.5	5.26	32.5
Q.5	84.21	35	7.89	20	7.89	45

It can be interpreted from the analysis that the experimental group students performed better than the control group on the interpretation of the physics concepts from the stories.

To test the hypothesis ' There will be no significant difference between the control group and experimental group on the interpretation of physics concepts from the stories' contingency chi square was employed on each question story wise . To get a better comprehensive picture question wise frequencies and χ^2 were calculated. Story wise detailed analysis and interpretation are presented below.

5.1.2.1 Interpretation of the physics concepts from the story: The Hare and the Tortoise

Question wise analysis of the response of the students on the story 'the hare and the tortoise' in terms of frequencies and χ^2 are presented below. The responses of students were also content analyzed.

Question 1: State the kind of motion exhibited by the tortoise?

Table 5.7: Analysis of responses of students on question-1(story 1)

Group	Correct Response	Incorrect Response	Not Responded	χ^2 and level of significance
Experimental Group	38	0	0	18.14
Control Group	22	15	3	0.01

The computed value of χ^2 18.14 is greater than the table value of χ^2 9.21 at 0.01 level against 2 degree of freedom. So the null hypothesis is rejected. It reveals that both the groups differ significantly in the interpretation of physics concepts on Question 1- story 1.

Hundred percent of the students of the experimental group responded that the motion of the tortoise to be uniform motion or uniform velocity. Fifty five percent of the students of the control group could correctly respond while thirty seven point five percent incorrectly responded to the question. Seven point five percent of the students

of the control group did not respond to the question. The incorrect responses given by students were

- *Uniformly accelerated motion*
- *Motion of rest*
- *Non uniform motion*
- *Inertia of motion*

Question 2: State the kind of motion exhibited by the hare?

Table 5.8: Analysis of responses of students on question-2 (story 1)

Group	Correct Response	Incorrect Response	Not Responded	χ^2 and level of significance
Experimental Group	**37**	**01**	**0**	**18.28**
Control Group	**20**	**14**	**06**	**0.01**

The computed value of χ^2 18.28 is greater than the table value of χ^2 9.21 at 0.01 level against 2 degree of freedom. So the null hypothesis is rejected. It reveals that both the groups differ significantly in the interpretation of physics concepts on Question 2-story 1.

Ninety seven point three six percent of the students of the experimental group and fifty percent of the students of the control group could respond correctly to the question. Two point six three percent of the students of experimental group and thirty five percent of the students of the control group responded incorrectly to the question. Fifteen percent of the students of the control group left the question un-attempted. Few of the students wrote:

- *Kinetic force*
- *Inertia of rest*
- *Uniformly accelerated motion*
- *Sleepy motion*

Question 3: Which are the points of zero velocity in the story?

Table 5.9: Analysis of responses of students on question-3 (story 1)

Group	Correct Response	Incorrect Response	Not Responded	χ^2 and level of significance
Experimental Group	35	03	0	4.14
Control Group	32	02	06	0.01

The computed value of χ^2 4.14 is less than the table value of χ^2 9.21 at 0.01 level against 2 degree of freedom. So the null hypothesis is not rejected. It reveals that both the groups did not differ significantly in the interpretation of physics concepts on Question 3- story 1.

Ninety two point one zero percent of the students of experimental group and eighty percent of the students of the control group responded correctly to the question. Seven point eight nine percent of the experimental group students and five percent of the control group students responded incorrectly to the question. Fifteen percent of the students of the control group did not respond to the question. Mostly all students irrespective of the group could respond correctly to the above question.

Question 4: Whose motion represents having velocity but zero acceleration? How can you say so?

Table 5.10: Analysis of responses of students on question-4 (story 1)

Group	Correct Response	Incorrect Response	Not Responded	χ^2 and level of significance
Experimental Group	34	04	0	19.32
Control Group	15	19	06	0.01

The computed value of χ^2 19.32 is greater than the table value of χ^2 9.21 at 0.01 level against 2 degree of freedom. So the null hypothesis is rejected. It reveals that both the

groups differ significantly in the interpretation of physics concepts on Question 4-story 1.

Eighty nine point four seven percent of the students of the control group and thirty seven point five percent of the students of the experimental group could respond correctly to the above question. Fifteen percent of the students of the control group did not respond to the question. Ten point five two percent of the students of the experimental group and forty seven point five percent of the students of the control group incorrectly responded to the question. The students who responded incorrect wrote – *'the motion of the hare as he ran and then fell asleep so he had velocity when he ran and when he slept zero acceleration'*.

It can be interpreted from the incorrect responses that majority of students of control group were not able to relate the concept of uniform velocity and zero acceleration.

Question 5: Justify whether displacement and distance are same or different in the story?

Table 5.11: Analysis of responses of students on question-5 (story 1)

Group	Correct Response	Incorrect Response	Not Responded	χ^2 and level of significance
Experimental Group	30	08	0	10.26
Control Group	17	16	07	0.01

The computed value of χ^2 10.26 is greater than the table value of χ^2 9.21 at 0.01 level against 2 degree of freedom. So the null hypothesis is rejected. It reveals that both the groups differ significantly in the interpretation of physics concepts on Question 5-story 1.

Seventy eight point nine four percent of the students of experimental group and forty two point five percent of the students of control group responded correctly to the question. Seventeen point five percent of the students of control group did not attempt the question. Twenty one point zero five percent of experimental group students and

forty percent of the control group students responded incorrectly to the question. Few of the students wrote:

- *Tortoise covers displacement as he goes in straight line whereas hare covers distance as hare stops in between to take rest.*
- *Its not an even surface so only distance can be covered*
- *Hare was fast so he covered distance and tortoise was slow so he covered displacement*
- *As hare rested both distance and displacement cannot be same*
- *Different as tortoise reached the point and hare was back*
- *No as displacement means speed and distance means area covered by tortoise.*
- *Displacement of rabbit is very fast than distance but tortoise has less displacement and more distance.*

Form the analysis it can be interpreted that both groups significantly differed in the interpretation of physics concepts from the story 'The Hare and the Tortoise' except for question no 3, where the significant difference was not observed. It can be concluded that except for question no 3, the experimental group students were better at interpreting the physics concepts from the story as compared to control group students.

5.1.2.2 Interpretation of the physics concepts from the story: The thirsty crow

Question wise analysis of the response of the students on the story 'the thirsty crow' in terms of frequencies and χ^2 are presented below. The responses of students were also content analyzed.

Question 1: Enlist the objects in the story that floated and sank in water separately.

Table 5.12: Analysis of responses of students on question-1(story 2)

Group	Correct Response	Incorrect Response	Not Responded	χ^2 and level of significance
Experimental Group	**38**	**0**	**0**	**7.35**
Control Group	**30**	**8**	**2**	**0.01**

The computed value of χ^2 7.35 is less than the table value of χ^2 9.21 at 0.01 level against 2 degree of freedom. So the null hypothesis is not rejected. It reveals that both the groups did not differ significantly in the interpretation of physics concepts on Question 1- story 2.

Hundred percent of the students of experimental group and seventy five percent of the students of control group answered the questions correctly. Twenty percent of control group students answered incorrectly while five percent of the control group students did not attempt the question.

Question 2: Why do the enlisted objects sink or float in water?

Table 5.13: Analysis of responses of students on question-2(story 2)

Group	Correct Response	Incorrect Response	Not Responded	χ^2 and level of significance
Experimental Group	**35**	**03**	**0**	**19.83**
Control Group	**16**	**22**	**02**	**0.01**

The computed value of χ^2 19.83 is greater than the table value of χ^2 9.21 at 0.01 level against 2 degree of freedom. So the null hypothesis is rejected. It reveals that both the groups differ significantly in the interpretation of physics concepts on Question 2- story 2.

Ninety two point one zero percent of the students of experimental group and forty percent of the students of the control group answered the questions correctly. Five percent of the students of the control group did not attempt the question. Seven point eight nine percent of the experimental group students and fifty five percent of the students of the control group answered the question incorrectly. Few of the students answered

- *Object is heavy than water then sink, if object is light than water then float*
- *They sink because of their heavy weight and they float because of their light mass*
- *If mass of object is less and weight is more then they sink*

- *Object sink due to high velocity and float due to low velocity*

It can be interpreted that the incorrect responses indicate that students were not able to use the proper scientific terminology wherever required. They used the terms of mass and weight interchangeably. Some of the students also related the concept of velocity and floatation. The performance of the experimental group students was better than the control group students.

Question 3: Which principle leads to rise in the level of water in the pot?

Table 5.14: Analysis of responses of students on question-3(story 2)

Group	Correct Response	Incorrect Response	Not Responded	χ^2 and level of significance
Experimental Group	**33**	**04**	**01**	**36.09**
Control Group	**06**	**27**	**07**	**0.01**

The computed value of χ^2 36.09 is greater than the table value of χ^2 9.21 at 0.01 level against 2 degree of freedom. So the null hypothesis is rejected. It reveals that both the groups differ significantly in the interpretation of physics concepts on Question 3- story 2.

Eighty six point eight four percent of the experimental group and fifteen percent of the students of the control group responded correctly to the question. Two point six three percent of the students of experimental group and seventeen point five percent of the students of control group did not attempt the question. Ten point five two percent of experimental group students and sixty seven point five percent of control group students answered the question incorrect. Few of the students wrote:

- *Pebbles take the water's place*
- *Hard things make the water rise*
- *Pebbles apply the force on water*
- *Pebbles are heavy*
- *Pebbles cut through the density of water and raise the level of water*

Question 4: Which forces can be identified in the story?

Table 5.15: Analysis of responses of students on question-4(story 2)

Group	Correct Response	Incorrect Response	Not Responded	χ^2 and level of significance
Experimental Group	33	01	04	9.98
Control Group	20	08	12	0.01

The computed value of χ^2 9.98 is greater than the table value of χ^2 9.21 at 0.01 level against 2 degree of freedom. So the null hypothesis is rejected. It reveals that both the groups differ significantly in the interpretation of physics concepts on Question 4-story 2.

Eighty six point eight four percent of the students of experiment group and fifty percent of the students of control group answered the question correctly. Ten point five two percent students of experiment group and thirty percent of control group students did not attempt the question. Two point six three percent of students of experimental group and twenty percent students of control group incorrectly answered the question.

Question 5: List the scientific concepts/ principles in the story. (Indicate in which aspect of the story the concepts/principles are seen)

Table 5.16: Analysis of responses of students on question-5(story 2)

Group	Correct Response	Incorrect Response	Not Responded	χ^2 and level of significance
Experimental Group	34	0	04	16.64
Control Group	17	09	18	0.01

The computed value of χ^2 16.64 is greater than the table value of χ^2 9.21 at 0.01 level against 2 degree of freedom. So the null hypothesis is rejected. It reveals that

both the groups differ significantly in the interpretation of physics concepts on Question 5- story 2.

Eighty nine point four seven percent of the students of experimental group and forty two point five percent of the students of control group could identify at least three concepts/principles of physics from the story. Twenty two point five percent of the students of control group incorrectly answered the question. Ten point five two percent of the experimental group students and thirty five percent of the control group students did not attempt the question. The principles identified by students are listed below:

- *Archimedes's principle when the water level rises on putting the pebbles in*
- *Pressure exerted by liquids on the walls of the pot*
- *The force of buoyancy /up-trust force by the water on the objects*
- *Less density of objects making the objects float on water*
- *Density of objects if greater than density of water the object will sink*
- *The gravitational force making the object fall towards the earth*
- *The displacement of water from one point to another*
- *The kinetic energy of the objects falling into the pot*
- *The third law of motion " the pebble fell down (action) the water level rose (reaction)"*
- *The volume of water raised in the pot due to displacement of water*
- *Sinking objects occupy some volume*
- *Density of water is 1kg/m^3*
- *Buoyant force is affected by density of objects*
- *Force / thrust by which the crow dropped the pebble*
- *Relative density of the objects that were dropped in water*
- *The mass and weight of the objects dropped in water*
- *The acceleration due to gravity acting on the objects dropped*

Few of the students wrote:

- *The crow was cunning and he had a plan in mind*
- *The crow used his brain and could finally drink the water*
- *The principle of rising of water level and picking hard things*

- *The crow was a scientist in his previous birth*
- *The crow had a strong beak to pick up the heavy objects*

Form the analysis it can be interpreted that both groups significantly differed in the interpretation of physics concepts from the story 'The thirsty crow' except for question no 1, where the significant difference was not observed. It can be concluded that except for question no 1, the experimental group students were better at interpreting the physics concepts from the story as compared to control group students.

5.1.2.3 Interpretation of the physics concepts from the story: The magical lantern

Question wise analysis of the response of the students on the story 'the magical lantern' in terms of frequencies and χ^2 are presented below. The responses of students were also content analyzed.

Question 1: Is the water acting as a fuel? Justify.

Table 5.17: Analysis of responses of students on question-1(story 3)

Group	Correct Response	Incorrect Response	Not Responded	χ^2 and level of significance
Experimental Group	**34**	**04**	**0**	**27.27**
Control Group	**11**	**20**	**09**	**0.01**

The computed value of χ^2 27.27 is greater than the table value of χ^2 9.21 at 0.01 level against 2 degree of freedom. So the null hypothesis is rejected. It reveals that both the groups differ significantly in the interpretation of physics concepts on Question 1- story 3.

