

Chapter 5

Data Analysis and Interpretation

CHAPTER 5

DATA ANALYSIS AND INTERPRETATION

5.0 INTRODUCTION

In the present chapter data analysis and interpretation is presented objective wise. As explained in the earlier chapter the present study endeavored in developing an instructional strategy and studying its effectiveness for comprehension in science among class VII students. Before developing an instructional strategy the researcher intended of doing situational analysis of the way science is taught in various schools in Vadodara city. In order to collect data for the said purpose classroom observations were done, semi structured interviews with teachers teaching the subject science and technology at seventh class was carried out and field notes were prepared during the seventy five classroom observations to note down the interactions taking place in the classroom. The participation of the students was also observed and interactions between teacher and students were noted down. The verbatim of the classroom observations was noted in the field note. The data analysis and interpretation of the observation of the classroom transaction is presented in the following paragraphs. The data analysis and interpretation of the responses of the students during the conduct of the activities during the process of implementation of the instructional strategy is also described in detail. The effectiveness of the instructional strategy is described in detail by calculating t value for each chapter followed by calculation of t value for all the six chapters. The effectiveness of the instructional strategy is also determined by calculating t value for the test based on science comprehension in the form of stories. The following paragraphs present detailed description of the analysis and interpretation.

5.1 ANALYSIS AND INTERPRETATION OF CLASSROOM OBSERVATION

The data analysis and interpretation of situational analysis is presented in the following section doing content analysis and classifying the data under different categories. The lesson observed were analysed categorizing the data into categories like introduction, explanation, use of audio visual aid, method and approaches of teaching, home work given. The detailed analysis under each of the categories is presented under separate sub caption.

5.1.1 Introduction of the lesson or sub content of the lesson

The manner the introduction of lesson is done is known to affect the responses of the students to the instructional process, Chiappetta and Collette (1984). The introduction

done during seventy five classroom observations of class VII of Vadodara city to teach the subject science and technology as observed by the researcher is presented in the following paragraphs. The researcher observed that the teachers did not use any activity or demonstration to introduce the lesson. In all the 100 percent cases it was found that the introduction of the lesson was done by directly writing the topic on the black board or either asking question related to the content taught previously. Topics such as force, electrostatic force, magnetic force, frictional force, lever, sensory organs which has lot of scope of either doing demonstrations of discrepant event, or putting thought provoking questions, showing a power point presentations were simply taught by writing the topic on the board followed by reading the content from the text book. Even the topics where in there is lot of scope of involving students in discussion like science in daily life were also taught by placing one or two questions. In thirteen percent of the cases it was found that the teacher did not take pain to write the name of the chapter on the board, rather it was also found that the class was of science and there was another subject note like Gujarati content written on the board or mathematics sum on the board. The teacher did not bother to erase the board. The way some of the teachers introduced the lesson is presented in the form of the episode in the following segment.

Episode 1

Teacher wrote the topic science in daily life on the blackboard and asked the students what does it mean?

Student 1 responded mobile. The teacher without listening to what the student wants to convey or further probing or letting other students to respond started reading the paragraph from the book followed by explanation.

Episode 2

Teacher instructed the students to leave one page for hard words and instructed students to underline hard words. Teacher asked who will tell the points covered under transportation in the previous class. Then the teacher started with the next topic.

Episode 3

Chapter was on science in daily life

Teacher: who will repeat the topics covered in the previous class, instructed the students to raise hand and answer.

Student1 transportation, communication and entertainment

Teacher asked about development in sequential order

Student 2 answered bus, rail Airplane

Teacher: what is information science? Who will explain? It is related to what?
Without waiting for reply teacher went further *Computer. We are able to do work within fraction of second. Information explosion has made fast development.* Further teacher talked about big size computer and now availability of palmtop and also informed about pen drive.

There was a little murmuring as soon as teacher talked about palmtop and pen drive. To this the teacher immediately said why is there murmuring and all were silent. Teacher instructed one student to read the further paragraph. When the student was reading the paragraph the teacher made the students underline hard words and instructed the students to write hard words five times.

Episode 4

Teacher: There are hundreds of diseases caused due to fungi but only three are mentioned here. So we are going to study only three. Then the teacher started reading the paragraph from the book.

Episode 5

Teacher: From where do I get energy to push the table?

Students: Food

Teacher: yes I get the energy from the food and thus can push the table

Teacher: how does a train move? Teacher without waiting for students response went on saying *train is nonliving and gets energy from the diesel (external fuel) to move. Living things get energy from food they eat and nonliving things get energy from external source. Define motion.* Teacher asked the students to define motion
Students could not come out with the definition.

To this the teacher said *from move came the word motion anything that moves is in motion. Today we are going to study motion and types of motion.*

Episode 6

Teacher wrote the topic our body part III and then said in this chapter we will study nervous system and sensory organs.

In certain other instances it was found that the teacher asked questions before continuing the chapter further. Few questions which were raised in different classroom situations are listed down.

What is electricity? Who will tell?

Who will revise adaptation?

Virus *kaun sa organism hai?* What is difference between virus and bacteria?

What is the difference between planet and star?

Who will tell adaptations in Xerophytes?

Who will revise adaptation in desert animal? (Immediately after this question the teacher gave hint by telling try to remember camel).

It was observed that the teacher did not give time to students to think and was observed that the teachers wanted the answer immediately after asking question(s). It was found that teachers involved only those students who volunteered to answer. Teachers never involved the non-volunteers in the class. The questions raised by the teacher focused on recall and recognize type and none of the teachers asked question catering to understanding or application level. It was also found that the teacher after asking the question either did not wait for student's response and if as in some case wait then did not relate it to what is to be taught further. In few instances the teacher themselves answered the question without waiting for the students to respond. The researcher strongly feels that the introduction of the topic should be such that creates curiosity in the mind of the students and make them inclined towards the subject.

5.1.2 Explanation of the concepts of the lesson

The teacher started with the chapter Circulatory System-Endocrine System. The exact happenings in the class are put in the following section in the form of episodes.

Episode 7

The teacher asked the question: Name the different types of system in our body. The students answered one by one. One of the students said digestive other said nervous third said respiratory and circulatory system. The teacher said yes all are the different systems in our body. Today we are going to learn circulatory system. Then she said *hum jo khate hai sab kuch body ke leye accha nahi hota* (whatever we eat is not good for our body). *Hum fast food khate hai* (we have fast food) *Who will explain balance diet?* To this the student said necessary nutrients vitamin, proteins, fats, minerals. Teacher said yes then said *when we breath in oxygen blood circulation se kya hoga* (what will happen because of blood circulation?) *tumne blood circulation padha tha?* (You have read blood circulation) *why is blood circulation necessary?* Nobody responded and therefore teacher went on saying *purification of blood, impure blood pheche jata hai* (impure blood goes back). *Blood hamare body ko oxygen pohochata hai aur carbon dioxide bahar nikalta hai* (blood provide oxygen to our body and removes carbon dioxide). *We go for morning walk. Air me oxygen hota hai*

(air contains oxygen). *Ye sab pura kam karne ke liye ek system hai neche definition deya hai underline karna* (in order to perform all this task there is one system. There is the definition, underline it). The teacher read the definition from the book “the system consisting of organs associated with blood circulation is known as blood circulatory system” teacher said underline it and then read it again.

It can be deduced from the above episode that the teacher was not following a sequential manner to teach rather the teacher was breaking the flow of teaching. As evident in the above episode the teacher while teaching a particular concept suddenly in between raised question (hum fast food kate hai..... who will explain balanced diet) which may be due to lack of planning on the part of the teacher.

Episode 8

Teacher was teaching the topic motion. Teacher was walking in the class. Teacher asked what am I doing? *Walking that is I am moving from moving came word motion. Anything that moves is in motion. Non living things can also move. Teacher asked the students is the leaf of the tree in motion?*

Students: few of them said yes few no

Teacher without responding to this went on to another concept speed. *Teacher started reading paragraph from the book. Teacher also read about the concept of speed.* One of the students asked the teacher a question.

Students asked what is velocity?

Teacher told velocity is scientific word for speed. Maie jaldi jaldi bolte hu to aap log mujhe bolte ho na ke aap ki speed bahot jayada hai. (when I speak fast you all tell me that madam your speed is fast) that is nothing but velocity. In science we use speed as velocity. Velocity is twenty five kilometer per hour. What is hour? Teacher herself told travelling time. *Teacher told velocity is distance divided by time and that is speed.*

The bell rang and the teacher told the students to read the paragraph covered.

It is deduced from the classroom observations that the language used for explanation of the terms was more focused to the language used in the text book. It was also observed that the teachers followed to teach the concept following the sequence in which the concepts have been presented in the textbook. It was found that the teachers used to read out the content presented in the text or made the students read out the content given under each paragraph and then explained the same thing either using the same language in English or translated the same thing in vernacular language or hindi language. The concept of motion was incorrectly taught in one of the classes wherein

the teacher said that the leaf is not in motion and confidently said that the leaf is in locomotion. Here the teacher was not clear about the concept of motion and locomotion. The concept of velocity and speed were incorrectly taught as mentioned in episode 8.

In one of the cases the teacher related the concept of parallel lines in mathematics while teaching the concept of bulbs in parallel connections.

While teaching the concept of electricity and flow of electrons the teacher asked the question why does the bulb glow? The student answered in Hindi *iron touch hota hai to on aur nahi hota to off* (if the iron touches then it is on and if it does not touch then off). Here the teacher should have clarified that in case of bulb the wire is not made of iron and also could have probed further as to when the wire touches the bulb what happens which makes the bulb glow and thus could have clarified that it is the flow of electrons which make the bulb glow.

In one of the classroom observation it was found that the teacher was explaining about the solar system by reading the content given in the book. In the book there is a mention of planet Pluto in the solar system the teacher did not inform the students that the planet is not considered as a planet as per the new researchers in the field of science and technology when asked by the researcher the teacher responded that as the planet is mentioned in the book and therefore it is necessary that it is taught as planet and strongly opined that it is important to follow the text book.

5.1.3 Method and Approach of teaching

In sixty percent of the classroom observation it was found that the teachers used to read out the content given in the textbook followed by explanation or first explained the concept and then read the content given in the text book. In some of the cases it was also observed that one of the students was made to read the paragraph followed by explanation in Hindi. In thirty percent of the cases teachers used lecture method while in rest ten percent of the case it was found that the teacher either used demonstration to explain the concept or used realia media to explain the concept. In none of the classroom observation the activity based teaching, inquiry based teaching, problem solving was used. None of the teachers divided the class into subgroups and made the students interact among themselves or conduct an activity in a group related to concepts to be learned. Thus it can be deduced that the teachers used to follow teacher centred approach of teaching. The method followed by the majority of the teachers to teach was by reading the paragraph from the book and then explaining or

first explaining and then reading out the paragraph from the book. One of the classroom observations is presented in the following episode.

Episode 9

The teacher was teaching the sensory organ tongue

Teacher: *Yash Jor she Bolo.* (Yash read aloud) *After the student completed reading teacher said now listen tongue se he sab hota hai* (teacher said tongue is responsible for many things). *Garam dud phi liya* (if you happen to drink very hot milk) *for two days you do not have sense. Jab khate ho tongue muh me gumati hai* (while you eat the tongue moves in the mouth). *Saliva is liberated. Tongue is useful in speaking. Ghar jana sugar lena, salt lena, lemon lena aur neem juice lena* (go home take sugar, salt, lemon and neem juice). *On our tongue various cell or taste bud are there. Figure me deko tip sweet then salty peche bitter* (look into the figure tip part sweet then salty and then bitter). *Each taste bud has special type of cell connected to nerve cell which in turn is connected to brain. Ye cells* (these cells) *are connected to sensory bud. When food material is put in mouth sensory bud will say bahut kadava he brain message dega duk do* (sensory bud will say it is very bitter and then the brain will give the message spit it out). *Diagram tongue ka karana jaruri nahi hai* (it is not necessary to do the diagram of tongue). *We are starting with the next organ.*

It was observed that teacher made use of the diagrams given in the textbook to explain the concepts there was no teaching aid used to explain the concept. Here there was a scope of making the students feel which taste is felt on which part of the tongue by providing the students with different food items having sweet, salty and bitter taste. It is also seen here that the teacher is telling the students that it is not important to do the diagram of tongue.

