

CHAPTER – V

DATA ANALYSIS AND INTERPRETATION

5.1 Introduction

The present chapter aims at analysis and interpretation of the data collected to find out how far the stated objectives of the study have been realised. The information collected from various sources (presented in chapter III) in two stages of the study has been analysed in this chapter under two sections as given below:

5.2 Preparation of the Instructional Programme.

5.3 Implementation of the Instructional Programme.

In section 5.2, data regarding the preparation of the instructional programme has been analysed by recording the interactions of parents, teachers, pupils and classroom. The summary of these interactions has been presented in this section.

In section 5.3 data regarding the Implementation of the Instructional programme has been presented in two sub sections, 5.3.1 and 5.3.2. In sub section, 5.3.1 data regarding the identification of process skills employed by the pupils during the instructional programme is presented. The data is described in terms of 'Context' of scientific investigation with respect to soil, sound and water. In sub section, 5.3.2 data regarding the acquisition of process skills is presented in terms of change in pupils' ideas during the instructional programme.

5.2 Preparation of the Instructional Programme

The Instructional Programme was conceptualised according to the constructivist model of curriculum development (Driver, 1988). According to it, in order to plan instruction, the teacher's practical knowledge about the school and pupils is an essential component (refer section 1.7). In order to experience and gain a practical knowledge of the case study school (refer chapter-IV) the researcher observed the curricular transaction in classrooms and interacted with teachers, parents and pupils.

The data was collected through employing various methods and sources (refer section 3.3.5). The data analysis resulted in emergence of certain patterns (refer section 3.3.7) these patterns were used to construct meaning on the preparation of the instructional programme (refer Fig.3.2) The summary of interactions have been presented in terms of four distinct patterns.

- 5.1.1 Interaction with parents
- 5.1.2 Interaction with teachers
- 5.1.3 Interaction with pupils
- 5.1.4 Interactions in the classroom

Given below is the description of each pattern along with the meaning construction.

5.2.1 Interaction with Parents

The interactions with parents centre on the schoolteacher and children. About the teachers, parents feel that *“teacher should show love, affections towards children”*. Another parents remarked, *“Teachers are like God, they should give suggestions to pupils”*. Parents feel that *“they (children) should grow and support us”*. Parents seem to prefer that boys should read more and get work. However on girls, parents feel that they should read less and needs to get married at earliest. Teachers in the school had complained that parents do not take interest to visit the school. When parents were asked about it, they replied that *“if there is any work, the teachers, themselves will call”*, one parent commented, *“If we visit the school regularly, teachers may not like it”*. Parents agreed that they have difficulties in supporting the education of the younger ones. One of the parent said, *“I have six children, total ten members in the family. Only I have to work”*.

• Meaning Construction

Parents have their own notion of a how a school should be; this notion is varied and has different meaning. For some parents school is in terms of providing infrastructural facilities like benches, desks etc. and for others schooling is all about taking care of children. Parents do not show initiative in visiting school as they expect teachers to take the initiative in calling them. Parents are facing the challenge of maintaining the family. This need has necessitated the importance of money in their day-to-day interactions. The emphasis on money has made the parents to believe that education is a source of employment (money). This belief results in actions where boys are encouraged and provided better educational opportunities than the girls.

5.2.2 Interaction with Pupils

The interactions with pupils centered on their parents, life at home, and teachers and subjects taught at school with an emphasis on environmental studies. Pupils opine that

parents do not take interest in the education of children. Their concern is to work and earn money as result pupils have to share domestic work, like rearing animals, fetching water from bore well (for boys) and cooking, taking care of young ones, cleaning house etc. (for girls). One of the pupils reported, *"We come to school early to escape the domestic work and parental scolding"*.

Pupils tend to view school as 'temple', or the 'place where lessons are taught'. However pupils do not seem to agree on teacher's classroom behaviours like one pupil reported, *"They give attention to only few and neglect the others who are not good at studies"*. pupils seems to have observed the contradiction in teachers actions like they scold the pupils who come late to school or class room, but they themselves come late to the school class rooms. In another instance, pupils have observed teachers talking in the assembly. However, if they attempted to talk in the assembly, teachers enforce strict silence and punishment. Nevertheless, pupils fear the punishment given by the teacher, who controls pupils by beating with a stick. The fear of getting punished forces the pupils to observe silence in classroom and assembly.

Pupil's experiences in the school have shaped their opinions on the subject taught to them. This was evident when, a question on defining environmental studies was asked to IV standard pupils. Most of the pupils did not attempt to answer. Those who have attempted said *"environment means lesson/ or chapters or Environment means to read what ever taught by Miss (Madam)"*. When a question, what is an environmental study was probed further, pupils gave various answers like-

P1 environment means samaja (social studies) Samaja (Social Studies) means environment.