Eighty nine point four seven percent of the experimental group students and twenty seven point five percent of the control group students answered the question satisfactorily. Twenty two point five percent of the control group students did not attempt the question. Ten point five two percent students of experimental group and fifty percent students of the control group answered the question incorrectly. Some of the students wrote:

- *Yes, water works as a fuel as the lantern lit when water was poured*

- *Yes, water expanded the quantity of fuel*
- *Water's weight is more than kerosene / water is heavier than kerosene*
- *The fuel covers deep length on the water*

Question 2: What made the lantern lit up again after the water being poured into it?

Table 5.18: Analysis of responses of students on question-2 (story 3)

Group	Correct Response	Incorrect Response	Not Responded	χ^2 and level of significance
Experimental Group	**33**	**4**	**01**	**26.41**
Control Group	**10**	**21**	**09**	**0.01**

The computed value of χ^2 26.41 is greater than the table value of χ^2 9.21 at 0.01 level against 2 degree of freedom. So the null hypothesis is rejected. It reveals that both the groups differ significantly in the interpretation of physics concepts on Question 2- story 3.

Eighty six point eight four percent of the students of experimental group and twenty five percent of the students of the control group answered the question correctly. Two point six three percent of experiment group students and twenty two point five percent control group students left the question unanswered. Ten point five two percent of the experiment group and fifty two point five percent of the control group answered the question incorrectly. Few of the answers by students were:

- *Water floated on kerosene*
- *Surface of lantern became hot and pouring the water help them cool and emit light*
- *Kerosene gets mixed with water and it acts as a fuel*
- *Kerosene covered the length of water*
- *By magic water converted to fuel*
- *Water gained strength and became fuel to light the lantern*

Question 3: What would have been his observation if he would have poured glycerine instead of water in the lantern containing kerosene?

Table 5.19: Analysis of responses of students on question-3 (story 3)

Group	Correct Response	Incorrect Response	Not Responded	χ^2 and level of significance
Experimental Group	23	13	02	21.96
Control Group	03	28	09	0.01

The computed value of χ^2 21.96 is greater than the table value of χ^2 9.21 at 0.01 level against 2 degree of freedom. So the null hypothesis is rejected. It reveals that both the groups differ significantly in the interpretation of physics concepts on Question 3- story 3.

Sixty point five two percent of the students of experimental group and only seven point five percent of the students of control group answered the question correctly. Five point two six percent of the experimental group and twenty two point five percent of the control group left the question unanswered. It was found that thirty four point two one percent of the experimental group students and seventy percent of the students of control group answered the question incorrectly. Few of the incorrect responses of the students are listed below:

- *Glycerine would float on kerosene as it is a lighter particle and the lantern would go off.*
- *Glycerine would have mixed up with kerosene*
- *Wick would not have got wet*
- *Both will get mix as both have equal weight so no increase in weight and hence lantern go off*
- *Kerosene being heavier than glycerine could rise up, and kerosene would settle down*
- *Density of glycerine is less than kerosene*
- *The wick would not light because it is not supporter of combustion*
- *There would be no effect*
- *It will burn but will not give bright light so he won't be able to study*

– *Glycerine will dissolve in kerosene and prevent kerosene to rise up*

It could be interpreted that the students who answered incorrectly were confused in predicting the density of different liquids and the effect it gives when they are mixed with each other.

Question 4: Name any other liquid that can be used instead of water to get the similar effect in the above story?

Table 5.20: Analysis of responses of students on question-4 (story 3)

Group	Correct Response	Incorrect Response	Not Responded	χ^2 and level of significance
Experimental Group	**21**	**15**	**02**	**21.78**
Control Group	**02**	**28**	**10**	**0.01**

The computed value of χ^2 21.78 is greater than the table value of χ^2 9.21 at 0.01 level against 2 degree of freedom. So the null hypothesis is rejected. It reveals that both the groups differ significantly in the interpretation of physics concepts on Question 4- story 3.

Fifty five point two six percent of the students of experimental group and only five percent of the students of control group answered correctly to the question. Five point two six percent of the experimental students and twenty five percent of the control group students did not respond to the question. Thirty nine point four seven percent of the experimental group and seventy percent of the control group answered incorrectly. Some of the students wrote:

- *We can use any oil instead of water*
- *No other liquid have the capacity to form different layers with kerosene*
- *Water is the most heaviest liquid and no other liquid could make kerosene rise*
- *Liquid that could be used should be heavier than kerosene*
- *Raju could use alcohol*
- *Water is cheap and it is easily available at every home*

Question 5: List the scientific concepts/principles in the story. (Indicate in which aspect of the story the concepts/principles are seen)

Table 5.21: Analysis of responses of students on question-5 (story 3)

Group	Correct Response	Incorrect Response	Not Responded	χ^2 and level of significance
Experimental Group	26	09	03	23.75
Control Group	06	13	21	0.01

The computed value of χ^2 23.75 is greater than the table value of χ^2 9.21 at 0.01 level against 2 degree of freedom. So the null hypothesis is rejected. It reveals that both the groups differ significantly in the interpretation of physics concepts on Question 5- story 3.

Sixty eight point four two percent of the students of experimental group and fifteen percent of the students of control group could identify at least three concepts/principles of physics from the story. Seven point eight nine percent of the experimental group and fifty two point five percent of the control group students did not attempt to answer the question. Twenty three point six eight percent of experimental group and thirty two point five percent of the control group students incorrectly answered the question.

The principles/concepts identified by the students are listed below:

- *Density of the liquid kerosene and water*
- *The concept of electrical energy and power (power cut)*
- *The gravitational force and the acceleration due to gravity: the liquid falls down and does not go up*
- *The buoyant force applied by the kerosene and water against gravity*
- *Relative density of liquids*
- *Pressure exerted by the liquid*
- *When immiscible liquids are mixed the lesser density liquid float on top while greater density liquid will settle down*
- *Relative densities of the liquids*

- *Archimedes's principle when the volume of the liquid kerosene is raised by pouring water*
- *Combustion of fuel kerosene*
- *Density of water is more than the density of kerosene. Density of glycerine is more than the density of water.*
- *Intensity of light rays, dim and bright*

Few of the students wrote:

- *Use heavier objects to lift up lighter objects*
- *Water helps to increase fire caused by fuel*
- *Water can be use in place of petrol*
- *Wick reaches the kerosene after pouring water*
- *Raju is a sincere and studies student*

It could be concluded that the students of the experimental group performed significantly better than the control group on interpretation of the physics concepts from the story 'the magical lantern'.

5.1.2.4 Interpretation of the physics concepts from the story: The cricket match

Question wise analysis of the response of the students on the story 'the cricket match' in terms of frequencies and χ^2 are presented below. The responses of students were also content analyzed.

Question 1: How do shoes with spikes help Pranay to play better?

Table 5.22: Analysis of responses of students on question-1 (story 4)

Group	Correct Response	Incorrect Response	Not Responded	χ^2 and level of significance
Experimental Group	37	01	0	25.21
Control Group	16	19	05	0.01

The computed value of χ^2 25.21 is greater than the table value of χ^2 9.21 at 0.01 level against 2 degree of freedom. So the null hypothesis is rejected. It reveals that both the groups differ significantly in the interpretation of physics concepts on Question 1- story 4.

Ninety seven point three six percent of the experimental group students and forty percent of the control group students answered the question correctly.

Ninety seven point three six percent of the students of the experimental group and forty percent of the students of control group answered the question correctly. Twelve point five percent of the students of control group did not attempt the question. Two point six three percent of the students of experimental group and forty seven point five percent of the students of control group answered incorrectly. Few of the control group students wrote:

- *The frictional force becomes less as spikes reduce friction*
- *Provides less friction with ground*

The responses reflect the lack of clarity on the concept of friction. The students were confused of whether the spikes increase or decrease the friction force. However they could identify that it is the frictional force that has a role to play.

Question 2: How does wearing a helmet and knee pads help players to protect themselves?

Table 5.23: Analysis of responses of students on question-2 (story 4)

Group	Correct Response	Incorrect Response	Not Responded	χ^2 and level of significance
Experimental Group	**31**	**07**	**0**	**24.06**
Control Group	**09**	**26**	**05**	**0.01**

The computed value of χ^2 24.06 is greater than the table value of χ^2 9.21 at 0.01 level against 2 degree of freedom. So the null hypothesis is rejected. It reveals that both the groups differ significantly in the interpretation of physics concepts on Question 2- story 4.

Eighty one point five seven percent of the students of experimental group and twenty two point five percent of the students of control group answered the question correctly. Twelve point five percent of the students of control group did not attempt the question. Eighteen point four two percent of the experimental group and sixty five percent of the control group students answered the question incorrectly. Few of the students wrote:

- *Ball has mass and is heavy and so hurts*
- *Knee pads are made of hard material*
- *The ball may broke his bones*

Question 3: How do the hand gloves help the wicket keeper to perform better in the cricket match?

Table 5.24: Analysis of responses of students on question-3 (story 4)

Group	Correct Response	Incorrect Response	Not Responded	χ^2 and level of significance
Experimental Group	**30**	**08**	**0**	**22.74**
Control Group	**09**	**23**	**08**	**0.01**

The computed value of χ^2 22.74 is greater than the table value of χ^2 9.21 at 0.01 level against 2 degree of freedom. So the null hypothesis is rejected. It reveals that both the groups differ significantly in the interpretation of physics concepts on Question 3- story 4.

Seventy eight point nine four percent of the experimental students and twenty two point five percent of the control group students answered the questions correctly. Twenty percent of the control group students did not attempt the question. Twenty two point zero five percent of the experimental students and fifty seven point five percent of the control group students did not satisfactorily answer the question. Few of the students did not provide justification on how gloves safeguarded from getting hurt. Some also said that gloves help to control ball from going here and there.

Question 4: Why is it so that while trying to catch the ball Hari got severe hurt on the palm while Gaurang could easily catch the ball?

Table 5.25: Analysis of responses of students on question-4 (story 4)

Group	Correct Response	Incorrect Response	Not Responded	χ^2 and level of significance
Experimental Group	34	02	02	24.73
Control Group	12	15	13	0.01

The computed value of χ^2 24.73 is greater than the table value of χ^2 9.21 at 0.01 level against 2 degree of freedom. So the null hypothesis is rejected. It reveals that both the groups differ significantly in the interpretation of physics concepts on Question 4- story 4.

Eighty nine point four seven percent of the students of the experimental group and thirty percent of the students of the control group could answer the question correctly. Five point two six percent of the students of experimental group and thirty two point five percent of the students of the control group left the question unanswered. Five point two six percent of the students of the experimental group and thirty seven point five percent of the students of the control group did not satisfactorily answer the question. Few of the control group students wrote:

- *Hari hand was imbalance and so felt hurt*
- *Conversion of energy took place in case of Gaurang and he could catch the ball*
- *Gaurang ran fast while Hari was slow*
- *We need both hands to catch the ball as ball is too heavy*
- *Because weight of ball is more than the weight and strength of Hari*
- *Gaurang gained some velocity in his hand and caught ball*

Question 5: List all possible scientific concepts and principles in the story. (Indicate in which aspect of the story the concepts/principles are seen)

Table 5.26: Analysis of responses of students on question-5 (story 4)

Group	Correct Response	Incorrect Response	Not Responded	χ^2 and level of significance
Experimental Group	32	03	03	17.09
Control Group	14	08	18	0.01

The computed value of χ^2 17.09 is greater than the table value of χ^2 9.21 at 0.01 level against 2 degree of freedom. So the null hypothesis is rejected. It reveals that both the groups differ significantly in the interpretation of physics concepts on Question 5- story 4.

Eighty four point two one percent of the experiment group students and thirty five percent of the control group students could identify at least five scientific principles/concepts in the story. Seven point eight nine percent of the experimental group and forty five percent of the control group students did not attempt the question. Seven point eight nine percent of the experimental group and twenty percent of the control group could not identify the scientific concepts and principle in the story.

The principles/concepts identified by the students are listed below:

- *Speed can be lessened by bringing the ball slowly to stationary form*
- *Law of inertia of direction when the ball bounced back/ high velocity ball on palm severe hurt on palm*
- *Fast moving ball the speed/velocity of ball*
- *Frictional force of the ground that gives grip to players*
- *The force of gravitation the ball comes down towards the earth*
- *The mass of ball and the ball falling under the acceleration due to gravity*
- *Force applied on the bat in a direction*
- *Acceleration of the ball when it comes with high velocity*
- *The kinetic energy of the moving ball and running player*
- *Pressure reduced by larger area of the hand gloves*

- *Reflection of sun rays on a sunny day*
- *Force of object depends on mass and acceleration, fast moving ball hurts the player. Newton's second law*
- *Less friction with ground the player slipped off lost balance*
- *Spines increase friction with ground and give grip*
- *Knee pads, helmet, hand gloves reduces the rate of change of momentum and less injury*
- *Pull hand back decrease velocity and increase time*
- *Gaurang screamed and crowd cheered; sound energy and vibrations*
- *Retardation when the velocity decreases with time*
- *Third law of motion when the ball bounced back to the fielder and when high velocity ball hit the palm severe hurt on palm*
- *Force changes direction of motion of ball*
- *Hari got hurt due to large momentum of ball*

Few of the students wrote:

- *Use two hands to catch the ball*
- *Increasing distance will give increase in acceleration and decrease in force*
- *Wear safety objects to avoid hurt*
- *Always hold or catch anything with balance*

It could be concluded that the students of the experimental group performed significantly better than the control group on interpretation of the physics concepts from the story 'the cricket match'.