5.1.4 Home work given

The homework given in most of the cases was either to write short notes or hard words or learning few concepts or in some cases no homework. Researcher found that the teachers did not give any challenging, innovative, creative homework to the students which really would make the student interested in the subject as well as develop scientific attitude among the students. It was felt that the homework was given in order to promote the product aspects of science. In majority of the cases it was found that homework was to write about concept of science or draw the diagram. In few of the cases it was observed that the teacher made the students underline the paragraph in the textbook and instructed the students to write the answers to the

chapter end exercise. Some of the home works given are presented in the following paragraph.

In one of the cases teacher told the students to prepare chart in groups' one on transportation, one on communication. The teacher did not specifically tell who is going to prepare which chart. She just instructed to prepare chart in group. The same teachers classes were observed till the end of the chapter but to the surprise of the researcher the teacher never bothered to find out whether the students made chart or not?

In another case teacher told the students to write the hard words underlined five times in their notebook. When asked by the researcher why is it that the hard words are underlined and students are made to write it five times the teacher opined that the students are yet developing the concept of science and therefore they are unaware of scientific terms so it is important that the students know each term and further added that it is found that the students don't know the spelling of many scientific word and spell it incorrectly in the examination so the students are made to write the words five times so that they learn the spelling as well as the word. Some other common homework given are as cited below

Write short notes on television and computer.

Learn three to four points for each planet

Write short notes on satellite

Write note on diseases caused by fungi

Complete the chapter end exercise

Students were given homework of learning the general symptoms for ring worm, psoriasis, exzema.

In one case the teacher gave the students to list the appliance in their home which works on electricity.

Read the chapter further or in some cases read whatever is taught in the class

Thus it can be deduced that the teachers gave homework focusing on writing of chapter end exercise or learning few concepts or writing short notes. It was also observed that the teacher made the students underline the answers in the textbook to the questions given in homework.

5.1.5 Use of Audio-Visual Aids and or demonstrations

As mentioned earlier in ninety percent of the cases teacher did not use any teaching aid while in ten percent of the case it was found that the teacher made use of

demonstration or realia media. In one of the classroom observation where in the teacher was teaching the topic parts of flower teacher made use of flower of vinca rosea and hibiscus. The classroom transaction is presented in episode ten.

Episode 10

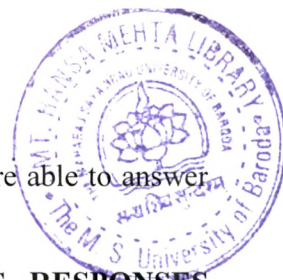
Teacher started the class by writing the chapter name flower and fruit. Teacher told the students that in this chapter they will be studying in details about various parts of the flower. Teacher explained about Vinca Rosea and Hibiscus. The teacher showed the students the Hibiscus and Vinca Rosea and told the students that vinca rosea is a flower which is found the entire year. The students were given flower vinca rosea one on each bench and then the teacher explained each part of the flower. The teacher also passed on hibiscus one on each bench and then explained each part of the flower. The students were then asked to identify each part of both the flowers one after the other. The teacher then explained the different parts of the flower and then made the students write about plants that flowers throughout the year and those which flowers once a year.

In another instance the teacher was teaching the chapter chemical substance and was teaching the topic preparation of carbon dioxide gas. The teacher taught the topic by demonstration. The classroom interaction is presented in the form of episode below.

Episode 11

The teacher instructed the students that one activity will be performed and everybody will be able to see. Teacher instructed the students to remain at their place only. The teacher instructed the class to make observation when the demonstration is being performed. The teacher took a transparent bottle and placed calcium carbonate in the bottle and added hydrochloric acid to the bottle. Then the teacher placed the burning incense stick in the bottle. The incense stick extinguished. The teacher asked the students to tell their observations one by one. The students said that the incense stick when placed in the bottle the stick got extinguished. The teacher said that the incense stick got extinguished because of the carbon dioxide which is also known as fire extinguisher. The teacher then wrote the chemical reaction which takes place when hydrochloric acid reacts with calcium carbonate. The students were instructed to note down the reaction in their book along with the properties of carbon dioxide gas.

It was observed that in both the classroom the students were highly active as compared to rest of the class. The students were very eager to learn the content and were curious to know as to what will happen next. The students were able to note



down observations as to what happened to the incense stick and were able to answer to the question raised by the teacher.

5.2 ANALYSIS AND INTERPRETATION OF STUDENTS RESPONSES DURING THE IMPLEMENTATION OF THE INSTRUCTIONAL STRATEGY

The researcher collected the data while the students were performing activities by noting down the responses of the students in the field note either by interacting with the students and/or referring the notebook as well as worksheets of the students. The analysis and interpretation of the data collected is presented in the following paragraph activity wise.

5.2.1 Analysis and interpretation of responses of students on activity for muscular force

In order to make the students understand the concept of muscular force there was tug of war organized among the class students. The class was divided into two subgroups and the students were made to play tug of war. After the play there was a discussion session held where in number of questions were raised and the students answered to the questions. The students were of the opinion that there is a force of pulling which is involved when they play tug of war. All the students said that the teams were trying to pull the opposite team towards them. Some of them opined that both the teams were applying pull in other direction. One of the student said that energy force is applied. Some of the students reported that the teams were applying force in the same direction. When probed further, majority of the students said that team A was applying force towards team A and team B was applying force towards its own side. They meant each team was applying force so as to pull the members of the opposite team towards the direction of their own team. During the discussion session held after the tug of war the students were asked to give some examples where in similar type of force is exerted. Initially only twenty percent of the students could come out with the answer. The students said that this type of force is seen in *kusti* and boxing. Few of the students responded that in weight lifting, lifting any object like, bag, compass, textbook, drawing water from well, taking out water from underground tank or over head tank also similar type of force is applied. The students were of the opinion that there is no motion involved while some of them said yes there is motion involved when they pull the opposite team. This may be because every time the team applied force there may not be any motion of the other team members as the opposite team

was also applying force. It could be deduced that students tried to relate the concept with the requirement of lot of strength to pull the other team members and therefore one of the students reported that energy force is applied. Few students were saying that there is pulling and therefore the force is of pulling. Thus it is clear that students have the concept that there is some pull required when the other team members are to be brought near their team but the students are not clear as to the pull which is applied requires muscular pull and therefore the force involved is called muscular force. On further probing few more students could come out with the examples such as when the cyclist paddles the cycle the force involved is muscular force. Even while playing basket ball, football, cricket and many more games there is muscular force involved. Then when the students were asked to define muscular force in their own words majority of the students could come out with their own definition of muscular force.

5.2.2 Analysis and interpretation of responses of students on activity for magnetic field lines and magnetic force

In order to develop the concept of magnetic field lines and magnetic force there was activity organized where the students were to find the distance from which the magnet attract the u pin. Students in eight different groups were able to observe and report that there is no physical contact required for attraction. But the groups initially found it difficult to find the maximum distance from which the given bar magnet can attract the u pins. The researcher demonstrated in one case taking a plastic scale and putting the u pin near the plastic scale such that one end of the u pin touches the zero of the scale the magnet was kept at a distance twelve centimeter on the scale gradually the researcher brought the magnet towards the u pin and then the students were able to see that the u pin got attracted to the magnet when the magnet was at 2.8 cm from the u pin, this then made the students find the maximum distance till which the force of magnet was felt. Students in all the groups were able to find that the magnet attracts the pins from some distance. The students also reported that if the pin is taken very far away from the magnet the magnet does not attract the pin. Thus the concept was developed that the magnet can exert the force in a limited region. The students could infer that there is no contact required for the magnet to attract the u pins. The students could also find that the distance at which the magnet is attracting the u pin is in between one and four centimeter. The reading taken by the group of students at which the bar magnet attracts the u pin is presented in the table 5.1.

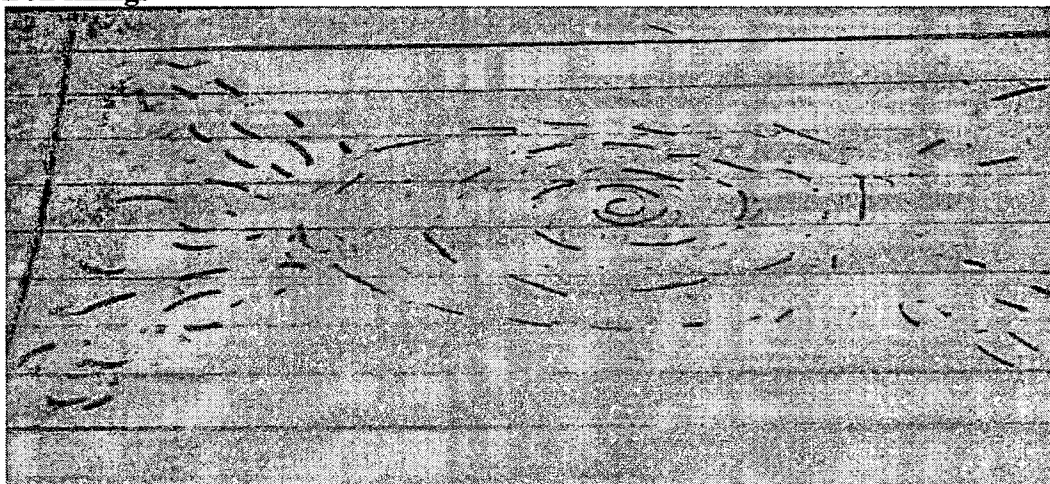
Table: 5.1
Reading of all groups denoting distance at which bar magnet attracts the u pin

Group number	First reading	Second reading	Third reading
Group number 1	2.8 centimeter	2.6 centimeter	2.6 centimeter
Group number 2	1.0 centimeter	1.2 centimeter	1.4 centimeter
Group number 3	2.0 centimeter	2.4 centimeter	2.6 centimeter
Group number 4	3.0 centimeter	3.2 centimeter	3.4 centimeter
Group number 5	1.0 centimeter	1.1 centimeter	1.3 centimeter
Group number 6	4.0 centimeter	2.0 centimeter	1.5 centimeter
Group number 7	3.0 centimeter	4.2 centimeter	2.8 centimeter
Group number 8	2.4 centimeter	2.6 centimeter	2.8 centimeter

It is deduced from the above table that the group number 1, 3 and 8 were much closer to the accurate value at which the bar magnet started attracting the u pins. The group 2 and 5 could not actually measure the correct distance. In case of the reading taken by group 6 there was lot of variation. But all the groups could infer that the magnet attracts the u pins from some distance. The students of all the groups responded that the magnet attracts the u pin from a little distance.