P2 environment means keeping school clean.

P3 environment means science. Science means reading and writing.

In order to get the ideas from all the pupils, pupils were asked to represent the idea in the form of diagrams on the paper. Pupils' idea on diagram revealed that environment. It consists of house, flag posts with an Indian flag; Bore well, Plants, Flowers and Rangoli. (Refer F pupils' diagrams in Appendix IV)

• **Meaning Construction**

The pupils seem to have shared the understanding and concerns of parents on money. The parental struggle of hard work to earn money has made the pupils to believe that money is the priority in the family. However, in the school, teacher tends to stress on

academic achievement. Pupils who perform well in the academics are getting appreciation and attention of the teachers. Pupils, who do not perform well, seldom get the teachers attention. This has made the pupils to believe that academic achievement is the priority at the school.

Pupils seem to have caught between the priorities of school and home. Pupils face difficulty in managing these priorities at home and school. One pupil remarked in frustration that *who has improved on getting education, I would open a Garage and earn money*. The mode of teacher's action to punish the pupils who does not meet their expectations has instilled a fear among pupils. This fear makes most of the pupils to observe silence in the presence of a teacher.

Pupil's ideas on environment seem to relate environment as the contents taught by their teachers or environment in terms of social studies or science, which involves reading and writing. Pupils seem to view environment in terms of physical objects like house, flag, rangoli, trees and flowers.

5.2.3 Interaction with Teachers

Interactions with teachers centered on pupils, parents, Head madam and their classroom teaching. Interaction with Head madam (in the school, the principal is referred as head madam or H.M.) centered around the pupils, parents and on the school.

Teachers in the school feel that *"if these children learn how to read, write and do math's that's enough"* ----- Teachers expect the pupils to learn properly, whatever is taught in the school ----- *"they should not fear whatever is taught to them, they should learn"*. However another *"teacher said --- they need to learn to memorise ----, they have to learn good things"*. Teachers often complain that parents do not come to school to check the progress of their children. *"They neither pay the school fees nor show interest in education of their children. They come to school for complaining the delay in distribution of rice, uniforms and scholarships"*

Teachers do not seem to be happy with the Head madam. Since all of them agree that, *"she does not seem to be aware of the school work Some teachers have labeled Head madam as 'Memo Madam'. Since, she threatens teacher with memos to get her work done"*.

Head madam on the other hand feels that her job is a like a *"mental torture"*. She says, *"In the school we have to do all the work, including the peon's work we*

have to even count sheep and cows too---". Head madam feels that villagers do not bother about education of their children. Moreover, parents do not come to school even with repeated instructions. The Head madam and teachers share a view that pupils need to be punished strictly for not following the school norms.

• **Meaning Construction**

Teachers in the school seem to be working on certain prejudices with the pupils. One of the commonly occurring prejudices is that *"If these pupils learn from the textbook that much is enough"*. This means, the pupils are not capable of learning beyond the textbook. Therefore, teachers insist on textbook learning. Teachers hold parents as responsible and blame them for the academic failure of the pupils.

Teachers insistence on being in charge of pupils learning like *"pupils should learn what is taught in the school"* and on unwritten norms like punishing those who violate school norms, seems to be guiding teachers behaviors, with respect to pupils. The relationship between the teachers and Head madam was far from being cordial. Head madam feared the education officials and therefore being very strict authoritative with the teachers. Teachers on the other hand use to blame the Head madam that *'she is not aware of the working procedure'* (rules and regulations about the school).

5.2.4 Interactions in the Classroom

In the classroom teachers used to dominate the interactions with pupils. In one of the class of VII std., a science class was on the separation of substances.

Teacher asked the Question (holding the textbook on her hand) *"How substances are separated?"* (Silence in the classroom). Teacher (without giving much time for the pupils to think) herself answered. *"Colour, shape characteristics are useful in separation of substances"*. Pupils are passively listening to the explanation of the teacher. The limited interactions of the pupils was observed in VI standard, where a revision of general knowledge class was on, Teacher asked the questions looking at the textbook,

T- What is the capital of Bangladesh?

P1- Dhaka.

T- Nile is a river or forest.

(Mass answer, some said river, some said forest)

T- It is a river.

The teacher way of asking question was eliciting answer from a very few pupils, occasionally there was a mass answering.