Overall it can thus be concluded that the students of the experimental group performed better than the control group students on the interpretation of the physics concepts from the stories. It was also found through the content analysis that the students of the experimental group had better clarity of the physics concepts and could identify more number of principles and concepts from the story.

5.1.3 Identification and logical sequencing of physics concepts from the images of events projected

To study the effectiveness of the intervention programme in terms of interpretation and logical sequencing of physics concepts from the images of events projected the techniques used were frequency, percentage and content analysis. The number of

concepts identified by the experimental group students and control group students were taken and a graph was plotted to predict the group performance. The effectiveness of the intervention in physics topics was also seen as the ability of the students to logically sequence the concepts in accordance with the occurrence of the phenomenon. Image wise the graphs are presented below followed by the description on logical sequencing of the physics concepts by the experimental group and control group students.

5.1.3.1 Identification and logical sequencing of physics concept from the image 1

The number of concepts identified by each student of the experimental group and the control group from image 1 were tabulated and the data was used to plot the graph. The graph on the number of physics concepts identified by the students on image 1 is represented below.

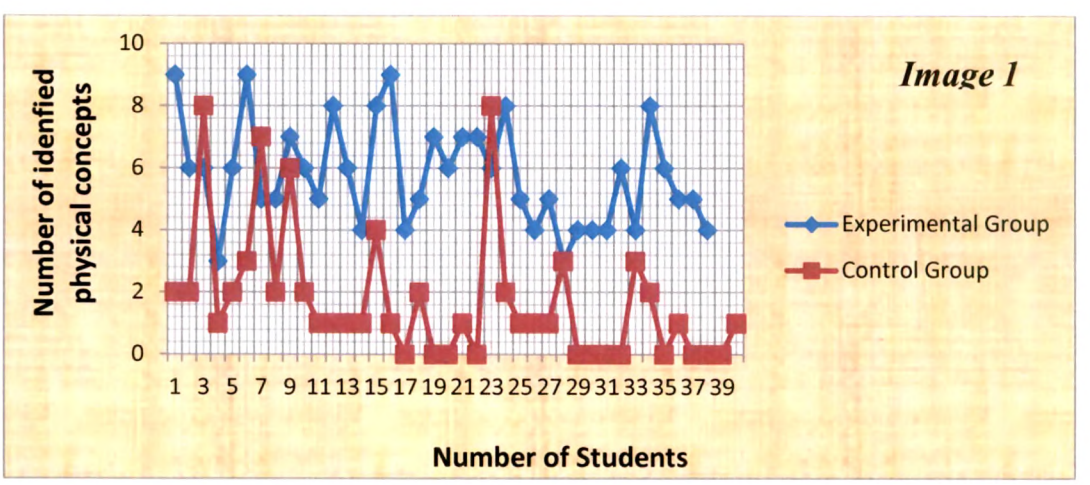

Fig 5.1 Identification of physics concepts from the image 1

It can be observed from the graph that the overall performance of the experimental group was better as compared to the control group. The concepts identified on the image 1 by the students of experimental group and control group were listed down and frequency of identification of a particular concept by the number of students was analyzed. The analyzed data was converted into percentage and presented in the table below.

Table 5.27
Identified Concepts/Principles from Image 1

Sr. No	Concepts/Principles of Physics	Percentage (%) of students identified a particular concept/principle of physics from Image 1	
		Experimental Group (%)	Control Group (%)
1	Force	78.94	10
2	Velocity	68.42	10
3	Kinetic Energy	63.15	20
4	Distance	57.89	-
5	Acceleration	52.63	30
6	Gravitation	36.84	15
7	Motion	36.84	17.5
8	Friction	34.21	32.5
9	Inertia	31.57	7.5
10	Work	28.94	7.5
11	Speed	26.31	7.5
12	Potential Energy	21.05	5
13	Displacement	18.42	5
14	Pressure	15.78	2.5
15	Circular Motion	13.15	-
16	Momentum	7.89	5
	Not Attempted	-	20

Sixty point five two percent (60.52%) of the students of experimental group and fifteen percent (15%) of the students of control group attempted to arrange the identified concept/principle in a logical sequence. The patterns adapted by students to arrange the identified concepts/principle were as follows:

- *Potential energy of the muscles- rotation of pedals- kinetic energy of the cycle and the cyclist- velocity of the cycle- momentum of the cycle and cyclist- acceleration produced- distance travelled.*
- *Pressure exerted by the foot on the pedal- the motion of cycle- friction of ground- external force applied by cyclist- velocity- kinetic energy- acceleration of the cycle- work done.*

- *External force applied- potential energy of the body converted into kinetic energy of cyclist- motion of the cycle along with cyclist- velocity and acceleration produced.*
- *Gravitation- external force applied to overcome the force of friction- motion of the body- velocity generated- acceleration produced- the body covers distance.*
- *Gravitation- Inertia of the cycle- work done to overcome friction and displace the body- circular motion of the tyre- external force applied- body gains velocity and kinetic energy- increased velocity leads to acceleration- the cyclist wins the race.*

Thirty nine point four seven percent (39.47%) students of the experimental group and fifty five percent (55%) of the students of the control group randomly listed down the identified concepts. Twenty percent (20%) of the students of the control group did not attempt the question while ten percent (10%) control group students wrote

- *Cycle riders moving*
- *Two boys cycling on the road*

5.1.3.2 Identification and logical sequencing of physics concept from the image 2

The number of concepts identified by each student of the experimental group and the control group from image 2 were tabulated and the data was used to plot the graph. The graph on the number of physics concepts identified by the students on image 2 is represented below.

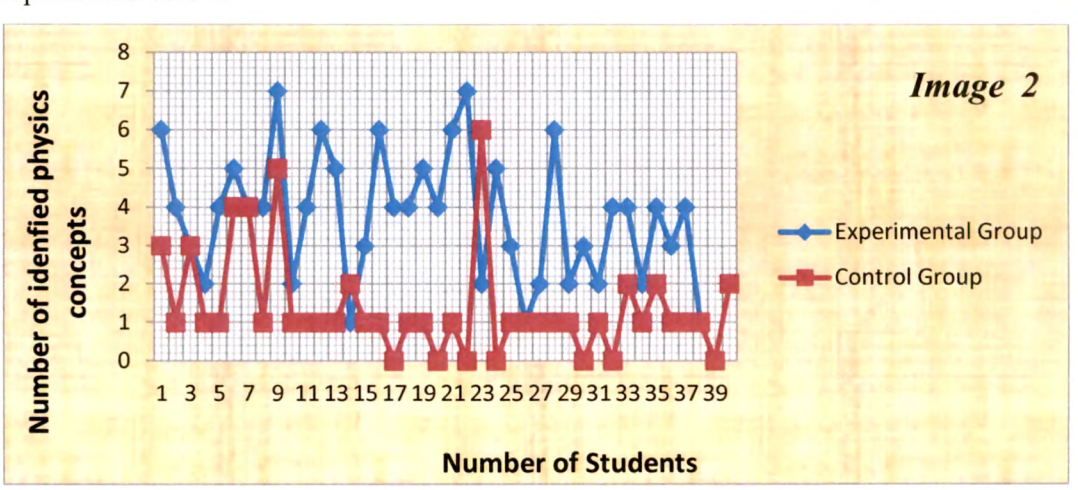

Fig 5.2 Identification of physics concepts from the image 2

It can be observed from the graph that the overall the performance of the experimental group was better as compared to the control group. The concepts identified on the image 2 by the students of experimental group and control group were listed down and frequency of identification of a particular concept by the number of students was analyzed. The analyzed data was converted into percentage and presented in the table below.

Table 5.28
Identified Concepts/Principles from Image 2

Sr. No	Concepts/Principles of Physics	Percentage (%) of students identified a particular concept/principle of physics from Image 2	
		Experimental Group (%)	Control Group (%)
1	Uniform Circular Motion	84.21	57.5
2	Force	55.26	7.5
3	Kinetic Energy	39.47	7.5
4	Uniform Acceleration	36.84	5
5	Velocity	36.84	7.5
6	Acceleration due to gravity (g)	36.84	2.5
7	Electric Energy	18.42	2.5
8	Centripetal Force	18.42	10
9	Potential Energy	15.78	5
10	Speed	13.15	5
11	Inertia	7.89	5
12	Gravitation	7.89	12.5
13	Distance	7.89	5
14	Friction	2.63	5
15	Fulcrum	-	2.5
	Not Attempted	-	5

Fifty seven point eight nine percent (57.89%) students of the experiment group and twelve point five percent (12.5%) of the control group students attempted to arrange the identified concept/principle in a logical sequence. The patterns adapted by students to arrange the identified concepts/principle were as follows:

- *Electric energy- External force exerted- Rotation of Giant wheel- Velocity of wheel- Velocity changes at each point- Acceleration due to gravity when it*

rotates- But constant acceleration produced- Uniform circular motion of wheel.

- *Gravitation- Inertia of Giant wheel- Electric energy used to rotate the wheel- Velocity and kinetic energy produced- uniform acceleration- uniform circular motion- distance (circumference) covered.*
- *Acceleration due to gravity- Force applied- Velocity produced- Centripetal force which keeps the wheel in circular motion- uniform circular motion.*

Forty two point one percent (42.10%) students of experimental group and seventeen point five percent (17.5%) students of control group randomly listed down the identified concepts. Fifty seven point five percent (57.5%) control group students could identify only one concept of uniform circular motion. Five percent (5%) of the students of control group did not identify any concept from the image while seven point five percent (7.5%) students from control group wrote:

- *Merry –go round ride*
- *Giant wheel going round and round*

5.1.3.3 Identification and logical sequencing of physics concept from the image 3

The number of concepts identified by each student of the experimental group and the control group from image 3 were tabulated and the data was used to plot the graph. The graph on the number of physics concepts identified by the students on image 3 is represented below.

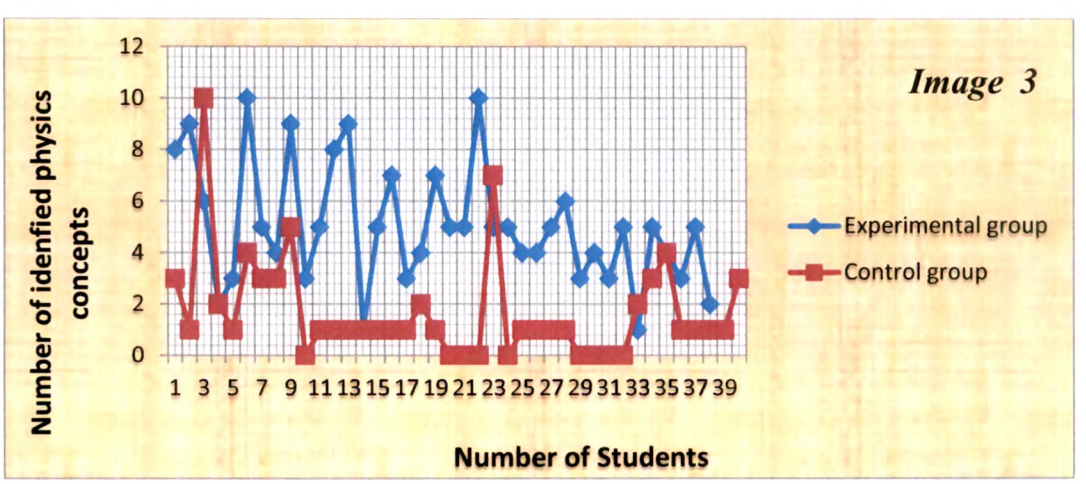

Fig 5.3 Identification of physics concepts from the image 3

It can be observed from the graph that the overall performance of the experimental group was better as compared to the control group. The concepts identified on the

image 3 by the students of experimental group and control group were listed down and frequency of identification of a particular concept by the number of students was analyzed. The analyzed data was converted into percentage and presented in the table below.