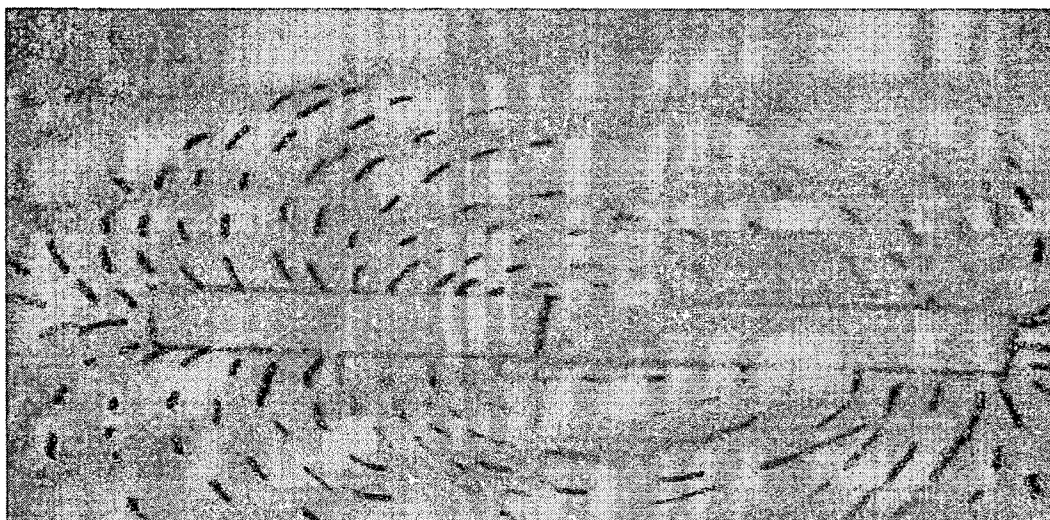
Students in all the eight different groups were able to get the magnetic field lines with the help of iron fillings and the bar magnet placed on a white sheet of paper. The students could also respond that the magnetic field lines are concentrated more at the poles and comparatively less at the centre. The students were able to draw the magnetic field lines before conducting the experiment but after actually conducting the experiment there was change in the perception of the students on how the actual magnetic field lines look like and thus there was refinement in the drawing of magnetic field lines. There was distinct difference seen in the drawings before the actual conduct of the experiment and after the conduct of the experiment. Some of the drawings of the students before and after the experimenting are presented in the following part in the form of frame:

Frame: 5.1 Diagram of the magnetic field lines drawn by student one before carrying out experiment of obtaining magnetic field lines with a bar magnet and iron fillings



The diagram above shows that the student felt that magnetic field lines originate as a whorl in water as seen in the middle part of the diagram. The diagram does not clearly describe the magnetic field lines at the centre and at the poles. While when we look at the diagram below in frame 5.2 it is clear that the student's perception about magnetic field lines has got refined. Though the diagram distinctly clarifies the number of field lines concentrated at the centre and the field lines concentrated at the poles of the magnet still the clarity as to the magnetic field lines originate at the poles has not yet developed. It can be deduced that the student was not able to perceive that the magnetic field lines originate from the poles.

Frame: 5.2 Diagram of magnetic field lines by student one after experimenting with iron fillings and bar magnet.



It is quite clear from the above two diagrams drawn by the same student that the clarity comes as to how will the magnetic field lines appear when the students are actually involved in conducting the experiment.

Similar is the case with the diagram drawn by student two as shown below. From the diagrams below it is very clear that the student had the concept of magnetic field lines but the concept that magnetic field lines are more at the poles and less at the centre was not much clear. From the two diagram presented below it is clear that the students perception that the magnetic field lines are concentrated more at the poles was attained but still the clarity as to magnetic field lines originate from the poles has not yet developed. The diagram after experimentation shows that the concentration of field lines is more at the poles as clearly visible from the two diagrams.

Frame: 5.3 Diagram of magnetic field lines by student two before and after experimenting with iron fillings and bar magnet.

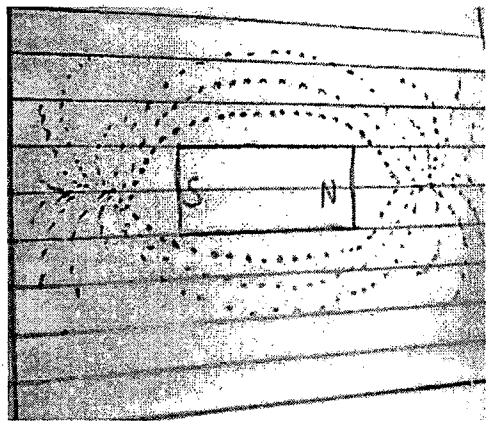


Diagram before experimentation

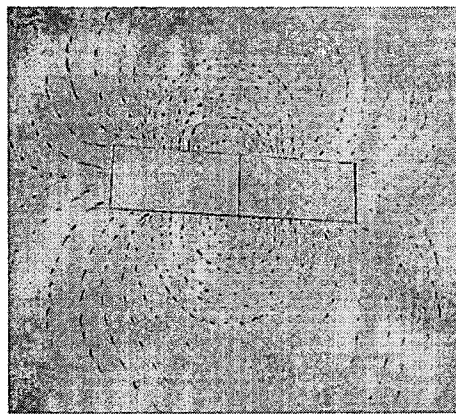


Diagram after experimentation

After the experimentation the student was clear that the field lines are concentrated more at the poles as compared to the center is absolutely clear in the student and is very well apparent from both the diagrams.

The frame below shows the diagram drawn by third student before and after conducting the hands on activity of experimenting with bar magnet and iron fillings on a white sheet of paper.

Frame: 5.4 Diagram of magnetic field lines by student three before and after experimenting with iron fillings and bar magnet.

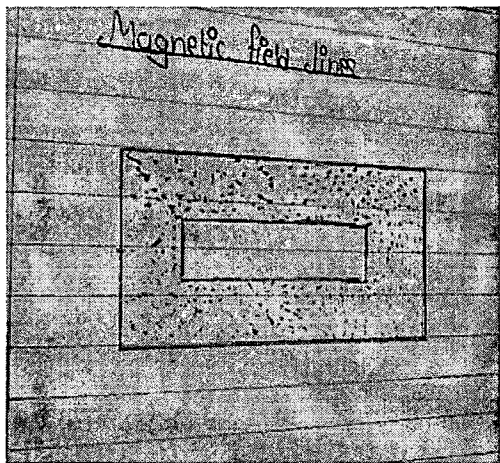


Diagram before experimentation

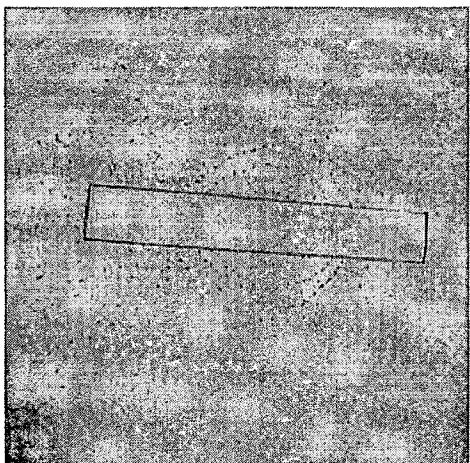


Diagram after experimentation

From the above diagram of the same student before actually conducting the experiment of spreading iron filling on white paper on which bar magnet is placed clearly indicates that the student was not very clear as to magnetic field lines. After the conduct of the experiment there was some change in the perception of the student about the magnetic field lines however still the student was not able to comprehend that the magnetic field lines originate from the poles. But the student was clearly able to comprehend that the magnetic field lines are concentrated more at the poles as compared to the centre of the magnet.

Frame: 5.5 Diagram of magnetic field lines by student four before and after experimenting with iron fillings and bar magnet.

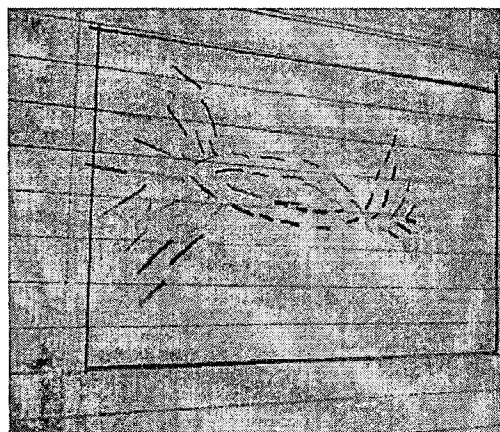


Diagram before experimentation

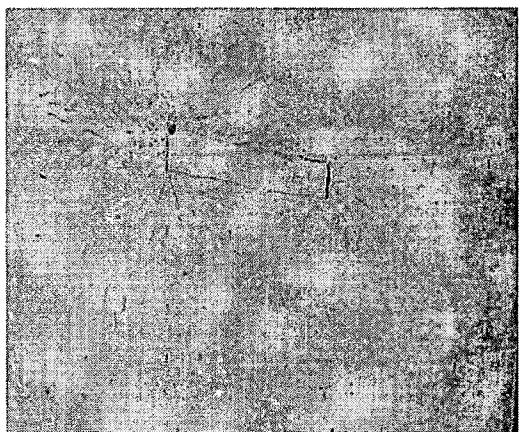


Diagram after experimentation

From the above diagram it is clear that student's perception about the magnetic field lines gets refined. The student has developed the skill of observation as it is evident from the diagram after the experimentation. The student has drawn the dot representing the north pole of the magnet. The student was very clear that the magnetic field lines originate from the poles. The student was clear that the magnetic field lines are concentrated more at the poles. Thus it can be deduced that comprehension about magnetic field lines has developed among the student.

Frame: 5.6 Diagram of magnetic field lines by student five before and after experimenting with iron fillings and bar magnet.

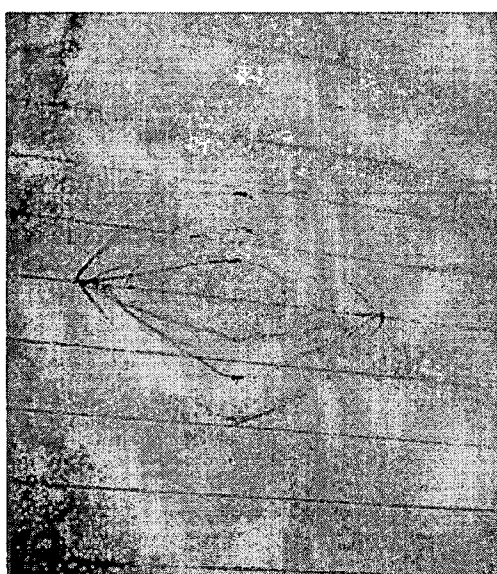


Diagram before experimentation

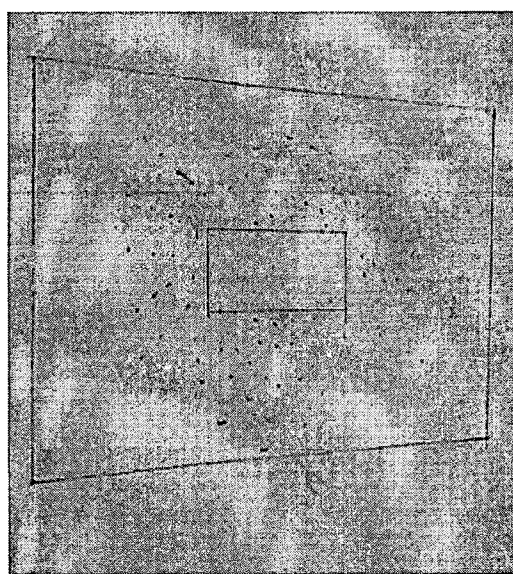


Diagram after experimentation

The above diagram clearly shows the enhancement in the understanding of student number five before experimentation and after experimentation. As observed from the diagram the student was not having the concept that the magnetic field lines are near the poles as well as the centre of the magnet before the experimentation. After conducting the experiment the student was able to draw magnetic field lines at the centre as well as at the poles.

The frame 5.7 shows the diagram of the magnetic field lines by student six before and after conducting experiment.

Frame: 5.7 Diagram of magnetic field lines by student six before and after experimenting with iron fillings and bar magnet.