Table 5.29
Identified Concepts/Principles from Image 3

Sr. No	Concepts/Principles of Physics	Percentage (%) of students identified a particular concept/principle of physics from Image 4	
		Experimental Group (%)	Control Group (%)
1	Thrust/Force	73.68	52.5
2	Newton's Third Law	68.42	15
3	Acceleration due to gravity	52.63	7.5
4	Kinetic Energy	44.73	17.5
5	Acceleration	34.21	10
6	Velocity	34.21	-
7	Potential Energy	26.31	-
8	Energy (Heat/Sound/Electric)	23.68	15
9	Pressure	23.63	20
10	Distance/Displacement	21.05	-
11	Work	18.42	5
12	Linear Motion	13.15	-
13	Mass	13.15	5
14	Momentum	13.15	-
15	Gravitation	7.8	7.5
16	Combustion	5.26	-
17	Inertia	5.26	7.5
18	Newton's Second Law	2.63	7.5
	Not Attempted	-	12.5

Sixty five point seven eight percent (65.78%) of the students of experimental group and twenty percent (20%) of the students of control group attempted to arrange the

identified concept/principle in a logical sequence. The patterns adapted by students to arrange the identified concepts/principle were as follows:

- *Electric energy to working of the engine- combustion of fuel- ignition applies force/thrust in upward direction- the ground exerts an equal and opposite force (third law of Newton)- pressure exerted- momentum of rocket- rocket moves against the direction of acceleration due to gravity of earth.*
- *Inertia of the rocket- gravitational force- the external force applied- the motion of rocket- velocity and kinetic energy acquired- F=m.a (second law of motion)- pressure exerted- linear motion in upward direction- third law of Newton.*
- *Thrust and pressure generated- displacement of rocket- work done- third law of Newton (action the fuel burnt, reaction the upward motion) - heat and sound energy produced.*
- *Large mass of rocket- fuel burnt in rocket- heat energy produced- gases move with high velocity in downward direction- the rocket moves up (third law of Newton) - large velocity large momentum- the rocket moves up.*

Thirty four point two one percent (34.21%) students of experimental group and twelve point five percent (12.5%) students of control group randomly listed down the identified concepts. Forty five percent (45%) control group students could identify only one concept. Twelve point five percent (12.5%) of the students of control group did not identify any concept from the image while ten percent (10%) students from control group wrote:

- *Launching of rocket*
- *Fuel burns and rocket flies*

5.1.3.4 Identification and logical sequencing of physics concept from the image 4

The number of concepts identified by each student of the experimental group and the control group from image 4 were tabulated and the data was used to plot the graph. The graph on the number of physics concepts identified by the students on image 4 is represented below.

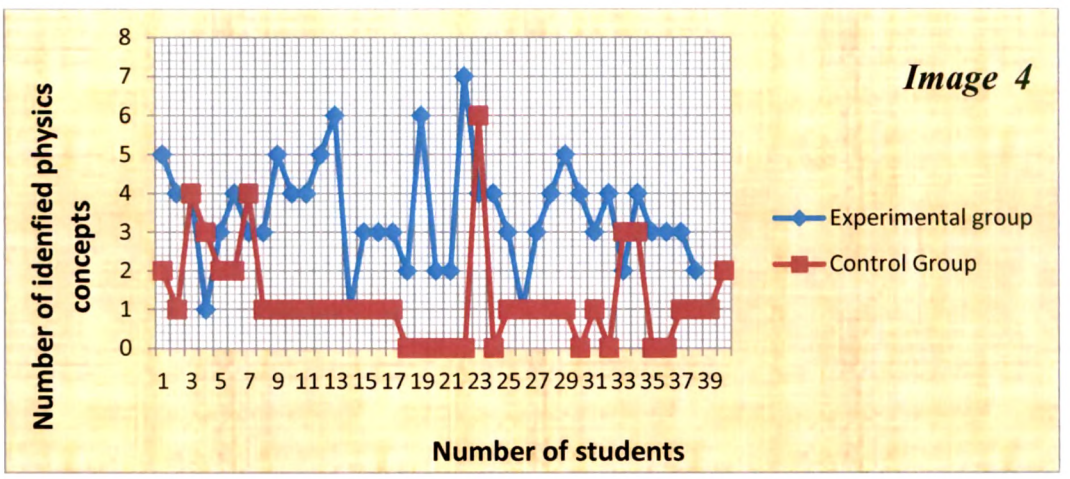

Fig 5.4 Identification of physics concepts from the image 4

It can be observed from the graph that the average performance of the experimental group students was better than the control group. The concepts identified on the image 4 by the students of experimental group and control group were listed down and frequency of identification of a particular concept by the number of students was analyzed. The analyzed data was converted into percentage and presented in the table below.

Table 5.30
Identified Concepts/Principles from Image 4

Sr. No	Concepts/Principles of Physics	Percentage (%) of students identified a particular concept/principle of physics from Image 4	
		Experimental Group (%)	Control Group (%)
1	Inertia	97.36	60
2	Force	50	22.5
3	Retardation	39.47	2.5
4	Momentum	36.84	5
5	Acceleration	21.05	2.5
6	Kinetic Energy	15.78	5
7	Newton's Third Law	13.15	5
8	Friction	13.15	5
9	Motion	13.15	5
10	Pressure	10.52	2.5
11	Gravitation	10.52	2.5
12	Newton's First Law	10.52	2.5
13	Velocity	7.89	2.5
14	Potential Energy	5.2	2.5
	Not Attempted	-	5

Thirty one point five seven percent (31.57%) of the students of experimental group and only two point five percent (2.5%) of the students of control group attempted to arrange the identified concept/principle in a logical sequence. The patterns adapted by students to arrange the identified concepts/principle were as follows:

- *Brakes applied- frictional force comes into action- retardation as the vehicle stops suddenly- lower part of body still in motion and has momentum- Inertia of motion- Newton's first law- seat belt help to avoid sudden change in momentum.*
- *External force applied- the force of friction- retardation of the vehicle- Inertia of motion- seat belt conservation of momentum.*
- *Kinetic energy of bus- acceleration produced while bus in motion- sudden brakes- retarded motion- person experience inertia of motion- sudden fall in forward direction- bus moves a little backward- third law of Newton.*

Sixty eight point four two percent (68.42%) students of experimental group and twenty two point five percent (22.5%) students of control group randomly listed down the identified concepts. Fifty two point five percent (52.5%) control group students could identify only one concept. Five percent (5%) of the students of control group did not identify any concept from the image while seventeen point five percent (17.5%) students from control group wrote:

- *Child with seat belt*
- *Seat belt stops person from falling down*
- *Suddenly brakes are applied*

5.1.3.5 Identification and logical sequencing of physics concept from the image 5

The number of concepts identified by each student of the experimental group and the control group from image 5 were tabulated and the data was used to plot the graph. The graph on the number of physics concepts identified by the students on image 5 is represented below.

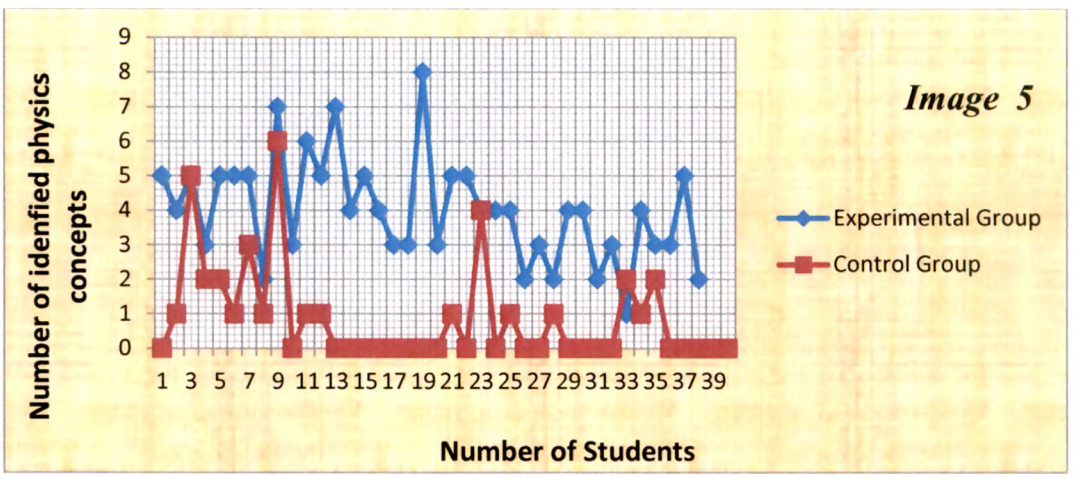

Fig 5.5 Identification of physics concepts from the image 5

It can be observed from the graph that the overall performance of the experimental group was better as compared to the control group. The concepts identified on the image 5 by the students of experimental group and control group were listed down and frequency of identification of a particular concept by the number of students was analyzed. The analyzed data was converted into percentage and presented in the table below.

Table 5.31
Identified Concepts/Principles from Image 5

Sr. No	Concepts/Principles of Physics	Percentage (%) of students identified a particular concept/principle of physics from Image 5	
		Experimental Group (%)	Control Group (%)
1	Momentum	47.36	-
2	Force	39.47	12.5
3	Kinetic Energy	36.84	5
4	Newton's Third Law	34.21	5
5	Newton's First Law	26.31	-
6	Motion	26.31	7.5
7	Transfer of Energy	26.31	-
8	Potential Energy	18.42	7.5
9	Displacement	18.42	-
10	Vibration/Oscillation	15.78	12.5
11	Velocity	15.78	7.5
12	Second Law of Motion	15.78	-
13	Acceleration	13.15	10
14	Conservation of Energy	13.15	2.5
15	Sound	10.52	2.5

16	Frequency	10.52	2.5
17	Conclusion of Galileo's Experiment	10.52	-
18	Gravitation	5.26	2.5
19	Heat Energy	5.26	-
20	Friction	2.63	5
21	Time Period	-	5
	Not Attempted	-	47.5

Thirty nine point four seven percent (39.47%) of the students of experimental group attempted to arrange the identified concept/principle in a logical sequence. None of the students of the control group could arrange the identified concept/principle in a logical sequence. The patterns adapted by students of experimental group to arrange the identified concepts/principle were as follows:

- *Potential energy of balls- force applied on the first ball by releasing it from a height- Newton's first law- the first law comes into motion and transfer the energy from one ball to another- first ball hits and displace the last ball to the same height- Third law of Newton- Momentum produced due to mass and velocity of balls- conservation of momentum- release of heat energy and sound energy- finally the ball will come to rest on friction with air after some time.*
- *External force applied- ball gain velocity and come to motion- transfer of energy from one ball to another (potential to kinetic to heat to sound energy)- frequency of vibrations.*
- *Newton's first law of motion, the ball comes to motion on application of force- Newton's second law of motion, the ball gains momentum- conservation of momentum- Newton's third law of motion, action and reaction are equal and opposite.*

Sixty point five two percent (60.52%) students of experimental group and fifteen percent (15%) students of control group randomly listed down the identified concepts. Twenty five percent (25%) control group students could identify only one concept. Forty seven point five percent (47.5%) of the students of control group did not identify any concept from the image while twelve point five percent (12.5%) students of control group wrote:

- *The pendulum is working*
- *The moving pendulum here and there*

5.1.3.6 Identification and logical sequencing of physics concept from the image 6

The number of concepts identified by each student of the experimental group and the control group from image 6 were tabulated and the data was used to plot the graph. The graph on the number of physics concepts identified by the students on image 6 is represented below.

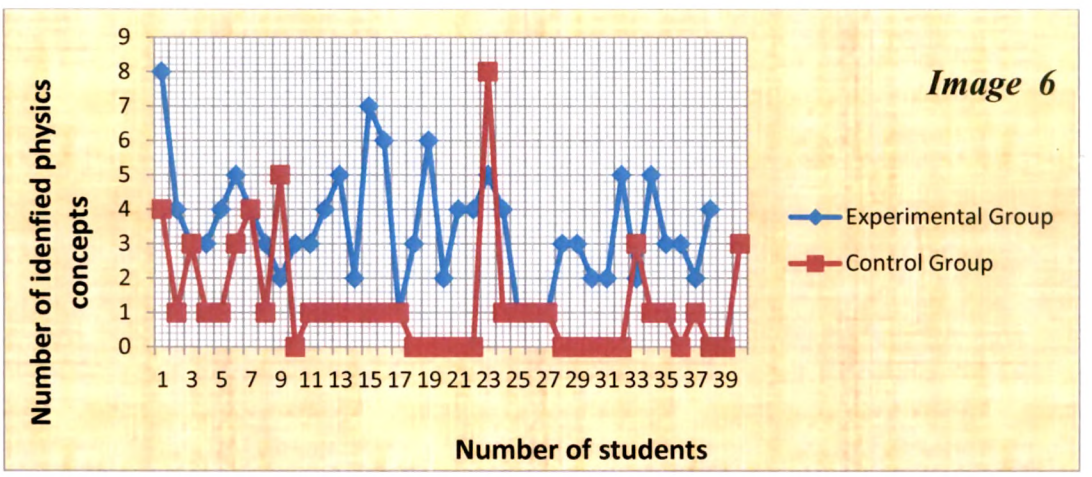

Fig 5.6 Identification of physics concepts from the image 6

It can be observed from the graph that the overall performance of the experimental group was better as compared to the control group. The concepts identified on the image 6 by the students of experimental group and control group were listed down and frequency of identification of a particular concept by the number of students was analyzed. The analyzed data was converted into percentage and presented in the table below.

Table 5.32
Identified Concepts/Principles from Image 6

Sr. No	Concepts/Principles of Physics	Percentage (%) of students identified a particular concept/principle of physics from Image 6	
		Experimental Group (%)	Control Group (%)
1	Force	94.73	17.5
2	Conservation of Momentum/ Momentum	68.42	40
3	Energy	34.21	15
4	Newton's Third Law	23.68	20
5	Inertia	23.68	5

6	Acceleration	18.42	-
7	Pressure	18.42	10
8	Friction	13.15	5
9	Work	10.52	-
10	Collision	10.52	2.5
11	Velocity	10.52	2.5
12	Gravitation	7.89	5
13	Mass	7.89	-
14	Newton's Second Law	5.26	2.5
15	Newton's First Law	2.6	2.5
	Not Attempted	-	25

Twenty three point six eight percent (23.68%) of the students of experimental group and two point five percent (2.5%) students of control group attempted to arrange the identified concept/principle in a logical sequence. The patterns adapted by students to arrange the identified concepts/principle were as follows:

- *Muscular force of the players- kinetic energy of players- large momentum of players- collision with each other- Inertia of motion- suddenly the velocity is brought to zero- large force in opposite direction- Newton's third law of motion- helmet reduce the sudden change in momentum.*
- *Unbalanced forces- friction with ground- mass of players- kinetic energy of the players- collision- change in momentum on collision- jerk felt, third law of motion.*
- *Kinetic energy of players- inertia of motion and direction- the first law of motion- momentum of players, the second law of motion- collision, the third law of motion- helmet, conservation of momentum*

Seventy six point three one percent (76.31%) students of experimental group and twenty percent (20%) students of control group randomly listed down the identified concepts. Forty five percent (45%) control group students could identify only one concept. Twenty five percent (25%) of the students of control group did not attempt to identify any concept from the image while seven point five percent (7.5%) students of control group wrote:

- *Boys play Rugby*

5.1.3.7 Identification and logical sequencing of physics concept from the image 7

The number of concepts identified by each student of the experimental group and the control group from image 7 were tabulated and the data was used to plot the graph. The graph on the number of physics concepts identified by the students on image 7 is represented below.

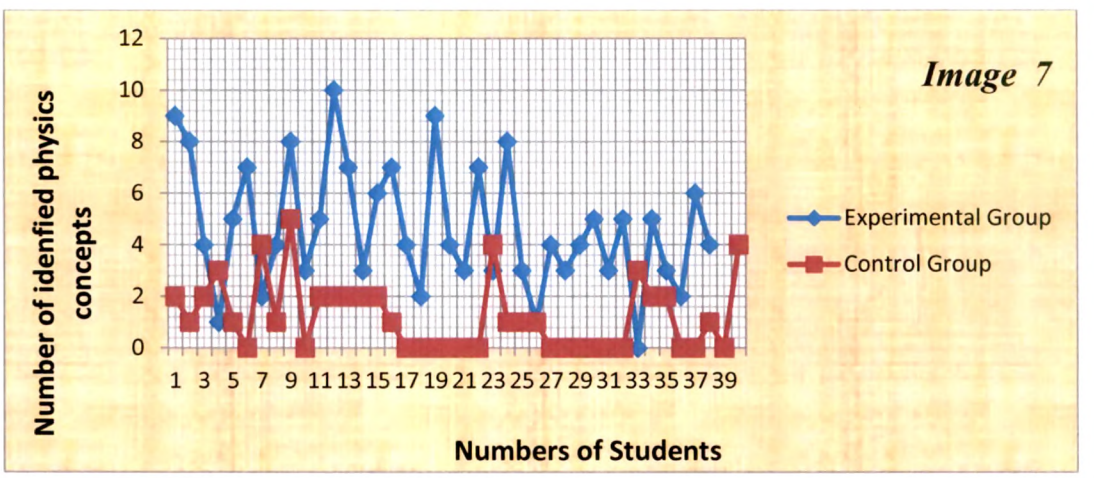

Fig 5.7 Identification of physics concepts from the image 7

From the graph it can be interpreted that the experimental group could identify more number of concepts as compared to the control group. The concepts identified on the image 7 by the students of experimental group and control group were listed down and frequency of identification of a particular concept by the number of students was analyzed. The analyzed data was converted into percentage and presented in the table below.

Table 5.33
Identified Concepts/Principles from Image 7

Sr. No	Concepts/Principles of Physics	Percentage (%) of students identified a particular concept/principle of physics from Image 7	
		Experimental Group (%)	Control Group (%)
1	Force	57.89	12.5
2	Kinetic Energy	55.26	20
3	Pressure	52.63	10
4	Acceleration due to gravity	52.63	5

5	Newton's Third Law	39.47	7.5
6	Displacement	31.57	-
7	Velocity	31.57	-
8	Potential Energy	28.94	17.5
9	Momentum	28.94	-
10	Acceleration	26.31	-
11	Motion	21.05	12.5
12	Friction	15.78	-
13	Gravitation	7.89	22.5
14	Energy	7.89	10
15	Newton's First Law	5.2	7.5
16	Newton's Second Law	5.2	2.5
	Not Attempted	2.63	35

Fifty percent (50%) of the students of experimental group attempted to arrange the identified concept/principle in a logical sequence. None of the students of the control group could arrange the concept/principle in a logical sequence. The patterns adapted by students of experimental group to arrange the identified concepts/principle were as follows:

- *Friction of the ground- force of feet in backward direction and athlete moves in forward direction (third law of motion)- potential energy of muscles- kinetic energy of feet- motion- velocity- acceleration due to gravity- final velocity zero- cushion reduce pressure- less momentum felt by athlete.*
- *Kinetic energy of athlete- friction of ground- pressure of feet on ground- acceleration while running- gravitation pull and acceleration due to gravity while fall- third law of Newton as the athlete falls and goes up and down on cushion- no hurt felt as cushion increase the rate of change in momentum.*
- *Force applied- motion of the athlete- displacement- velocity gained- accelerated motion- third law when athlete falls on cushion.*
- *Potential energy of muscles- kinetic energy of body- motion against gravity- gravitational pull- acceleration due to gravity- fall- velocity goes to zero- reduced momentum.*

Forty seven point three six percent (47.36%) students of experimental group and twenty seven point five percent (27.5%) students of control group randomly listed down the identified concepts. Thirty two point five percent (32.5%) control group students could identify only one concept. Thirty five percent (35%) of the students of control group and two point six percent (2.6%) students of experimental group did not attempt to identify any concept from the image while five percent (5%) students of control group wrote:

- *The athlete is jumping*

5.1.3.8 Identification and logical sequencing of physics concept from the image 8

The number of concepts identified by each student of the experimental group and the control group from image 8 were tabulated and the data was used to plot the graph. The graph on the number of physics concepts identified by the students on image 8 is represented below.

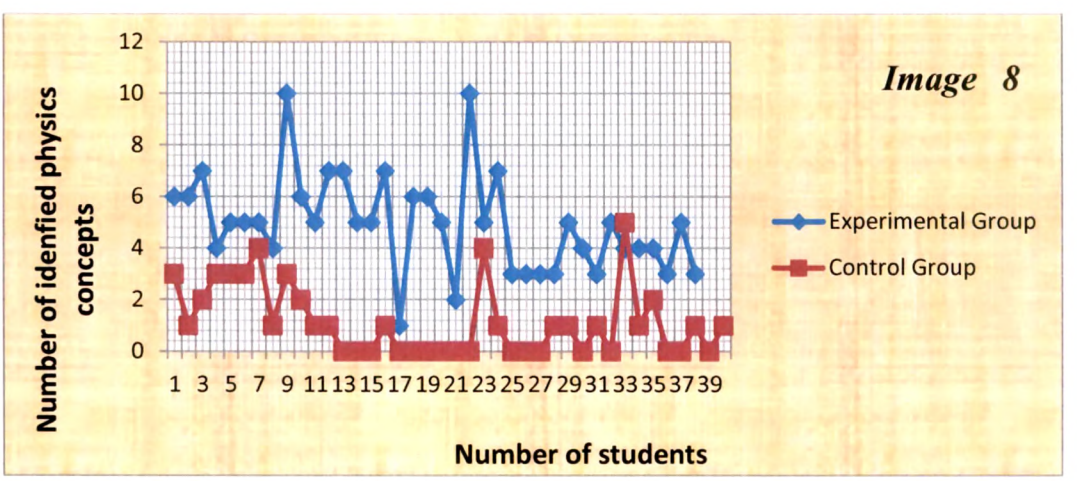

Fig 5.8 Identification of physics concepts from the image 8

From the graph it can be interpreted that the experimental group could identify more number of concepts as compared to the control group. The concepts identified on the image 8 by the students of experimental group and control group were listed down and frequency of identification of a particular concept by the number of students was analyzed. The analyzed data was converted into percentage and presented in the table below.

Table 5.34
Identified Concepts/Principles from Image 8

Sr. No	Concepts/Principles of Physics	Percentage (%) of students identified a particular concept/principle of physics from Image 8	
		Experimental Group (%)	Control Group (%)
1	Kinetic Energy	84.21	20
2	Potential Energy	63.15	7.5
3	Force	60.05	17.5
4	Pressure	47.36	15
5	Acceleration due to gravity	39.47	5
6	Power	26.31	10
7	Velocity	25.78	2.5
8	Work	23.68	-
9	Sound	23.68	-
10	Displacement	21.05	2.5
11	Gravitation	18.42	27.5
12	Electric Energy	13.15	10
13	Buoyancy	10.52	-
14	Law of energy conservation	10.52	-
15	Newton's Third Law	7.89	2.5
	Not Attempted	-	27.5

Sixty point five two percent (60.52%) of the students of experimental group and twelve point five percent (12.5%) students of the control group attempted to arrange the identified concept/principle in a logical sequence. The patterns adapted by students of experimental group to arrange the identified concepts/principle were as follows:

- *Kinetic energy of falling water- transformed to potential energy of water stored in dam- water allowed to fall from a height- the potential energy of water converted to kinetic energy to rotate the turbine- production of electricity*

- *Potential energy of water- force of falling water- kinetic energy of water- the displacement of water- sound energy produced- conservation of energy: potential to kinetic to electric energy- law of conservation of energy- power generated.*
- *Kinetic energy of falling water- acceleration due to gravity- force of water falling- pressure generated- third law of motion (falling water reaching the ground bounce a little up)- velocity of flowing water- potential energy of still water.*

Thirty nine point four seven percent (39.47%) students of experimental group and twelve point five percent (12.5%) students of control group randomly listed down the identified concepts. Thirty two point five percent (32.5%) control group students could identify only one concept. Twenty seven point five percent (27.5%) of the students of control group did not attempt to identify any concept from the image while fifteen percent (15%) students of control group wrote:

- *Water falling from a dam*
- *Fall of water*

5.1.3.9 Identification and logical sequencing of physics concept from the image 9

The number of concepts identified by each student of the experimental group and the control group from image 9 were tabulated and the data was used to plot the graph. The graph on the number of physics concepts identified by the students on image 9 is represented below.

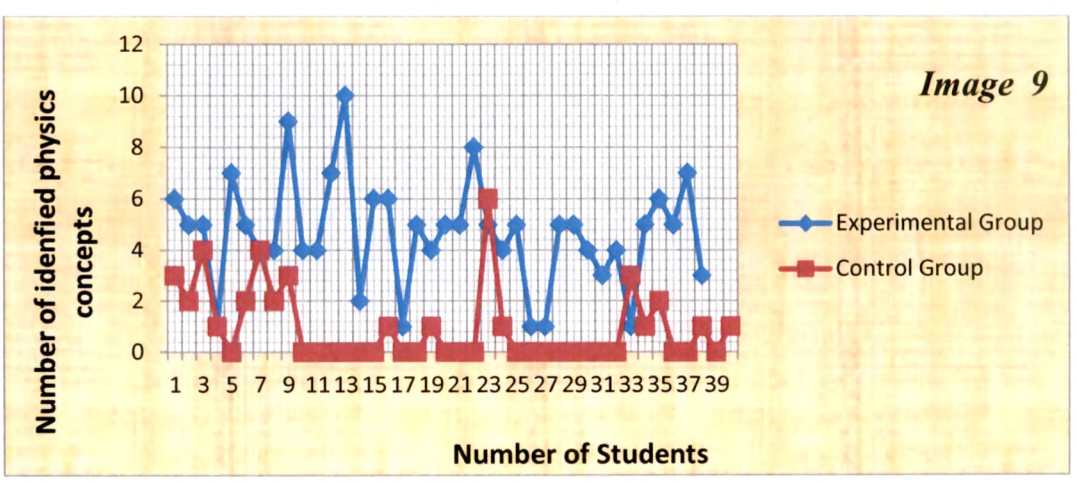

Fig5.9 Identification of physics concepts from the image 9

From the graph it can be concluded that the performance of the experimental group students was better as compared to control group on the identification of concepts from the image. The concepts identified on the image 9 by the students of experimental group and control group were listed down and frequency of identification of a particular concept by the number of students was analyzed. The analyzed data was converted into percentage and presented in the table below.