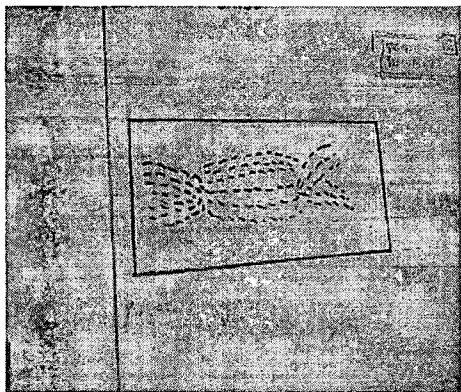


Diagram before experimentation

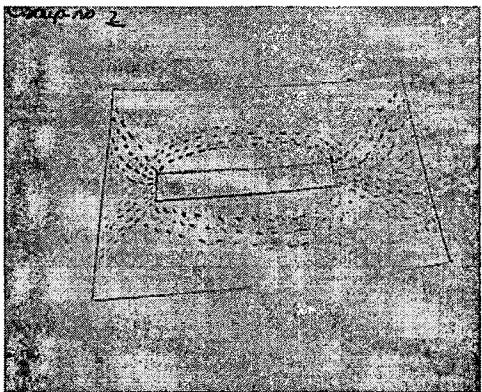


Diagram after experimentation

It is very clear from the diagram above that the student was able to understand clearly as to magnetic field lines is concentrated more at the poles as is clearly observed from the diagram drawn by the student after the experimentation. Also the concept that the magnetic field lines originate from the poles was understood by the student as the student is able to draw the magnetic lines originating from the poles.

Frame: 5.8 Diagram of magnetic field lines by student seven before and after experimenting with iron fillings and bar magnet.

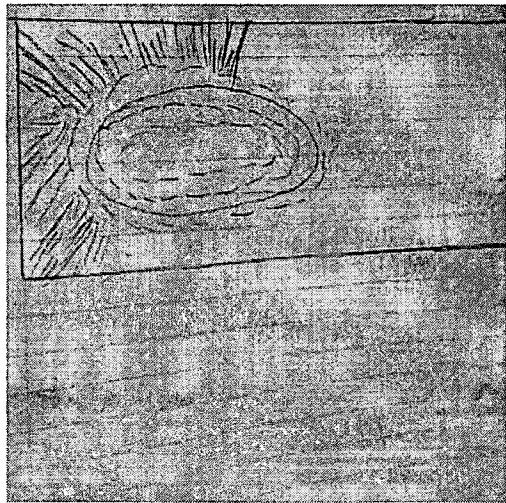


Diagram before experimentation

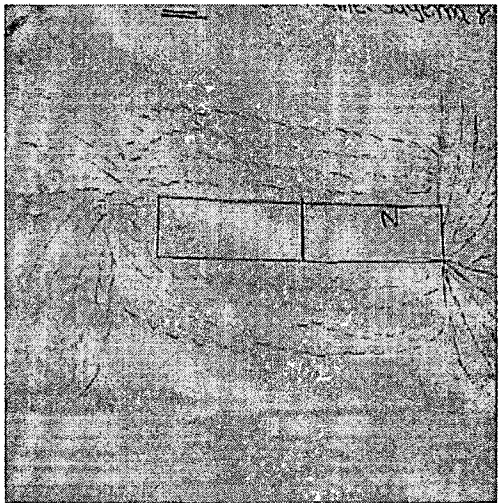


Diagram after experimentation

The diagrams above clearly indicate the refinement in the student's perception about magnetic field lines. It is very clear that the student after experimentation was clear

about the concept that the magnetic field lines are concentrated more at the poles in comparison to the centre of the magnet. Also the magnetic field lines originate from the poles was clear to the student as seen in the diagram after experimentation. As visible from the diagram before experimentation the student was not able to understand that the field lines originate from poles. The student has drawn the magnetic field lines originating from the centre also.

Frame: 5.9 Diagram of magnetic field lines by student eight before and after experimenting with iron fillings and bar magnet.

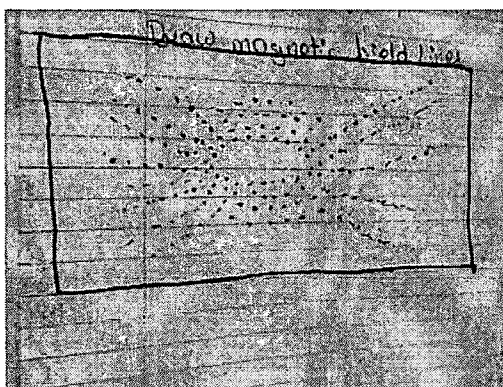


Diagram before experimentation

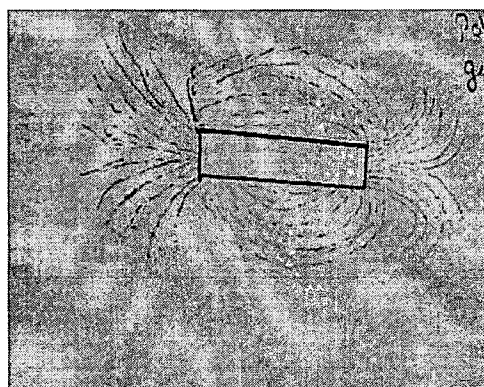


Diagram after experimentation

The diagram clearly shows that the student was able to comprehend well when the student was involved in hands on activity. The student after experimentation was very distinctly and appropriately able to draw the magnetic field lines.

Frame: 5.10 Diagram of magnetic field lines by student nine before and after experimenting with iron fillings and bar magnet.

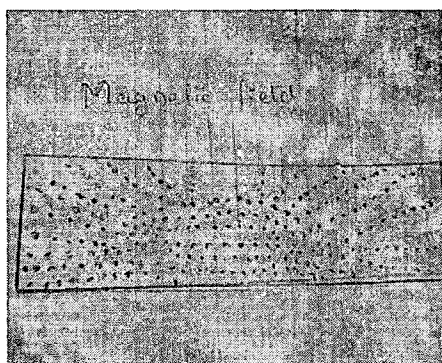


Diagram before experimentation

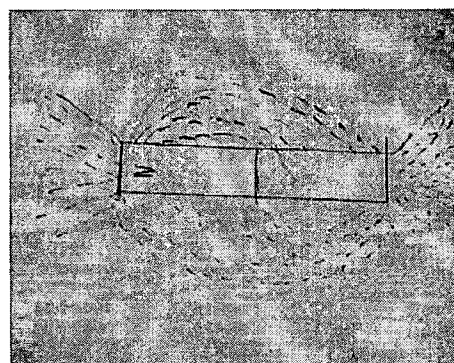


Diagram after experimentation

Similar is the case with this student. The two diagrams clearly indicate the refinement in the concept about the magnetic field lines.

It is very clear from the above diagrams that the students get clarity about a particular concept when involved in actual conduct of the experiment. The students could make use of process skill observation which is very much evident from the difference in the both the drawing of each student. In case of student four it is seen the keen observation done by the student who has put a dot on the magnet showing the north pole of the magnet.

5.2.3 Analysis and interpretation of responses of students on activity for principle used in maglev train

In order to make the students understand the principle used in working of maglev train the researcher demonstrated magnetic levitation by making a toy made of low cost material. Students were very excited to see the pencil move in air. The entire class was highly enthusiastic to prepare the model. The students asked the researcher the place from where the magnets can be brought and also asked the procedure of making the toy. It was found that two students in the class had prepared similar type of model using box of fruity and the cap of fruity. They had brought the model to the school. The students were able to understand that because of the magnet used in maglev train the train travels above the surface of the track and that is known as magnetic levitation. When asked to explain magnetic levitation majority of the students were able to explain in their own words.

5.2.4 Analysis and interpretation of responses of students on activity for gravitational force

In order to develop the concept of gravitational force students were asked to drop different objects and find out the time taken for each object to reach the floor. Students were of the opinion that the heavier object comes down first. Of the given object students of all the groups opined that duster comes down first then keys, then ball followed by pen, scale, chalk and hair pins. Hundred percent students reported that the objects when dropped, all the object come down towards the surface. The students further developed the concept that all the objects are attracted towards the centre of the earth because there is something pulling the objects towards it. The students were made to do the activity of stretching their arm for two minutes horizontally straight from the shoulder. All the students' hundred percent students reported that after some time they feel pain in their hand. Few of them reported that they felt as if their hand will come out of their body, few said that the hand was gradually coming down. One of the student reported that blood of arm goes and

therefore pain is felt. One of the students reported that weight of the arm is felt and therefore it pains. When asked why did this happens then some of the students said that arm was in air and there is no support to arm and therefore it pains and gradually comes down. It can be inferred from the responses of the students that the students were clear that the objects dropped in air are always attracted towards the centre of the earth. The students also had clarity that there is some type of pull which is pulling the object towards itself. Thus it can be concluded that the concept of gravitational force was clear to the students.

5.2.5 Analysis and interpretation of responses of students on activity for electrostatic Force

In order to make the students understand the electrostatic force there were activities conducted. The responses of the students after conducting the activity of attracting paper pieces with the help of a scale rubbed on hair is presented first followed by activity of rubbing a balloon on wall and sticking it on wall. Students reported that the scale attracts the pieces of paper. Students opined that there is something like magnet which is pulling the paper pieces towards itself. After doing the activity students could find that rubbing causes some effect which makes the paper attracted towards the scale. The students could also infer that the scale loses its effect after sometime. The students were very much surprised when they saw that the scale rubbed on wool if it is touched with hand and then brought near the pieces of paper does not attract the pieces of paper. The students were able to understand that the effect does not remain for a longer time.

Students when asked as to what will happen when the inflated balloon is rubbed on wool and brought near to the wall all the groups except one predicted that the balloon will burst because the balloon is rubbed. One of the group said balloon will break as balloon will become hot. The reason the group gave for bursting of the balloon was that the wool is soft and wall is hard so balloon will not touch the wall. The second group was of the opinion that balloon will touch the wall because frictional force is produced. The third group reported that when balloon is rubbed the friction between the wool and the balloon will increase and therefore balloon will become warm and when brought near to the wall balloon will blast. The students of the group further related the concept with rubbing of hands in winter makes the hand warm. Fourth group students answered that the balloon will stick to the wall because of static electricity. Fifth group reported that balloon will stick to the wall because of magnetic

force and after sometime will fall down because magnetic structure does not remain for long time. Sixth group reported that balloon will explode because rubbing the balloon with the wool causes the layer of the balloon become warm so the balloon explodes. Seventh group made prediction that when the balloon is rubbed with the wool the surface of the balloon becomes thin and hot and therefore when touch to the wall the balloon will burst. Eight group reported *that balloon will break because of hydrogen gas in the balloon is smashed to the wall the hydrogen is out of the balloon that is why the balloon will burst. The air in the balloon stops because the pressure of the balloon is going less with rubbing of wool.* But after conducting the activity students reported that the balloon sticks to the wall. The groups also tried to stick the balloon without rubbing and thus inferred that the balloon does not stick to the wall till it is rubbed. The students also reported that the effect does not last long and added that the balloon falls down after some time. This clearly indicates that the students gradually developed the concept. It is also evident from the answers given by the students that the students relate the concept learnt by them earlier to the concept which they are learning. The students had already performed the activity related magnetic force and so related the effect due to static electricity to the effect because of magnetic force.

For the activity where the students were asked to predict that when two inflated balloon rubbed on wool and brought near each other what will happen. The students predicted that the two balloons when rubbed with the wool and brought near to each other will attract each other before actually experimenting but when they themselves experimented they changed their observation to balloons repelling each other. Of course the students were not aware about the exact reason for the same as it was evident from their worksheets where in none of the student could write the reason for the repulsion between the two balloons rubbed with the same material. But from the responses of the students it was clear that students related the concept of attraction and repulsion in case of magnet. The students could relate the concept that as like poles of the two magnets when brought near each other repels similarly when the balloons are rubbed on same material there is same effect produced on both the balloons because of which the balloons repel each other. Thus it is clear that the students could understand that the balloons acquire similar charges and therefore when brought near each other the balloons repelled each other.