Table 5.35
Identified Concepts/Principles from Image 9

Sr. No	Concepts/Principles of Physics	Percentage (%) of students identified a particular concept/principle of physics from Image 9	
		Experimental Group (%)	Control Group (%)
1	Pressure	84.21	17.5
2	Force	60.52	10
3	Gravitation	44.73	5
4	Motion	39.47	12.5
5	Mass	39.47	5
6	Surface area	23.68	5
7	Friction	23.68	12.5
8	Momentum	23.68	5
9	Kinetic Energy	23.68	2.5
10	Inertia	21.05	2.5
11	Weight	18.42	2.5
12	Velocity	18.42	7.5
13	Sound	13.15	2.5
14	Acceleration	13.15	5
15	Second law of motion	7.89	5
	Not Attempted	-	45

Thirty six point eight four percent (36.84%) of the students of experimental group and five percent (5%) students of the control group attempted to arrange the identified concept/principle in a logical sequence. The patterns adapted by students to arrange the identified concepts/principle were as follows:

- *Mass of tank- high inertia of tank- more force applied to make it move- large surface area of belt- less pressure felt on ground when tank moves- momentum of the tank*
- *Gravitational force of earth- heavy tank- large force applied to move the tank- large area of the belt- less pressure on ground- velocity of the tank- the tank moves- large momentum due to large mass- sound produced on motion of tank.*
- *Motion of tank- frictional force- more force to overcome friction and inertia- less pressure due to large surface area of belt over tyre- velocity and kinetic energy of the tank- momentum produced.*

Sixty three point one five (63.15%) students of the experimental group and forty two point five percent (42.5%) students of control group randomly listed the concepts/principle from the image. Forty five percent (45%) students of the control group did not attempt to identify any concept from the image while seven point five percent (7.5%) control group students wrote:

- *The tank is moving*
- *Panzer is going for war*

5.1.3.10 Identification and logical sequencing of physics concept from the image 10

The number of concepts identified by each student of the experimental group and the control group from image 10 were tabulated and the data was used to plot the graph. The graph on the number of physics concepts identified by the students on image 10 is represented below.

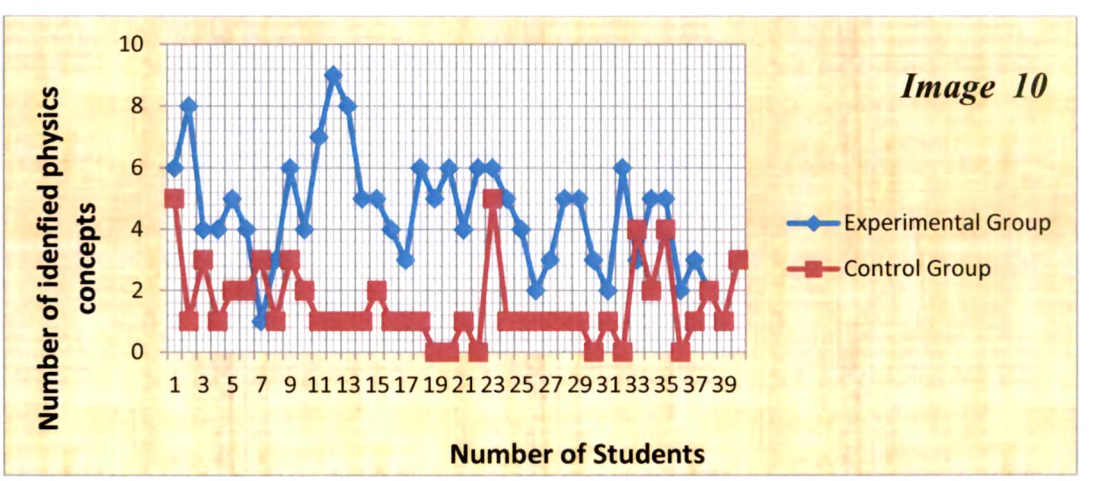

Fig 5.10 Identification of physics concepts from the image 10

From the graph it can be concluded that the performance of the experimental group students was better as compared to control group on the identification of concepts from the image. The concepts identified on the image 10 by the students of experimental group and control group were listed down and frequency of identification of a particular concept by the number of students was analyzed. The analyzed data was converted into percentage and presented in the table below.

Table 5.36
Identified Concepts/Principles from Image 10

Sr. No	Concepts/Principles of Physics	Percentage (%) of students identified a particular concept/principle of physics from Image 10	
		Experimental Group (%)	Control Group (%)
1	Potential Energy	78.94	30
2	Kinetic Energy	76.31	30
3	Force	50	12.5
4	Recoil Velocity	44.73	35
5	Newton's Third Law	42.10	12.5
6	Work	26.31	-
7	Law of conservation of energy	23.68	-
8	Pressure	21.05	15
9	Distance	18.42	-
10	Acceleration	13.15	5
11	Motion	13.15	5
12	Transformation of energy	13.15	-
13	Momentum	13.15	5
14	Mechanical Energy	10.52	-
15	Sound Energy	7.89	2.5
16	Friction	5.26	2.5
17	Resistance of air	2.63	-
	Not Attempted	-	7.5

Fifty two point six three percent (52.63%) of the students of experimental group and ten percent (10%) students of the control group attempted to arrange the identified

concept/principle in a logical sequence. The patterns adapted by students to arrange the identified concepts/principle were as follows:

- *Potential energy of the bow- external force on the arrow- the string of bow stretched- pressure of arrow at a particular point on bow- kinetic energy of the arrow- transformation of energy- string stretched backward and bow moves forward, the third law of motion- velocity of bow- the bow displaces and covers distance- work done- vibrations of sound produced.*
- *Potential energy of bow- stretched string gives kinetic energy to arrow- arrow moves- sound produced- law of conservation of energy.*
- *Potential energy of bow- external force- kinetic energy of bow- distance covered- work done*
- *External force applied- pressure on the string- Newton's third law of motion, string stretched back and arrow moves in front- motion of the arrow- sound produced.*

Forty seven point three six percent (47.36%) of the students of experimental group and thirty percent (30%) students of the control group randomly listed down the identified concepts from the image. Forty five percent (45%) students of the control group could identify only one concept from the image. Seven point five percent (7.5%) students of control group did not attempt to identify the concept from image. Seven point five percent (7.5%) control group students wrote:

- *Bow and arrow*

5.1.3.11 Identification and logical sequencing of physics concept from the image 11

The number of concepts identified by each student of the experimental group and the control group from image 11 were tabulated and the data was used to plot the graph. The graph on the number of physics concepts identified by the students on image 11 is represented below.

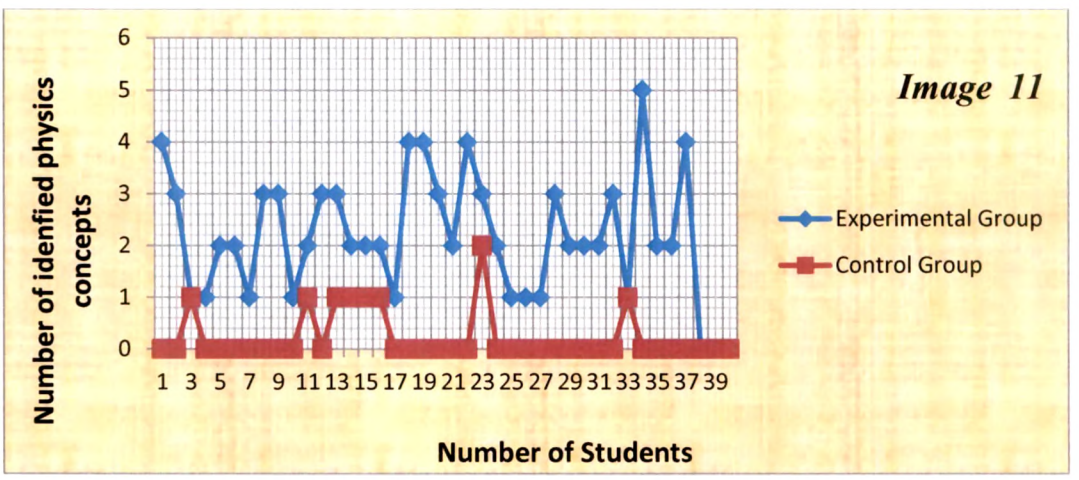

Fig 5.11 Identification of physics concepts from the image 11

From the graph it can be concluded that performance of the experimental group students was better as compared to control group on the identification of concepts from the image. The concepts identified on the image 11 by the students of experimental group and control group were listed down and frequency of identification of a particular concept by the number of students was analyzed. The analyzed data was converted into percentage and presented in the table below.

Table 5.37
Identified Concepts/Principles from Image 11

Sr. No	Concepts/Principles of Physics	Percentage (%) of students identified a particular concept/principle of physics from Image 11	
		Experimental Group (%)	Control Group (%)
1	Vibrations	63.15	-
2	Sound waves	52.63	15
3	Reflection of sound	39.47	10
4	Frequency of sound	18.42	2.5
5	Amplitude of sound	15.78	-
	Not Attempted	15.78	65

Thirty six point eight four percent (36.84%) of the students of experimental group attempted to arrange the identified concept/principle in a logical sequence. None of the control group students were able to provide a logical sequence of the identified

concepts from image. The patterns adapted by students of experimental group to arrange the identified concepts/principle were as follows:

- *Sound of heart beats of child- propagation of sound through stethoscope – multiple reflection of sound- amplification of sound waves- frequency of sound of heart beats of baby- examination of baby as per the frequency of heart beats.*
- *Sound waves- vibrations of heart beats- multiple reflection of sound*
- *Vibrations of heart beats- propagation of sound- reflection of sound in stethoscope- frequency of sound.*

Forty seven point three six percent (47.36%) students of experimental group randomly listed down the identified concepts. Two point five percent (2.5%) of the control group students could identify two concepts of *reflection of sound* and *frequency* while fifteen percent (15%) control group student could identify only one concept of *Sound* from the image. Sixty five percent (65%) students of control group and fifteen point seven eight percent (15.78%) students of experiment group did not identify any concept from the image. Seventeen point five percent (17.5%) students of control group wrote:

- *Medicine is injected to baby*
- *Doctor checking a cute baby*
- *Heart beat of baby*

5.1.3.12 Identification and logical sequencing of physics concept from the image 12

The number of concepts identified by each student of the experimental group and the control group from image 12 were tabulated and the data was used to plot the graph. The graph on the number of physics concepts identified by the students on image 12 is represented below.

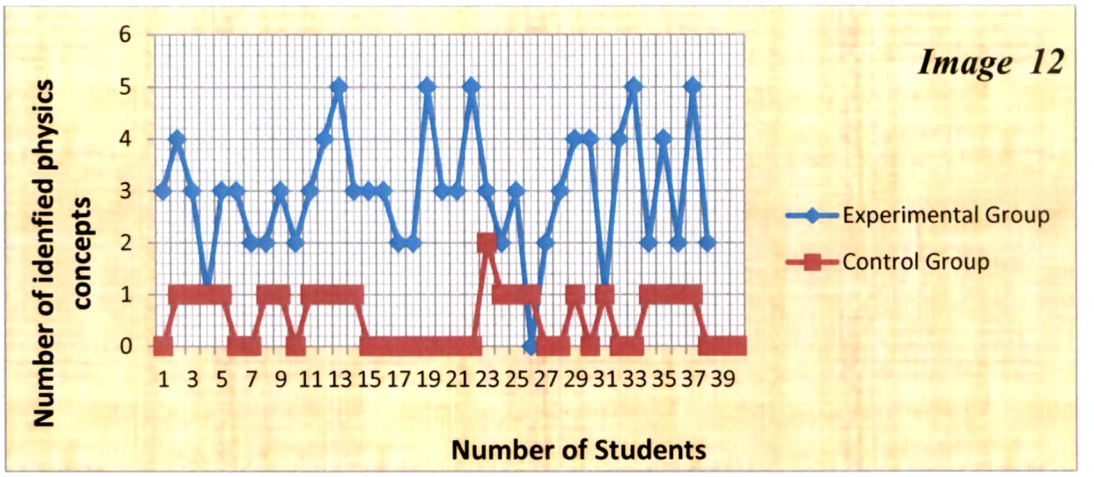

Fig 5.12 Identification of physics concepts from the image 12

From the graph it can be concluded that the performance of the experimental group students was better as compared to control group on the identification of concepts from the image. The concepts identified on the image 12 by the students of experimental group and control group were listed down and frequency of identification of a particular concept by the number of students was analyzed. The analyzed data was converted into percentage and presented in the table below.

Table 5.38
Identified Concepts/Principles from Image 12

Sr. No	Concepts/Principles of Physics	Percentage (%) of students identified a particular concept/principle of physics from Image 12	
		Experimental Group (%)	Control Group (%)
1	Ultrasound waves	81.57	47.5
2	Electric energy	55.26	-
3	Vibrations	47.36	-
4	Sound waves	44.73	2.5
5	Sound propagation	21.05	-
6	Frequency of sound	21.05	-
7	Amplitude of sound	15.78	-
	Not Attempted	5.26	27.5

Fifty two point six three percent (52.63%) of the students of experimental group attempted to arrange the identified concept/principle in a logical sequence. None of the control group students were able to provide a logical sequence of the identified concepts from image. The patterns adapted by students of experimental group to arrange the identified concepts/principle were as follows:

- *Electrical energy- sending ultrasonic vibrations- transmitted waves- conversion to electrical signals- three dimensional image of foetus- frequency and amplification of sound of heart beats.*
- *Vibrations of sound- amplitude of sound- frequency of sound- sound propagation-digital image of foetus.*
- *Ultrasound waves- vibrations- sound waves propagation- digital image of baby.*

Thirty nine point four seven percent (39.47%) students of experimental group and two point five percent (2.5%) students of control group randomly listed down the identified concepts. Forty five percent (45%) control group students could identify only one concept of *ultrasound waves* from the image. Twenty seven point five percent (27.5%) of the students of control group and five point two six percent (5.26%) experimental group students did not attempt to identify any concept from the image. Twenty five percent (25%) students of control group wrote:

- *The baby is at rest in womb*
- *Resting stage of baby*
- *Heart patients and baby foetus*
- *New born foetus evolved*

5.2 ANALYSIS OF STUDENTS' REACTION TOWARDS THE INTERVENTION PROGRAMME

The researcher constructed a reaction scale to know the reaction of the students towards the implemented intervention programme in physics topics. The students rated their responses on the reaction scale. It was analyzed using frequency, percentage and equal probability chi square technique. The analyzed data is presented below in Table 5.39

Table 5.39

Percentage analysis of student's reaction towards the intervention programme

Sr. No	*STATEMENTS*	*Always (%)*	*Most* Often (%)	*Often (%)*	*Sometimes (%)*	*Never (%)*
1.	The activities carried out during the intervention programme were meaningful.	63.15	26.31	5.26	2.63	2.63
2.	The teaching learning process adopted during the programme made concepts of physics easier to Understand.	42.10	18.42	31.57	5.26	2.63
3.	Learning through this programme was a joyful experience.	39.47	21.05	28.94	7.89	2.63
4.	The intervention programme cultivated and developed interest in physics.	50.0	18.42	23.68	7.89	-
5.	The intervention programme made learning of physics live, interesting and easy.	55.26	31.57	7.89	5.26	-
6.	The discussions carried out after each activity facilitated understanding the concept.	52.63	18.42	15.78	10.52	2.63
7.	The programme enabled me to relate the learned concepts in the class with its application in the world outside.	57.89	23.68	13.15	2.63	2.63
8.	Each activity done under particular concept was relevant.	52.63	36.84	7.89	2.63	-
9.	The programme simplified the definitions and concepts which made it easy to comprehend.	63.15	13.15	13.15	7.89	2.63
10.	Activity based learning enabled me to easily learn the difficult concepts in physics.	55.26	21.05	10.52	7.89	5.26

Sr. No	*STATEMENTS*	*Always (%)*	*Most* Often (%)	*Often (%)*	*Sometimes (%)*	*Never (%)*
11.	The intervention program enabled me to easily remember the difficult concepts in physics.	60.52	18.42	10.52	7.89	2.63
12.	Activities done during the programme facilitated understanding of the Physics concept.	65.78	15.78	10.52	5.26	2.63
13.	The intervention programme in physics concepts helped me raise my achievement scores in physics.	28.94	39.47	23.68	2.63	5.26
14.	The discussions in class during the interaction made me relate the classroom learning with my real world outside.	50.0	21.05	18.42	7.89	2.63
15.	The intervention programme enabled me visualize physics as a part of my everyday life itself.	57.89	18.42	15.78	5.26	2.63
16.	Such intervention needs to be done for the concepts in biology and chemistry also.	44.73	13.15	23.68	10.52	7.89
17.	My class was noisy and over- enthusiastic during the activities.	50.0	21.05	21.05	5.26	2.63
18.	Discussions during the interactions helped me relate one concept with the other.	60.52	18.42	15.78	5.26	-
19.	I felt free and comfortable to ask questions in the class during the interactions.	47.36	23.68	15.78	7.89	5.26
20.	The programme developed my interest in learning physics concepts.	55.26	26.31	10.52	5.26	2.63

To test the hypothesis ' There will be no significant difference in the observed frequency and frequency expected against equal probability on various statements of the reaction scale', on each statement frequencies and chi square were calculated to get better picture on students' responses. Reactions of the students' analyzed statement wise in terms of frequencies and chi square are presented below.

***STATEMENT 1*: The activities carried out during the intervention programme were meaningful.**

Table 5.40: Analysis of responses of students on statement-1

	ALWAYS	MOST OFTEN	OFTEN	SOME TIMES	NEVER	χ^2 and level of significance
f_o	24	10	02	01	01	46.95
f_e	7.6	7.6	7.6	7.6	7.6	(0.01)

At the 0.01 significant level, the table value of χ^2 against 4 degree of freedom is 13.277. For statement 1 the calculated value of χ^2 is greater than the table value of χ^2. So, the null hypothesis is rejected. Therefore there is significant difference in expected frequencies and observed frequencies.

Majority (Sixty three point one five percent) of the students were of the opinion that activities carried out during the intervention programme were always meaningful. Twenty six point three one percent of the students revealed that the most often activities carried out during the intervention were meaningful. Five point two six percent of the students often felt the activities carried out during the intervention programme to be meaningful. While two point six three percent said that the activities were sometimes meaningful. Two point six three percent of the students were of the view that the activities carried out were never meaningful. It can thus be concluded that majority of the students had a positive response towards the activities carried out during the intervention programme.

STATEMENT 2: **The teaching learning process adopted during the programme made concepts of physics easier to understand.**

Table 5.41: Analysis of responses of students on statement-2

	ALWAYS	MOST OFTEN	OFTEN	SOME TIMES	NEVER	χ^2 and level of significance
f_o	16	07	12	02	01	18.53 (0.01)
f_e	7.6	7.6	7.6	7.6	7.6	

At the 0.01 significant level, the table value of χ^2 against 4 degree of freedom is 13.277. For statement 2 the calculated value of χ^2 is greater than the table value of χ^2. So, the null hypothesis is rejected. Therefore there is significant difference in expected frequencies and observed frequencies.

Forty two point one zero percent of the students were in favour of the statement. They felt that the pedagogy adopted for the teaching of the physics concepts made it easier to understand. Eighteen point four two percent of the students were of the view that the teaching learning process most often made the physics concept easy to understand. Thirty one point five seven percent of the students felt often the teaching learning process adopted made the physics concept easier to understand while only five point two six percent said that the teaching learning process adopted during the programme sometimes made the concepts easy to understand. Two point six three percent of the students were not in favour of the statement. Thus it can be said that according to students the teaching learning process adopted during the intervention programme made concepts of physics easier to understand.

STATEMENT 3: **Learning through this programme was a joyful experience.**

Table 5.42: Analysis of responses of students on statement-3

	ALWAYS	MOST OFTEN	OFTEN	SOME TIMES	NEVER	χ^2 and level of significance
f_o	15	08	12	02	01	16.58 (0.01)
f_e	7.6	7.6	7.6	7.6	7.6	

At the 0.01 significant level, the table value of χ^2 against 4 degree of freedom is 13.277. For statement 3 the calculated value of χ^2 is greater than the table value of χ^2. So, the null hypothesis is rejected. Therefore there is significant difference in expected frequencies and observed frequencies.

Thirty nine point four seven percent of the students supported the statement. They felt that learning through the programme was always a joyful experience. Twenty one point five percent felt that learning through the programme was most often a joyful experience while thirty one point five seven percent felt learning through the programme was often a joyful experience. Only five point two six percent said learning through the programme was sometimes a joyful experience. For two point six three percent of students learning through the programme was never a joyful experience. It can be concluded that overall learning through the programme was a joyful experience for the students.

***STATEMENT 4*: The intervention programme cultivated and developed interest in physics.**

Table 5.43: Analysis of responses of students on statement-4

	ALWAYS	MOST OFTEN	OFTEN	SOME TIMES	NEVER	χ^2 and level of significance
f_o	19	07	09	03	0	24.58
f_e	7.6	7.6	7.6	7.6	7.6	(0.01)

At the 0.01 significant level, the table value of χ^2 against 4 degree of freedom is 13.277. For statement 4 the calculated value of χ^2 is greater than the table value of χ^2. So, the null hypothesis is rejected. Therefore there is significant difference in expected frequencies and observed frequencies.

Fifty percent of the students said that the intervention programmed developed interest in physics. Eighteen point four two percent were of the view that the intervention programme most often developed interest in physics while twenty three point six eight percent of the students said the intervention programme often developed their interest in physics. Seven point eight nine percent of the students felt the intervention

programme sometimes developed their interest in physics. It can be seen that a significant number of students were of the view that the intervention programme could develop their interest in physics.

***STATEMENT 5*: The intervention programme made learning of physics live, interesting and easy.**

Table 5.44: Analysis of responses of students on statement-5

	ALWAYS	MOST OFTEN	OFTEN	SOME TIMES	NEVER	χ^2 and level of significance
f_o	21	12	03	02	0	36.16
f_e	7.6	7.6	7.6	7.6	7.6	(0.01)

At the 0.01 significant level, the table value of χ^2 against 4 degree of freedom is 13.277. For statement 5 the calculated value of χ^2 is greater than the table value of χ^2. So, the null hypothesis is rejected. Therefore there is significant difference in expected frequencies and observed frequencies.

A large majority of the students (fifty five point two six percent) were of the view that the intervention programme always made the learning of physics live, interesting and easy. Thirty one point five seven percent students indicated that most often they felt the programme made the learning of physics live, interesting and easy. Nine point eight nine percent felt it often and five point two six percent viewed that sometimes the intervention programme made the learning of physics live, interesting and easy. Hence the analysis indicate that majority of the students favoured the statement.

***STATEMENT 6*: The discussions carried out after each activity facilitated understanding the concept.**

Table 5.45: Analysis of responses of students on statement-6

	ALWAYS	MOST OFTEN	OFTEN	SOME TIMES	NEVER	χ^2 and level of significance
f_o	20	07	06	04	01	24.95
f_e	7.6	7.6	7.6	7.6	7.6	(0.01)

At the 0.01 significant level, the table value of χ^2 against 4 degree of freedom is 13.277. For statement 6 the calculated value of χ^2 is greater than the table value of χ^2. So, the null hypothesis is rejected. Therefore there is significant difference in expected frequencies and observed frequencies.

According to fifty two point six three percent of students the discussions after the activity always facilitated understanding of the concept. Eighteen point four two percent said most often the discussions facilitated the understanding of the concept. Fifteen point seven eight percent were of the view that often the discussions facilitated understanding of the concept. Ten point five two percent reported that the discussions sometimes facilitated understanding of the concept whereas only two point six three percent said that the discussions never facilitated understanding of the concept. It can be concluded that the students were in favour of discussions carried out after the activities conducted.

***STATEMENT 7*: The programme enabled me to relate the learnt concepts in the class with its application in the world outside.**

Table 5.46: Analysis of responses of students on statement-7

	ALWAYS	MOST OFTEN	OFTEN	SOME TIMES	NEVER	χ^2 and level of significance
f_o	22	09	05	01	01	35.89
f_e	7.6	7.6	7.6	7.6	7.6	(0.01)

At the 0.01 significant level, the table value of χ^2 against 4 degree of freedom is 13.277. For statement 7 the calculated value of χ^2 is greater than the table value of χ^2. So, the null hypothesis is rejected. Therefore there is significant difference in expected frequencies and observed frequencies.

Majority of the students (fifty seven point eight nine percent) of the students were of the view that the programme always enabled them to relate the physics concepts with its application in the world outside. Twenty three point six eight percent of the students said that most often the programme enabled them to relate the physics concepts with its application in the world outside. Thirteen point one five percent

agreed that often the programme enabled them to relate the physics concepts with its application in the real world and two point six three percent students said that sometimes the programme enabled them. However two point six three percent of the students said that the programme never enabled to relate the physics concepts with its application in the real world. Since majority of the students were in support of the statement it can be said that the intervention programme did help the students to relate the physics concepts learnt in class with its application in the world outside.

***STATEMENT 8*: Each activity done under particular physics topic was relevant.**

Table 5.47 : Analysis of responses of students on statement-8

	ALWAYS	MOST OFTEN	OFTEN	SOME TIMES	NEVER	χ^2 and level of significance
f_o	20	14	03	01	0	36.95
f_e	7.6	7.6	7.6	7.6	7.6	(0.01)

At the 0.01 significant level, the table value of χ^2 against 4 degree of freedom is 13.277. For statement 8 the calculated value of χ^2 is greater than the table value of χ^2. So, the null hypothesis is rejected. Therefore there is significant difference in expected frequencies and observed frequencies.