5.2.6 Analysis and interpretation of responses of students on activity for frictional force

The students were given the activity of writing on a paper greased with oil. All the groups reported that the writing on the paper becomes light because the oil on the paper sticks the pen and makes it slippery and does not allow the ink to flow through the pen and therefore after writing few sentences the sentences becomes light and after some time it is difficult to write. Thus it is inferred that the concept of frictional force was very clear to all the groups.

5.2.7 Analysis and interpretation of responses of students on activity for various effects of force

Students were shown demonstration to show various effects of force on the object. After the demonstrations the students were asked to list the effects of the force on the objects. Eighty eight percent of the students could list the effects of force on motion. The students could infer that when the moving object is obstructed its speed reduces. When the moving object is allowed to roll it comes to rest after some time because of force of friction. All the students reported that the shape of the object can be changed when force is applied on it.

5.2.8 Analysis and interpretation of responses of students on activity for motion and types of motion

Students were given a chart consisting of fifteen activities/objects/tasks and were asked to identify the type of motion in each case. The data analysis of the responses given by the students for each of the fifteen activities/objects/tasks is presented in the following paragraph.

Eighty three percent of the students responded that the type of motion of the soldiers in the march past is rectilinear, rest seventeen percent could not come out with technical term rectilinear but responded that the motion is straight line motion. The students responded two types of motion for motion of bullock cart on a straight road. Seventy six percent students responded that the bullock chart will move in curved path and rest twenty four percent said that the bullock cart will move in straight path. All the students hundred percent students responded that the motion of hands of athlete in a race is periodic type of motion. Hundred percent students responded that the motion of pedal of bicycle is circular motion. Ninety eight percent students responded that the motion of earth around the sun is rotational and two percent did not respond. Forty eight percent students responded that the motion of swing is periodic

and rest fifty two percent responded that the motion of swing is oscillatory. All the hundred percent students responded that the motion of pendulum is periodic motion. Eighty four percent students responded that the motion of a child in merry go round is circular while sixteen percent responded that the motion is rotational. Eleven percent students responded that the motion of see saw is up down motion while rest eighty nine percent responded it as oscillatory motion. All hundred percent students responded that motion of hammer of electric bell is oscillatory motion. Sixty four percent of the students said that the motion of strings of guitar is oscillatory while twelve percent did not respond and rest twenty four percent responded that the motion is vibration. Students were not able to respond to the motion of the surface of drum when the drum is hit. All the students responded that the motion of wheel of sewing machine performs circular motion. Eighty eight percent students responded that the motion of needle of sewing machine is periodic motion five percent responded it as up and down motion and rest seven percent responded it to be oscillatory. All the students hundred percent students responded that the motion of a flying butterfly is motion along curved path or zigzag motion. From the responses of the students it is very clear that the concept of different types of motion is clear among the students as majority of the students are able to relate the concept and identify the type of motion in each of the activity/objects asked to them. Thus it can be concluded that the students could comprehend different types of motion.

5.2.9 Analysis and interpretation of responses of students on activity for speed

All the students were made to do the calculation of speed based on the data obtained from the running race organized. It was found that the students were able to calculate the speed by dividing the distance in meter by the time taken in second to cover that distance. Here the researcher noticed that few students were facing problem to put the decimal points, few were facing problem in division. Thus it is deduced that the concept clarity of mathematics is very much required when the students were to calculate speed. It can be understood that the concept clarity in basic mathematics is very much required while solving numerical in science. It was found that students were very clear that the student who covered the specified distance in less time is said to have more speed as compared to the one who covered the same distance taking more time.

5.2.10 Analysis and interpretation of responses of students on activity of classifying the lever

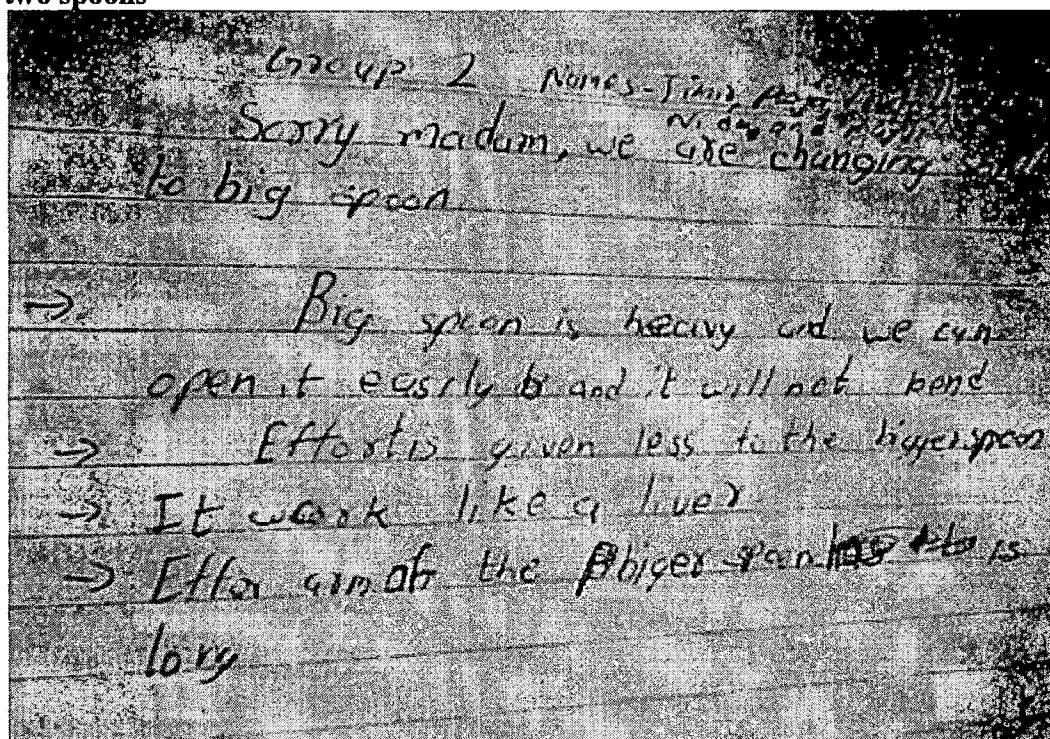
Students were given a kit containing fifteen pictures of levers. There were five pictures of each type of lever. The students were to classify the levers according to the position of the fulcrum, load and effort. It was found that all the groups were able to classify the levers into first, second and third type of lever when the picture clearly showed the fulcrum but when the fulcrum was not apparently seen in the picture the students got confused and could not classify it either into first, second or third type of lever. For instance the students were not able to identify the type of lever in case of the picture of human hand. When probed further the students reported that the fulcrum is not visible and therefore they got confused as to which type of lever is the hand. On providing little bit of hint the students could relate the concept of fulcrum and identified the type of lever correctly. Here it is observed that the students were able to classify the given pictures into three categories based on the position of fulcrum, effort and load. Thus it can be inferred that the students were able to comprehend the concept of types of lever.

5.2.11 Analysis and interpretation of responses of students on the activity for the concept longer the effort arm less is the effort required to lift the load

When the students were asked which spoon of the two spoons one with small handle or the other with longer handle should be used to easily open a container which is tightly fitted. Group one students opined that both the spoons should be used and said that first fit small spoon in between the cap of the container and then fit big spoon on the side of the small spoon and then it will be easy to open the container. Group two initially was of the opinion that the spoon with smaller handle will be requiring less force but the group in the course of time changed their answer and said that “sorry madam we want to change our answer to spoon with longer handle and said that it will be easy to handle the spoon with longer handle and also added that it works like lever saying that effort arm of spoon with longer handle is bigger and therefore will require less force”. Group three was of the opinion that spoon with small handle will be easy to open the container. Group four said that when spoon with longer handle is inserted in the container the spoon will slip and not enter the lid of the container while spoon with smaller handle will not slip and one can easily open the container. Rest four groups were also of the same opinion that it will be easier to insert the smaller spoon in the lid of the container and therefore spoon with smaller handle will require

less effort but while the groups were performing the activity of opening the lid of the container using both the spoons they found the case opposite to what they had predicted and thus the groups changed their response saying that when small spoon was entered it slipped as the handle was small so it was not easy to handle it as it slipped while in case of the spoon with longer handle it was easy to catch hold of the handle and thus was easy to open the lid of the container with less force. One of the group further added that this works like lever saying that effort arm of the spoon with longer handle is bigger and therefore will require less effort. The snapshot of the written part of the note of this group is presented in the following frame.

Frame: 5.11 one groups observation on opening a lid of the given container using two spoons



5.2.12 Analysis and interpretation of responses of students on the activity of balancing the lever using rupee coin

The students were given activity of balancing the see-saw lever prepared by using a scale and pencil by placing rupee coins provided to them. The students were given different weight according to groups. They were made to build a lever using a scale of wood of 30 centimeter. The students of group 1 were given a weight of 20 gm which the students were to keep in load cup. The students were instructed to keep the pencil at 15 cm, 20 cm and 10 cm on the scale from the load and find out the effort required to balance the lever. The following table shows the number of coins required to balance the lever as reported by group number one.

Table: 5.2
Readings taken by group one students for different positions of load arm keeping load constant

Effort arm	Effort	Load Arm	Load
15 centimeter	4 coin	15 centimeter	20 gram
10 centimeter	8 coin	20 centimeter	20 gram
20 centimeter	2 coin	10 centimeter	20 gram

The group one was able to find that as the effort arm increases the effort required to lift the load decreases. The students were also able to find the number of coins required to balance the lever by keeping the load constant and varying the load arm and effort arm.

The group two students were given load as 50 gm and they were instructed to find the coins required to balance the lever placing the pencil at 15, 5 and 10 centimeter respectively as load arm. The coins required as reported by members of group two is as shown in the following table

Table: 5.3
Readings taken by group two students for different positions of load arm keeping load constant

Effort arm	Effort	Load Arm	Load
15 centimeter	10 coin	15 centimeter	50 gram
25 centimeter	2 coin	05 centimeter	50 gram
20 centimeter	5 coin	10 centimeter	50 gram

It is clear from the responses given in the above table that the students were able to find the coins required to balance the lever. The students also reported that with the increase in effort arm the effort required to balance the lever becomes less. Thus it can be inferred that the comprehension of principle of lever is clear among the group members.

The group three students were given load as 10 gm and they were instructed to find the coins required to balance the lever placing the pencil at 15, 10 and 25 centimeter respectively from the load. The coins required as reported by members of group three is as shown in the following table

Table: 5.4
Readings taken by group three students for different positions of load arm keeping load constant

Effort arm	Effort	Load Arm	Load
15 centimeter	2 coin	15 centimeter	10 gram
20 centimeter	1 coin	10 centimeter	10 gram
5 centimeter	10 coin	25 centimeter	10 gram

The readings taken by group three shows that students were able to find the number of coins required to balance the lever. The students also made a mention that more coins less will be the effort distance.

The group four students were given load as 10 gm and they were also instructed to find the coins required to balance the lever placing the pencil at 15, 10 and 25 centimeter respectively as load arm. The coins required as reported by members of group four is as shown in the following table

Table: 5.5
Readings taken by group four students for different positions of load arm keeping load constant

Effort arm	Effort	Load Arm	Load
15 centimeter	2 coin	15 centimeter	10 gram
20 centimeter	1 coin	10 centimeter	10 gram
5 centimeter	9 coin	25 centimeter	10 gram

It is clear from the readings taken by the group that the students were able to find the relationship between load, effort, load arm and effort arm. The group reported that nine coins will be required for load arm 25 centimeter which actually should have been ten coins. This may be attributed to the students not taking the load arm exactly 25 centimeter which could have created the above error.

The group five students were given load as 20 gm and they were instructed to find the coins required to balance the lever placing the pencil at 15, 20 and 10 centimeter respectively as load arm. The coins required as reported by members of group five is as shown in the following table

Table: 5.6
Readings taken by group five students for different positions of load arm keeping load constant

Effort arm	Effort	Load Arm	Load
15 centimeter	3 coin	15 centimeter	20 gram
10 centimeter	8 coin	20 centimeter	20 gram
20 centimeter	2 coin	10 centimeter	20 gram

This group made a little bit of error in finding the number of coins required to balance the lever. Instead of four coins for load and effort arm at fifteen centimeter the group reported three coins.