Fifty two point six three percent opined that each activity done under particular physics topic was always relevant. Thirty six point eight four percent revealed that most often the activities conducted under particular physics topic were relevant. Seven point eight nine percent said that often the activities done under particular physics topic were relevant while two point six three percent were of the view that only sometimes the activities done were relevant. It can be concluded that majority of the students were in favour for the statement.

***STATEMENT 9*: The programme simplified the definitions and concepts which made it easy to comprehend.**

Table 5.48: Analysis of responses of students on statement-9

	ALWAYS	MOST OFTEN	OFTEN	SOME TIMES	NEVER	χ^2 and level of significance
f_o	24	05	05	03	01	41.53
f_e	7.6	7.6	7.6	7.6	7.6	(0.01)

At the 0.01 significant level, the table value of χ^2 against 4 degree of freedom is 13.277. For statement 9 the calculated value of χ^2 is greater than the table value of χ^2. So, the null hypothesis is rejected. Therefore there is significant difference in expected frequencies and observed frequencies.

Majority of the students (sixty three point one five percent) said that the programme always simplified the definitions and concepts. Thirteen point one five percent said that the programme most often/often simplified the definitions and concepts which made it easy to comprehend. Seven point eight nine percent were of the view that the programme sometimes simplified the definitions and concept. However two point six three percent of students were of the view that the programme never simplified the definitions and concepts of physics.

***STATEMENT 10*: Activity based learning enabled me to easily learn the difficult concepts in physics.**

Table 5.49: Analysis of responses of students on statement-10

	ALWAYS	MOST OFTEN	OFTEN	SOME TIMES	NEVER	χ^2 and level of significance
f_o	21	08	04	03	02	28.79
f_e	7.6	7.6	7.6	7.6	7.6	(0.01)

At the 0.01 significant level, the table value of χ^2 against 4 degree of freedom is 13.277. For statement 10 the calculated value of χ^2 is greater than the table value of χ^2.

So, the null hypothesis is rejected. Therefore there is significant difference in expected frequencies and observed frequencies.

Fifty five point two six percent of the students were of the view that activity based learning always enabled them to easily learn the difficult concepts in physics. Twenty one point zero six percent of the students of the responded that most often the activity based learning enabled them to easily learn the difficult concepts. Ten point five two percent of the students were of the view that often the activity based learning helped them to learn the difficult concepts. Seven point eight nine percent of the students were of the view that often the activity based learning enabled them to easily learn the difficult concepts. However only five point two six percent of the students opined that the activity based learning never enabled them to easily learn the difficult concepts in physics. Overall the students favoured the statement.

***STATEMENT 11*: The intervention programme enabled me to easily remember the difficult concepts in physics.**

Table 5.50: Analysis of responses of students on statement-11

	ALWAYS	MOST OFTEN	OFTEN	SOME TIMES	NEVER	χ^2 and level of significance
f_o	23	07	04	03	01	37.58
f_e	7.6	7.6	7.6	7.6	7.6	(0.01)

At the 0.01 significant level, the table value of χ^2 against 4 degree of freedom is 13.277. For statement 11 the calculated value of χ^2 is greater than the table value of χ^2. So, the null hypothesis is rejected. Therefore there is significant difference in expected frequencies and observed frequencies.

Majority of the students (sixty point five two percent) were of the opinion that the intervention programme always enabled to easily remember the difficult concepts in physics. Eighteen point four two percent of the students were of the view that most often the programme enabled to remember the difficult concept in physics. Ten point five two percent of the student opined that often the programme enabled to remember the difficult concepts. Seven point eight nine percent of the students revealed that only

sometimes the programme enabled to remember the difficult concepts. Two point six three percent of the students felt that the programme never enabled to remember the difficult concepts in physics. Majority of the students favoured the statement.

***STATEMENT 12*: Activities done during the programme facilitated understanding of the physics concept.**

Table 5.51: Analysis of responses of students on statement-12

	ALWAYS	MOST OFTEN	OFTEN	SOME TIMES	NEVER	χ^2 and level of significance
f_o	25	06	04	02	01	47.32
f_e	7.6	7.6	7.6	7.6	7.6	(0.01)

At the 0.01 significant level, the table value of χ^2 against 4 degree of freedom is 13.277. For statement 12 the calculated value of χ^2 is greater than the table value of χ^2. So, the null hypothesis is rejected. Therefore there is significant difference in expected frequencies and observed frequencies.

Sixty five point seven eight percent said that the statement always held true. Fifteen point seven eight percent said that the statement was found to be most often true while ten point five two percent of the students found the statement to be true often. Five point two six percent opined that the statement was found to be sometimes true while two point six three percent students said that the statement was never found to be true. It can be concluded that the activities done during the programme facilitated understanding of the physics concept.

***STATEMENT 13*: The intervention programme in physics concepts helped me raise my achievement scores in physics.**

Table 5.52: Analysis of responses of students on statement-13

	ALWAYS	MOST OFTEN	OFTEN	SOME TIMES	NEVER	χ^2 and level of significance
f_o	11	15	09	01	02	15.79
f_e	7.6	7.6	7.6	7.6	7.6	(0.01)

At the 0.01 significant level, the table value of χ^2 against 4 degree of freedom is 13.277. For statement 13 the calculated value of χ^2 is greater than the table value of χ^2. So, the null hypothesis is rejected. Therefore there is significant difference in expected frequencies and observed frequencies.

Twenty eight point nine four percent of the students agreed that the programme helped in raising their achievement scores in physics. Thirty nine point four seven percent felt the same most often and twenty three point six eight percent felt the same often. Two point six three percent of the students felt it sometimes. However five point two six percent of the students were against the statement. Majority of the students supported the statement and hence it can be said that the intervention programme in physics concepts helped the students to raise their achievement scores in physics.

***STATEMENT 14*: The discussion in class during the interaction made me relate the classroom learning with my real world outside.**

Table 5.53: Analysis of responses of students on statement-14

	ALWAYS	MOST OFTEN	OFTEN	SOME TIMES	NEVER	χ^2 and level of significance
f_o	19	08	07	03	01	22.74
f_e	7.6	7.6	7.6	7.6	7.6	(0.01)

At the 0.01 significant level, the table value of χ^2 against 4 degree of freedom is 13.277. For statement 14 the calculated value of χ^2 is greater than the table value of χ^2. So, the null hypothesis is rejected. Therefore there is significant difference in expected frequencies and observed frequencies.

Fifty percent of the students agreed that the discussion in class during the interaction always made them relate the classroom learning with their real world outside. Twenty one point five percent of the students felt the statement most often and eighteen point four two percent felt so often. Seven point eight nine percent students felt that the discussion in class sometimes made them relate the classroom learning with their real

world outside while two point six three percent students never felt so. Hence majority of the students supported the statement.

***STATEMENT 15*: The intervention programme enabled me visualize physics as a part of my everyday life itself.**

Table 5.54: Analysis of responses of students on statement-15

	ALWAYS	MOST OFTEN	OFTEN	SOME TIMES	NEVER	χ^2 and level of significance
f_o	22	07	06	02	01	33.89
f_e	7.6	7.6	7.6	7.6	7.6	(0.01)

At the 0.01 significant level, the table value of χ^2 against 4 degree of freedom is 13.277. For statement 15 the calculated value of χ^2 is greater than the table value of χ^2. So, the null hypothesis is rejected. Therefore there is significant difference in expected frequencies and observed frequencies.

Majority of the students (fifty seven point eight nine percent) favoured that the intervention programme always enabled them to visualize physics as a part of their life. Eighteen point four two percent said that they felt it most often whereas fifteen point seven eight percent said they felt so often. Five point two six percent said that sometimes the intervention programme enabled to visualize physics as a part of their life and two point six three said they never felt so.

***STATEMENT 16*: Such intervention needs to be done for the concepts in biology and chemistry also.**

Table 5.55: Analysis of responses of students on statement-16

	ALWAYS	MOST OFTEN	OFTEN	SOME TIMES	NEVER	χ^2 and level of significance
f_o	17	05	09	04	03	13.556
f_e	7.6	7.6	7.6	7.6	7.6	(0.01)

At the 0.01 significant level, the table value of χ^2 against 4 degree of freedom is 13.277. For statement 16 the calculated value of χ^2 is greater than the table value of χ^2. So, the null hypothesis is rejected. Therefore there is significant difference in expected frequencies and observed frequencies.

Forty four point seven three percent of the students said that such intervention needs to be done in biology and chemistry also. Eighteen point four two were of the view that they need such intervention in biology and chemistry most often whereas twenty three point six eight percent felt its necessity often. Ten point five two percent of the students said that they needed such interventions in biology and chemistry sometimes while seven point eight nine percent never felt such need. It can be concluded that majority of the students felt the need of such interventions for the concepts in biology and chemistry also.

***STATEMENT 17*: Such intervention needs to be done for the concepts in biology and chemistry also.**

Table 5.56: Analysis of responses of students on statement-17

	ALWAYS	MOST OFTEN	OFTEN	SOME TIMES	NEVER	χ^2 and level of significance
f_o	19	08	08	02	01	23.95
f_e	7.6	7.6	7.6	7.6	7.6	(0.01)

At the 0.01 significant level, the table value of χ^2 against 4 degree of freedom is 13.277. For statement 17 the calculated value of χ^2 is greater than the table value of χ^2. So, the null hypothesis is rejected. Therefore there is significant difference in expected frequencies and observed frequencies.

Fifty percent of the students reported that the class was always noisy and over enthusiastic during the activities. Twenty one point five percent said that the class was most often noisy and over enthusiastic. The other twenty one point five percent students were of the opinion that the class was often noisy and over enthusiastic during the activities. Five point two six percent of students said that the class was

sometimes noisy and over enthusiastic while two point six three percent students never felt so.

***STATEMENT 18*: Discussion during the interaction helped me relate one concept with the other.**

Table 5.57: Analysis of responses of students on statement-18

	ALWAYS	MOST OFTEN	OFTEN	SOME TIMES	NEVER	χ^2 and level of significance
f_o	23	07	06	02	0	39.42
f_e	7.6	7.6	7.6	7.6	7.6	(0.01)

At the 0.01 significant level, the table value of χ^2 against 4 degree of freedom is 13.277. For statement 18 the calculated value of χ^2 is greater than the table value of χ^2. So, the null hypothesis is rejected. Therefore there is significant difference in expected frequencies and observed frequencies.

Majority of the students favoured the statement. Sixty point five two percent of the students were of the view that discussion during the interaction always helped them to relate one concept with the other. Eighteen point four two percent students felt that most often the discussions helped in relating one concept with the other while fifteen point seven eight percent students often felt so. Five point two six percent students felt that the discussions sometimes helped them to relate one concept with the other.

***STATEMENT 19*: I felt free and comfortable to ask questions in the class during the interactions.**

Table 5.58: Analysis of responses of students on statement-19

	ALWAYS	MOST OFTEN	OFTEN	SOMETIMES	NEVER	χ^2 and level of significance
f_o	18	09	06	03	02	18.79
f_e	7.6	7.6	7.6	7.6	7.6	(0.01)

At the 0.01 significant level, the table value of χ^2 against 4 degree of freedom is 13.277. For statement 19 the calculated value of χ^2 is greater than the table value of χ^2. So, the null hypothesis is rejected. Therefore there is significant difference in expected frequencies and observed frequencies.

Forty seven point three six percent of the students always felt free and comfortable to ask questions in the class during the interactions. Twenty three point six eight percent students were of the view that most often they felt free to ask questions in the class while fifteen point seven eight percent often felt free to ask questions in the class. Seven point eight nine percent said that they sometimes felt free and comfortable to ask questions in the class during the interaction while five point two six percent said that they never felt free to ask questions in class. Overall it can be seen that the students positively responded to the statement.

***STATEMENT 20*: The programme developed my interest in learning physics concepts.**

Table 5.59: Analysis of responses of students on statement-20

	ALWAYS	MOST OFTEN	OFTEN	SOMETIMES	NEVER	χ^2 and level of significance
f_o	21	10	04	02	01	31.95
f_e	7.6	7.6	7.6	7.6	7.6	(0.01)

At the 0.01 significant level, the table value of χ^2 against 4 degree of freedom is 13.277. For statement 20 the calculated value of χ^2 is greater than the table value of χ^2. So, the null hypothesis is rejected. Therefore there is significant difference in expected frequencies and observed frequencies.

Majority of the students were of the view that the programme developed their interest in learning physics concepts. Fifty five point two six percent of the students always felt that the programme developed their interest in learning physics concepts. Twenty six point three one felt the same most often. Ten point five two percent of the students responded that the programme most often developed their interest in learning physics concepts while five point two six percent students felt the same sometimes. However two point six three percent of the students were of the view that the programme never

developed their interest in learning physics concepts. Overall the students of the experimental group had a favourable positive reaction towards the implemented intervention programme.

The chapter dealt with the analysis and interpretation of the data obtained from the study. It can be concluded that the intervention programme in physics could make a significant difference in the achievement of the students of experimental group. The developed programme was effective and the students had positive reaction towards the implemented intervention programme on the physics concepts. The next chapter attempts to draw the findings from the analysis and interpreted data and draw implications and inferences keeping in view the reviewed literature.