The group six students were given load as 50 gm and they were instructed to find the coins required to balance the lever placing the pencil at 15, 5 and 10 centimeter

respectively as load arm. The coins required as reported by members of group six is as shown in the following table

Table: 5.7

Readings taken by group six students for different positions of load arm keeping load constant

Effort arm	Effort	Load Arm	Load
15 centimeter	10 coin	15 centimeter	50 gram
25 centimeter	2 coin	05 centimeter	50 gram
20 centimeter	5 coin	10 centimeter	50 gram

The group seven students were given load as 30 gm and they were instructed to find the coins required to balance the lever placing the pencil at 20, 15 and 10 centimeter respectively as load arm. The coins required as reported by members of group seven is as shown in the following table

Table: 5.8

Readings taken by group seven students for different positions of load arm keeping load constant

Effort arm	Effort	Load Arm	Load
15 centimeter	6 coin	15 centimeter	30 gram
10 centimeter	12 coin	20 centimeter	30 gram
20 centimeter	3 coin	10 centimeter	30 gram

The group eight students were given load as 30 gm and they were instructed to find the coins required to balance the lever placing the pencil at 15, 20 and 10 centimeter respectively as load arm. The coins required as reported by members of group eight is as shown in the following table

Table: 5.9

Readings taken by group eight students for different positions of load arm keeping load constant

Effort arm	Effort	Load Arm	Load
15 centimeter	6 coin	15 centimeter	30 gram
10 centimeter	12 coin	20 centimeter	30 gram
20 centimeter	3 coin	10 centimeter	30 gram

It can be deduced that the students of all the groups were able to find out that the longer the effort arm less is the effort required for lifting the load. All the groups could explain the relationship among load, load arm, effort and effort arm. Thus the principle of lever was clear to all the students.

5.2.13 Analysis and interpretation of the responses of students to measurement of three dimensions length, breadth and height of the given object and using the same calculating volume

The student were given the activity of measuring the length, the breadth and the height of the given object like cassette cover, match box, science textbook, eraser, box of colgate toothpaste. The table below represents the percentage of students who were able to measure the three dimensions correctly and the percentage of students who committed error in measurement of either of the three dimensions or more than one dimensions.

Table: 5.10
Percentage of students who measured the three dimension length, breadth and height of the given object correctly and incorrectly

Name of the object whose length, breadth and height was to be measured	Percentage of students who got all the three dimensions correctly	Percentage of students who made error in measurement of either one, two or all three dimensions
Cassette Cover	93	7
Match Box	89	11
Science Text book	85	15
Eraser	94	06
Box of colgate toothpaste	96	04

It was found that ninety three percent of the students could correctly measure the length, the breadth and the height of the given cassette cover while seven percent students committed error in measuring either the length or the breadth or the height. The error committed by the student was few out of the seven percent wrote length instead of breadth and some made error in measurement of the height. The error committed in measurement of the height was students were taking the whole numbers only and not taking the exact measurement considering the fraction after the whole number in terms of decimal points measurable with the help of the measuring instrument. Eighty nine percent of the students could correctly measure the length the breadth and the height of the given match box. In case of match box the students could not correctly measure the height. While in case of measurement of science textbook, eraser and box of colgate toothpaste the percentages of students who committed error was fifteen, six and four respectively. It could be inferred from the above that when the dimension was small students found it difficult to make correct

measurement in comparison to the case where the dimension was a little larger. Though majority of the students were able to measure the dimensions correctly it was found that only few student correctly wrote the unit for volume that is cubic centimeter while rest all the students wrote the unit of volume as centimeter. The students were not able to comprehend that the unit for volume will be cubic centimeter.

Though ninety percent of the students were able to measure the length, breadth and height of the given objects correctly it was found that only forty six percent of the students were able to calculate the volume of the object correctly. There were fifty four percent of the students who committed error in calculation of volume. The error committed by majority of the students was in putting the decimal point. One of the students was to multiply five with 3.5 and 1.1. The student multiplied 5 with 3.5 got the answer as 17.5 and then did not multiply it with 1.1 but directly wrote the answer as 17.5. The other common errors which the students committed were placing of the decimal point.

5.2.14 Analysis and interpretation of the responses of students to measurement of mass of the given object

The students were given different objects and were to measure mass of the given objects using spring balance given to them. The table below shows the percentage of the students who correctly measured the mass of the given objects and also the percentage of the students who committed error in measurement of the mass.

Table: 5.11
Percentage of students who correctly measured mass of the given objects

Object	Correct value	Percentage of students who measured correctly	Percentage of students who committed error
Mass of object 1	280 gram	65	35
Mass of object 2	250 gram	86	14
Mass of object 3	215 gram	76	24
Mass of object 4	65 gram	69	31
Mass of object 5	390 gram	81	19
Mass of object 6	265 gram	78	22

Approximately more than seventy six percent of the students were able to measure the mass of the given object correctly except in case of object number one. It can be

concluded that the students were now able to use the spring balance and measure the mass. The students were able to determine the least count and accordingly measure the mass of the given object. The students who earlier committed mistake in taking reading by not placing the instrument in line with the eye were found taking reading placing the measuring instrument at the correct position while taking the reading. Thus the students developed the skill of measurement.

5.2.15 Analysis and interpretation of the responses of students to measurement of volume of irregular shaped object which is insoluble in water and which sinks in water

The students were provided stone in small groups and were instructed to measure the volume of the given stone using a calibrated measuring cylinder filled with potassium permanganate. The researcher was observing the groups when they were taking readings. It was observed that all the groups took the initial reading correctly without any error. The group was to immerse the stone tied to a string and note the reading in the measuring cylinder. The groups calculated the volume of given stone by subtracting the volume of potassium permanganate before immersing the stone from the reading got after immersing the stone. All the groups correctly reported the readings. The students also determined the volume of the given stone using displacement vessel. The readings reported by the groups were same using both the methods of measuring the volume. It can be concluded that the measurement of volume of the irregular shaped object which sinks in water and is insoluble in water was very clear to all the students. The researcher also observed that the students were taking the reading by considering the upper meniscus as the liquid was coloured liquid. Thus, the concept that the measurement of the liquid when it is colourless should be done considering the lower meniscus and when the liquid is coloured then the upper meniscus need to be considered was well taken up by the students.

5.2.16 Analysis and interpretation of the responses of students to activity of predict observe and explain

Students were given an activity of predicting which of the twenty one given objects will float, sink or mix in water. Hundred percent students were of the opinion that the stone will sink in water. They said that the stone was heavier than water and therefore stone sinks in water. Few of the students even related it with the activity done of finding out the volume of the given stone using displacement vessel. For wood eighty five of the students were of the opinion that wood will float and gave the reason that it

is lighter than water and therefore will float, twelve percent said it will sink in water while the remaining three percent did not respond.

For the object plastic pen sixty eight percent of the students said pen will float in water giving the reason that plastic is lighter and therefore will float in water, twenty six percent predicted that pen will sink while three percent of the students did not respond. It can be deduced that the students were able to make correct predictions for the objects which they have observed in their day to day life.

For eraser seventy eight percent of the students predicted that eraser will sink while twenty two percent made prediction that eraser will float in water.

For the object piece of iron eighty five percent of the students predicted that the piece of iron will sink giving the reason that iron is heavier while twelve percent made prediction that it will float giving reason that the steamers float on water and they are made of iron and three percent of the students did not respond.

For the object tomato seventy eight percent of the students predicted that tomato will sink in water while twenty two percent predicted that tomato will float up in water. In case of potato eight three percent students reported that the potato will sink down while twelve percent reported that potato will float up and five percent said it will move up and down in water. The students related the same logic as in case of potato to that of tomato and made prediction that tomato will sink in water.

In case of banana with its peel eighty percent of the students reported that banana will sink while seventeen percent said that banana will float and three percent reported that the banana will neither sink nor float. For the object plastic spoon ninety percent of the students made prediction that the spoon will float in water while ten percent felt that the spoon will sink in water. In case of steel spoon eighty eight percent of the students reported that the spoon will sink in water seven percent said that the spoon will float in water and five percent did not respond.

In case of chalk sixty six percent of the students predicted that chalk will sink in water. These sixty six percent students further said that chalk will dissolve, mix, melt and spread in water and one of the students made a mention that the white colour of the chalk will start spreading in water, while thirty four percent reported that chalk will float up in water.

For the object sponge seventeen percent of the students made prediction that sponge will sink, five percent reported that the sponge will move up and down, sixty nine

percent said that sponge will float up while nine percent reported that water will enter into the sponge and then the sponge will sink.

For the object tooth brush fifty six percent of the students reported that the brush will float, thirty seven percent said the brush will sink and seven reported that the brush will move up and down. In case of soap ninety eight percent of the students reported that soap will sink in water and further added that after some time the soap will dissolve in water and there will be foam formed on the water while two percent reported that soap will float in water. In case of the object candle forty nine students reported that candle will sink while fifty one reported that the candle will float in water. It can be deduced that there was a mixed response for candle. This may be because the students would have never got chance to observe candle in water.

For lemon fifty nine percent of the students reported that lemon will sink in water five percent reported that lemon will lie in between and thirty six percent reported that lemon will float in water. In case of ladies finger thirty nine percent reported that ladies finger will sink, fifty six percent reported that ladies finger will float up while five percent reported that ladies finger will move up and down.

For the object sand eighty five percent made prediction that sand will sink in water, three reported that sand will float in water while twelve percent reported that sand will dissolve in water and further added that it will melt.

In case of oil twelve percent of the students reported that oil will sink in water, forty nine percent reported that oil will float in water while thirty nine percent reported that oil will mix with water. For kerosene fifteen percent students reported that kerosene will go down, forty two reported that kerosene will float while forty three percent said that it will mix with water. For petrol seven percent reported that petrol will sink in water, seven percent said petrol will be in between, forty four percent reported that petrol will float up while forty two percent reported that petrol will mix with water and form rainbow colour. It can be inferred that the students were able to predict correctly as to whether the object will float, sink or melt in water only for the object which they have seen in water. It was surprising for the students to observe that when banana along with the peel is dropped in water it floats. The students related the boat floating in water with banana floating in water. Thus it is clear that the students relate the concept with already existing concepts in their minds. The concept that the heavier things sink in water and lighter objects float up was very well deep rooted in the minds of the students.

5.2.17 Analysis and interpretation of the responses of students to activity of finding out how shadows are formed and which colour makes a perfect mirror

The students tried to place different objects in between the source of light and screen. The students observed that when any object was placed in between the light source and the screen its shadow was observed on the screen. When asked why shadow is formed all the students said light is obstructed and this makes the shadow to fall on screen. The students were also made to explore that when the white sheet of paper, green sheet of paper, blue sheet of paper, red sheet of paper and black sheet of paper were placed underneath the piece of transparency provided to them then in which of the sheets were they able to see their face clearly. Majority of the students responded that they were not able to see the image of their face clearly by placing white sheet of paper underneath transparency where as in case of black sheet of paper and red sheet of paper the face was very clearly visible. All the students could come out with the same inference. When further asked why does that happen? The student from one group reported that white colour absorbs less light and allow most of the light to pass as compared to black paper which absorbs more light and allows either no or less light to pass through it. Thus the students could understand the concept as to what makes a perfect mirror.

5.2.18 Analysis and interpretation of the responses of students to activity of laws of reflection

The students of all the eight groups were able to find the measure of angle of incidence and measure of angle of reflection when laser light was made incident on the mirror at different angles. Except for group three and group five rest all the groups were able to come to the conclusion that the measure of angle of incidence and measure of angle of reflection are equal. The group 3 reported that the measure of angle of incidence is 38 and that of the angle of reflection is 40. The group five also had a variation of 3 degree in between the measure of angle of incidence and measure of angle of reflection. They were instructed to repeat the experiment. On repeating the experiment thrice the groups were able to find that the measure of angle of incidence and measure of angle of reflection is equal. Here it was observed by the researcher that initially around ninety percent of the students were unaware of using protractor to measure the angle. The students were not very clear as to which of the reading out of the two readings calibrated on the protractor needs to be taken as the reading of the angle.

5.2.19 Analysis and interpretation of the responses of students to activity of forming of a word that remains the same in the mirror

The students were instructed to find out the word that remains same when seen in the mirror. The students of group four first came out with the word MADAM which will be the same in its mirror image. One of the group students reported that though M and A remains the same in the mirror images but the alphabet D does not remain same. The students of group number five could come out with one word which appears the same in its mirror image and that is the word CIVIC. Listening to the word the rest of the groups also wrote the word CIVIC on paper and tried to observe the word in the mirror. The students were highly excited to watch the word remaining the same. Another group suddenly said that MAM remains same when observed in the mirror. The group three said MOM remains same. The other response was WOW. It can be concluded from the responses of the students that they were now clear with the concept of lateral inversion. The students could clearly understand that in the mirror the left becomes right and the right becomes left. Thus it can be concluded that the concept of lateral inversion was understood by the students.

5.2.20 Analysis and interpretation of the responses of students to the activity of observing through concave mirror

The students were given concave mirror and were instructed to find the image formed by varying the distance of the object from the concave mirror. Here it was found that the student instead of moving the object, were moving the mirror. The observations as reported by the students were image appears larger at the near position and very small as well as inverted at far position. One of the student reported that when the cap of the pen is kept nearer to the mirror the cap of the pen is seen erect but as one puts the mirror back the cap of the pen is seen very large and also at one position the cap of the pen is seen inverted and small. It can be understood here that when the student placed the cap of the pen very near to the mirror the object was between pole and principal focus and therefore a magnified, erect and virtual image was obtained as reported by the student. One of the students reported “my face becomes big when mirror is near and face becomes small when mirror is far. At very far distance the image is not clear”. Another response was the image was very big in size when the mirror is at the near distance. It was further added that on changing the angle of mirror the image is not clear. Another response was by placing mirror close to the face image is very big and when mirror is taken away from face then the image is

inverted. The image observed is very clear when the mirror is very near but the image is not fully observed. When the mirror is taken away image is only little clear but seen complete. There was one unique observation made by one of the student who reported that when mirror is taken away from face, the image of face was tinny like a ball. Further the student reported that the mirror is curved mirror and such type of mirror is used in funny things like circus. One of the students tried to feel the surface of the concave mirror and said that “when thumb is rubbed on the mirror it is smooth but due to rubbing there are marks on mirror and when trying to observe it is felt as if there are marks on face”. There was one observation that the face appears fat when observed by keeping the mirror near to the face. Eyes are seen very big. One more observation was image appears larger at near position but by moving the mirror the image becomes *ulta* (inverted) and large and still when the mirror is moved the image remains *ulta* but becomes smaller in size. Thus it is inferred that the students could find out that by varying the object distance the image formed becomes larger or smaller. The students could also infer that the images formed by concave mirror may be virtual as well as real depending on the position of the object from the mirror.

5.2.21 Analysis and interpretation of the responses of students to the activity of touching the surface of concave and convex mirror

The students were provided with both the mirrors concave and convex and were asked to touch the surface of both the mirrors and find out the difference in the surface of the mirrors. The students after touching the surfaces of both the surfaces reported that the surface in case of convex mirror is little bit upward while in case of concave mirror it is flat and smooth. The students were able to respond as to which of the two mirrors is concave and which one is convex just by touching the surface of both the mirrors provided to them. Thus the researcher found that the students were able to understand the concept of concave and convex mirror and were able to identify that the mirror in which bulging is felt is convex mirror.

5.2.22 Analysis and interpretation of the responses of students to the activity of observing through convex mirror

The students reported that the image in case of convex mirror remains small and virtual even if the position of the mirror is changed. The students also reported that in case of concave mirror beyond a particular distance the image was inverted whereas in case of convex mirror image is not inverted even if the distance is changed.

5.2.23 Analysis and interpretation of the responses of student to activity of focusing sunlight using concave mirror

The students in different groups were given a concave mirror and a white paper containing writing in black coloured font. The students after performing the experiment of focusing the rays of sun on the paper could burn the paper. The students were asked as to why does the paper burn? To which student responded that the rays of sun are made to be falling on one point and those rays burn the paper. Here it can be seen that the students are able to relate the concept that the rays of sun when made incident on the concave mirror after reflection the rays meet at the focal point and because of convergence of the rays at one point the paper starts burning. One group of the student was discussing among themselves that if a screen is taken and concave mirror is kept such that the rays of sun after reflection fall on a part of the screen then there will be lot of fumes and the entire screen will catch fire.

5.2.24 Analysis and interpretation of the responses of students to activity of predicting the image of the alphabets A to Z in a plane mirror

The students when asked to carry out the activity of writing the alphabets as it will appear in the mirror many of the students wrote M as W and W as M. Thus it can be deduced that the few students were having concept that the alphabets will be seen upside down when observed in the mirror. The percentage of students who correctly responded to the mirror image of the alphabets A to Z is presented in the following table.

Table: 5.12

Responses of the students in percentage on mirror images of alphabets

Alphabets	Percentage of student who responded		Alphabets	Percentage of student who responded		Alphabets	Percentage of student who responded	
	correctly	incorrectly		correctly	incorrectly		correctly	incorrectly
A	90	10	J	65	35	S	75	25
B	65	35	K	89	12	T	62	38
C	73	27	L	60	40	U	63	36
D	62	38	M	59	41	V	65	35
E	75	25	N	56	44	W	59	41
F	76	24	O	100	-----	X	100	-----
G	73	27	P	63	37	Y	63	37
H	100	-----	Q	59	41	Z	40	60
I	100	-----	R	68	32			

From the above table it is clear that the students made maximum error while predicting the image of the alphabet L, M, N, Q, W and Z.

5.2.25 Analysis and interpretation of the responses of students to images formed placing two mirrors at different angles

All the students were able to find out the number of images formed by placing the two mirrors at different angles. The students were able to put the value of angle in the formula and calculate the number of images which will be formed for a particular angle between the two mirrors but for the case when two mirrors are parallel the students could not calculate the number of images as uncountable using the formula. When the students were asked to find out the number of images formed when the angle between two mirrors is zero that is when the mirrors are kept parallel to each other the researcher found that eighty percent gave the answer as thirty five, eighteen percent said zero and two percent said one. The students had observed that when two mirrors are kept parallel to each other the number of images formed are many and cannot be counted but when the same was to be deduced using the formula the students were not able to comprehend that anything divided by zero is undefined and thus were unable to get the correct value. Here it is very clear that the conceptual clarity of mathematics plays very important role in order to develop understanding in physics.

5.2.26 Analysis and interpretation of the responses of students to experiment of finding that wax is made of carbon and hydrogen and oxygen is required for burning of candle

Students were provide with eight transparent glasses, a candle and match box. The students conducted experiment of inverting the glass on burning candle. The students reported that the surface of glass turns black. Some of the students also reported that when the glass was completely inverted onto the candle then the candle turns off while few said that candle will extinguish. One of the groups reported that if the glass is partially inverted then the candle continues burning. The students also observed that after some time there are droplets of water seen on the surface of the glass.

5.3 EFFECTIVENESS OF AN INSTRUCTIONAL STRATEGY

The data analysis for objective four was carried out finding the difference of pre test score from post test score and calculating gain score for both the groups experimental and control group then the applying t test and calculating t value for each chapter and

also calculating t value for the entire test. The details of the t value calculated is presented chapter wise.

The table 5.13 presents the summary of the t value for the chapter measurement. The mean gain score for experimental as well as control group was calculated and in order to find out whether the difference in the mean gain score is significant or not t value was calculated.

Table: 5.13
t value for experimental and control group for chapter Measurement

	Mean Gain Score	SEM	SD	df	t value
Experimental Group	4.65	0.1667	1.202	92	5.45*
Control Group	3.33	0.1726	1.118	92	

*significant at 0.01 level

It is evident from the table 5.13 that the calculated t value of 5.45 is greater than the expected value of 2.617 at 0.01 level of significance for ninety two degree of freedom thus, the null hypothesis that there will be no significant difference in the mean gain score on comprehension for the chapter measurement of experimental group studied through instructional strategy and control group studied through traditional method of teaching is rejected. This signifies that the mean gain score on comprehension of experimental group is significantly greater than the mean gain score on comprehension of the control group. This shows that the instructional strategy was effective and had a significant effect on comprehension in science of the experimental group students.

Table 5.14 presents the summary of the t value for the chapter water. The mean gain score for experimental as well as control group was calculated and in order to find out whether the difference in the mean gain score is significant or not t value was calculated.

Table: 5.14
t value for experimental and control group for chapter Water

	Mean Gain Score	SEM	SD	df	t value
Experimental Group	6.88	0.2809	2.02	92	5.46*
Control Group	4.69	0.2799	1.81	92	

*significant at 0.01 level

It is evident from the table number 5.14 that the calculated t value of 5.46 is greater than the expected value of 2.617 at 0.01 level of significance for ninety two degree of

freedom thus, the null hypothesis that there will be no significant difference in the mean gain score on comprehension for the chapter water of experimental group studied through instructional strategy and control group studied through traditional method of teaching is rejected. This signifies that the mean gain score on comprehension of experimental group is significantly greater than the mean gain score on comprehension of the control group. This shows that the instructional strategy was effective and had a significant effect on comprehension in science of the experimental group students.

Table 5.15 presents the summary of the t value for the chapter Reflection of light. The mean gain score for experimental as well as control group was calculated and in order to find out whether the difference in the mean gain score is significant or not t value was calculated.

Table: 5.15
t value for experimental and control group for chapter Reflection of Light

	Mean Gain Score	SEM	SD	df	t value
Experimental Group	7.67	0.1856	1.339	92	8.27*
Control Group	5.21	0.2374	1.538	92	

*significant at 0.01 level

It is evident from the table number 5.15 that the calculated t value of 8.27 is greater than the expected value of 2.617 at 0.01 level of significance for ninety two degree of freedom thus, the null hypothesis that there will be no significant difference in the mean gain score on comprehension for the chapter reflection of light of experimental group studied through instructional strategy and control group studied through traditional method of teaching is rejected. This signifies that the mean gain score on comprehension of experimental group is significantly greater than the mean gain score on comprehension of the control group. This shows that the instructional strategy was effective and had a significant effect on comprehension in science of the experimental group students.

Table 5.16 presents the summary of the t value for the chapter lever. The mean gain score for experimental as well as control group was calculated and in order to find out whether the difference in the mean gain score is significant or not t value was calculated.

Table: 5.16
t value for experimental and control group for chapter Lever

	Mean Gain Score	SEM	SD	df	t value
Experimental Group	6.61	0.2934	2.11	92	4.16*
Control Group	4.88	0.2875	1.86	92	

*significant at 0.01 level

It is evident from the table number 5.16 that the calculated t value of 4.16 is greater than the expected value of 2.617 at 0.01 level of significance for ninety two degree of freedom. Thus, the null hypothesis that there will be no significant difference in the mean gain score on comprehension for chapter lever of experimental group studied through instructional strategy and control group studied through traditional method of teaching is rejected. This signifies that the mean gain score on comprehension of experimental group is significantly greater than the mean gain score on comprehension of the control group. This shows that the instructional strategy was effective and had a significant effect on comprehension in science of the experimental group students.

Table 5.17 presents the summary of the t value for the chapter curved mirror. The mean gain score for experimental as well as control group was calculated and in order to find out whether the difference in the mean gain score is significant or not t value was calculated.

Table: 5.17
t value for experimental and control group for chapter Curved Mirror

	Mean Gain Score	SEM	SD	df	t value
Experimental Group	5.84	0.1723	1.24	92	10.44*
Control Group	3.21	0.1820	1.17	92	

*significant at 0.01 level

It is evident from the table number 5.17 that the calculated t value of 10.44 is greater than the expected value of 2.617 at 0.01 level of significance for ninety two degree of freedom. Thus, the null hypothesis that there will be no significant difference in the mean gain score on comprehension for chapter curved mirror of experimental group studied through instructional strategy and control group studied through traditional method of teaching is rejected. This signifies that the mean gain score on comprehension of experimental group is significantly greater than the mean gain score on comprehension of the control group. This shows that the instructional

strategy was effective and had a significant effect on comprehension in science of the experimental group students.

Table 5.18 presents the summary of the t value for the chapter motion, force and speed. The mean gain score for experimental as well as control group was calculated and in order to find out whether the difference in the mean gain score is significant or not t value was calculated.

Table: 5.18
t value for experimental and control group for chapter Motion, Force and Speed

	Mean Gain Score	SEM	SD	df	t value
Experimental Group	7.82	0.2658	1.917	92	6.25*
Control Group	5.30	0.3038	1.96	92	

*significant at 0.01 level

It is evident from the table number 5.18 that the calculated t value of 6.25 is greater than the expected value of 2.617 at 0.01 level of significance for ninety two degree of freedom. Thus, the null hypothesis that there will be no significant difference in the mean gain score on comprehension for chapter motion, force and speed of experimental group studied through instructional strategy and control group studied through traditional method of teaching is rejected. This signifies that the mean gain score on comprehension of experimental group is significantly greater than the mean gain score on comprehension of the control group. This shows that the instructional strategy was effective and had a significant effect on comprehension in science of the experimental group students.

Table 5.19 presents the summary of the t value for all the six chapters. The mean gain score for experimental as well as control group was calculated and in order to find out whether the difference in the mean gain score is significant or not t value was calculated.

Table: 5.19
t value for experimental and control group for all the six chapters

	Mean Gain Score	SEM	SD	df	t value
Experimental Group	39.5	0.9200	6.63	92	9.52*
Control Group	26.64	0.9805	6.35	92	

*significant at 0.01 level

It is evident from the table number 5.19 that the calculated t value of 9.52 is greater than the expected value of 2.617 at 0.01 level of significance for ninety two degree of freedom. Thus, the null hypothesis that there will be no significant difference in the

mean gain score on comprehension of experimental group studied through instructional strategy and control group studied through traditional method of teaching is rejected. This signifies that the mean gain score of experimental group is significantly greater than the mean gain score on comprehension of the control group. This shows that the instructional strategy was effective and had a significant effect on comprehension in science of the experimental group students.

5.3.1 Analysis and interpretation of the responses to science comprehension of a story thirsty crow

The analysis and interpretation of the science comprehension of a story thirsty crow based on the concept of density is presented by listing the scientific principles involved in the story as listed by experimental group and control group students followed by t value in the table 5.20.

Majority of the students from the experimental group could list the scientific principle involved in the story as compared to control group. The response to the question of listing of scientific aspects and principles included in the story of thirsty crow by the experimental group students is as below:

- ☐ the crow used his idea and scientific matter
- ☐ crow dropped pebble in water so water level comes up.
- ☐ Because of dropping something in water the water level increases
- ☐ Dropping of harda the taste of water will be sweet
- ☐ The stone takes place of air in the jar and therefore water level comes up
- ☐ Some substance float in water, some melt in water while some mix with water and become soft
- ☐ When pebble and coal are dropped in water level will rise up as they are heavy than water. Plastic float in water because it is light in substance.
- ☐ Harda and chalk are soluble in water.
- ☐ Small stones go down into the water because of heavy weight. Spoon is floating in water because it is light in water
- ☐ Chalk, harda, coal are soluble in water
- ☐ Pebble and plastic spoon are insoluble in water
- ☐ Coal, chalk, harda are solute
- ☐ Chalk gets dissolved in water because it has the space the water molecules go into the chalk and the chalk gets heavier. One of the students responded that chalk will soak water.

- ☐ Birds can fly because they are lighter in weight and they can lift their body in air
- ☐ When chalk is dropped in water there are bubbles which come out.
- ☐ Water level rises when heavy things are dropped in water, substance like stone and coal sinks in water as they are heavy and therefore water level rises up while when plastic spoon is dropped water level does not rise up.
- ☐ The piece of coal will dissolve because of oxygen and water will be little bit up and little bit black also, similarly when chalk goes downwards we can see something white in color in water that means chalk started dissolving.
- ☐ One of the students related the concept of finding the volume of given stone using string and placing it in beaker and the student opined that as in the case of finding volume the water level was rising up so will be the case when pebble is dropped.
- ☐ When chalk and piece of sugar are dropped in water as they are soluble in water they dissolve in water and the water level did not come up.
- ☐ Few students responded that coal is solvent
- ☐ Heavy things settle down in water and lighter things float in water
- ☐ Harda was seen small as it dissolves very slowly
- ☐ As the jar tumbled the water flow. Water has property to flow
- ☐ When the pebble is dropped it took the space and break the molecular structure
- ☐ Crow could pick up pebble, harda, plastic spoon because of beak of the crow act as lever.

Certain misconceptions observed were students reported that when harda is dropped in water the volume of the water increases. The students had a similar notion that when coal and chalk are dropped in water the volume of the water increases. It was found that the students of control group could not list the scientific principles in the story. The control group students wrote the principle is stone, crow also saw harda small in size picked it up and flew away. The thirsty crow has drunk the water. Many of the students wrote the moral of the story in the principle. It was found that few of the students had left the question unattempted.

In order to find out whether the mean gain score obtained by experimental group is significantly different than the mean gain score of control group t value was calculated. The table 5.20 gives the summary for t value

Table: 5.20
t value for experimental and control group for story thirsty crow

	Mean gain score	SEM	SD	df	t value
Experimental Group	10.67	0.4986	3.5958	92	6.458*
Control Group	6.405	0.3989	2.5856	92	

*significant at 0.01 level

It is evident from the table number 5.20 that the calculated t value of 6.458 is greater than the expected value of 2.617 at 0.01 level of significance for ninety two degree of freedom. Thus, the null hypothesis that there will be no significant difference in the mean gain score on science comprehension of a story thirsty crow of experimental group studied through instructional strategy and control group studied through traditional method of teaching is rejected. This signifies that the mean gain score on comprehension of experimental group is significantly greater than the mean gain score on comprehension of the control group. This shows that the instructional strategy was effective and had a significant effect on comprehension in science of the experimental group students.

5.3.2 Analysis and interpretation of the responses to science comprehension of a story foolish donkey and clever salt merchant

The response to the question of listing of scientific aspects and principles included in the story of foolish donkey and the clever salt merchant by the experimental group students is as below. Majority of the students could list the following principles

- ☐ Salt dissolves in water
- ☐ Cotton being porous becomes heavy after absorbing water
- ☐ Salt makes homogeneous solution with water
- ☐ Water is universal solvent
- ☐ The effort required to lift heavy load is more and the effort required to lift less weight is less
- ☐ Cotton is not soluble in water
- ☐ Gravitational force acts on donkey
- ☐ The weight on the donkeys back becomes heavy when cotton absorbs water
- ☐ The weight on the donkeys back becomes lighter when salt gets dissolved in water
- ☐ The sea water evaporates because of heat of sun
- ☐ Salt is light in weight and mixes with water and is soluble in water

- ☐ Cotton is porous and light weight which absorbs water and becomes heavy
- ☐ As the donkey tumbles over the stone due to sudden stop of force the donkey falls down
- ☐ Donkey is able to lift heavy load on his back because of muscular force
- ☐ There is force of friction involved when the donkey tumbles over a rock
- ☐ The donkey falls in water because of force of stone which acts on the donkey
- ☐ Donkey slips on a rock because rock is slippery and because of gravity donkey falls in the water with water
- ☐ Organism cannot carry heavy load
- ☐ The donkey fell in the river as there was a stone. The donkey was walking with salt bag on his back and therefore was applying full force. When donkey tumbled over the rock the force was opposed and thus in result the donkey fell down
- ☐ The donkey fell down on the ground because of gravitational pull
- ☐ Property of solubility. The solute particles which gets dissolved in particular solvent are soluble
- ☐ Absorption phenomena. Cotton soaks water and becomes heavy
- ☐ Liquids can flow

Few students also had written

- ☐ *All the time you got to do easy things and make someone cheat but at the end you are in trouble*
- ☐ *Donkey is very lazy and therefore uses tricks every day*
- ☐ *Donkey was very foolish and merchant was very tricky and clever*

In order to find out whether the mean gain score obtained by experimental group is significantly different than the mean gain score of control group t value was calculated. The table below gives the summary for t value

Table: 5.21
t value for experimental and control group for story foolish donkey and clever salt merchant

	Mean gain score	SEM	SD	df	t value
Experimental Group	7.288	0.2624	1.8925	92	7.3418*
Control Group	4.619	0.2408	1.5609	92	

*significant at 0.01 level

It is evident from the table number 5.21 that the calculated t value of 7.3418 is greater than the expected value of 2.617 at 0.01 level of significance for ninety two degree of freedom. Thus, the null hypothesis that there will be no significant difference in the mean gain score on science comprehension of a story foolish donkey and clever salt merchant of experimental group studied through instructional strategy and control group studied through traditional method of teaching is rejected. This signifies that the mean gain score on comprehension of experimental group is significantly greater than the mean gain score on comprehension of the control group. This shows that the instructional strategy was effective and had a significant effect on comprehension in science of the experimental group students.

5.3.3 Analysis and interpretation of the responses to science comprehension of a story cap seller and monkeys

The response to the question of listing of scientific aspects and principles included in the story of cap seller and monkeys by the experimental group students is as below:

- ☐ The cap seller is able to walk because of frictional force
- ☐ Muscular force is involved when the cap seller carries a bag filled with caps
- ☐ There is spark in the acrylic jacket because of static electricity
- ☐ Anything thrown up in air comes towards centre of earth because of gravitational force
- ☐ Monkeys can climb from one tree to another
- ☐ Seasons are caused because of revolution of earth around the sun
- ☐ Day and night are caused because of rotation of earth around its own axis
- ☐ Climbing uphill the cap seller started sweating because more energy is required to climb uphill
- ☐ Monkeys imitate human beings
- ☐ Monkeys are our ancestors

In order to find out whether the mean gain score obtained by experimental group is significantly different than the mean gain score of control group t value was calculated. The table below gives the summary for t value

Table: 5.22
t value for experimental and control group for story cap seller and monkeys

	Mean gain score	SEM	SD	df	t value
Experimental Group	8.134	0.3612	2.6048	92	7.317*
Control Group	4.523	0.3183	2.0628	92	

*significant at 0.01 level

learning by doing the experiments very much interesting. The students were of the opinion that learning becomes easy when the experiment is conducted and then it is very easy to understand and remember the concept taught. Around seventy seven percentage of the students found the activity of predict observe explain very interesting and rest twenty three percent opined that thought the activity was interesting but it was little bit difficult for them to predict as to what will be the result. All the students found working in group helpful for understanding the concepts of science. The students opined that it was felt as if the laboratory was brought to the class when the researcher made them do number of experiments.

The present chapter contained analysis of the data along with the interpretation. On the basis of data analysis it is found that the instructional strategy proved to be effective for comprehension in science for the experimental group students as compared to the control group students. But it is not only enough to present the findings rather the results obtained need to be terminated into meaningful inferences and implications. The succeeding chapter presents discussion based on major findings of the present study and comes out with the implication of the study along with suggestions for further research.