The environmental studies class consists of teacher reading the lesson from the textbook and explaining each paragraph. This was evident in an IV standard classroom where a teacher started the class by reading a lesson on story of the forest. Pupils were given an opportunity to read the lesson. In II and I standard, the District Primary Education Programme (DPEP) was under way. The teacher and pupils were mutually interacting with each other. Pupils had a free choice to learn, as some of them were writing on the wall, some were talking to the teachers, other were moving around.

• **Meaning Construction**

The curricular transaction in the school seems to follow two distinct patterns. One pattern resembles 'Lecture Method', where another pattern resembles 'DPEP intervention.'

The 'lecture method' pattern was seen in the classes of VII to IV standard. Here the teacher uses the textbook as a means to conduct the classes. The lecture method would mean teacher with a restricted movement in the class holding a textbook in the hand and dominating the interactions in the classroom. This authoritative influence is seen in the classroom. Where silence is appreciated and interactions among pupils were labeled as 'Noise'. Teachers seem to have a notion that pupils should learn what is taught in the class. This '*should learn*' implies that teacher is '*knowledge giver*' and a pupil is '*knowledge receiver*'. The 'DPEP intervention' was seen in classes III to I standard. Here pupils seem to have freedom to learn without the use of textbook. Teacher was facilitating the learning of pupils through individualised instruction.

5.2.5 Meaning Construction – Preparation of the Instructional Programme

The interaction of pupils, parents, teacher and classroom were triangulated to gain an insight into 'practical knowledge' of the situation and to realise the need for the preparation of the Instructional Programme (Refer Fig. 3.2).

The parent seems to view the education in terms of getting employment. They expect their children to provide economic support to the family. Parents seem to carry the notions such as "*who has improved on getting education, only those, who have money can afford education*" These notions seem to be very strong among parents,

which make them to discourage the education of their children. Only very few children, that too only boys have made it to the high school. Because of parental discouragement and forced responsibility to earn money makes the children to drop out from the school. This reality reinforces the fact that primary education is what most of the pupils get in their lives. However, teachers in the school do not seem to be aware of this reality. Teachers seem to stress on textbook learning. The textbook is the only criteria for teachers to arrive at curricular decisions in the classroom. The emphasis on exam, overcrowding classrooms, lack of parental interests and prejudice about rural children seem to prevent the teachers from conducting the classroom innovations. Pupils in the school have to comply with the authority of the teacher, who expects the pupils to share the value of obedience and submission to authority. The '*teacher is the knowledge giver*' is the notion prevailing among the pupils. When asked to define environment studies, pupils reported, "*Environment is 'what is taught by madam' (Teacher)*". This seems to support the presence of the notion, that teacher is the knowledge giver. The emphasis on teacher and textbook seems to defeat the very purpose of environmental studies, which is to relate classroom learning to the day-to-day aspects of the surrounding environment (Refer section 1.3).

It is this prevailing situation needs an urgent attention, where a change is brought in the curricular transactions, to realize the purpose of environmental studies. The change is needed with respect to helping the pupils to relate the textbook to their surrounding environment through meaningful learning experiences. Thereby facilitating the classroom interactions and making pupils responsible for their learning... The need of bringing in pupils' learning necessitated the process approach to curriculum (For details, refer section 1.2).

This approach to learning requires teachers to create intentional learning environment with stress on systematic investigation of the surrounding environment using process skills. . In order to create the intentional learning environment, the need of an instructional programme was felt, for the following reasons,

- to support the teacher initiatives to introduce process approaches to school curriculum.
- to facilitate the teacher to create learning environment in terms of 'context' of scientific investigation.
- to provide criteria for teacher in identifying and assessing process skills employed by the pupils.

- to facilitate the instructional effort of teacher and pupils' through instructional components.

The very need of Instructional programme made the researcher to review the relevant literature on constructivist approach to group learning and practical knowledge (gained from interactions with pupils, teacher, parents and classroom interactions) to evolve the components of the instructional programme. (for details, refer appendix I).

The Instructional Programme prepared to realize the very purpose of environmental studies has been presented in the Appendix 1.

5.3 Implementation of the Instructional Programme

The data regarding the Implementation of the Instructional programme has been presented in two sub sections, 5.3.1 and 5.3.2.

5.3.1 To identify the process skills employed by the pupils during the Instructional Programme.

5.3.2 To study the acquisition of process skills employed by the pupils during the Instructional Programme.

5.3.1 To identify the Process skills employed by the pupils during the Instructional Programme

In sub section 5.3.1, data regarding the identification of process skills employed by the pupils during the instructional programme has been presented in terms of 'context' of scientific investigation. The data was collected through employing various methods and sources (refer section 3.3.5). The data analysis resulted in emergence of certain patterns (refer section 3.3.7) these patterns were used to construct meaning on identifying the process skills employed by the pupils (refer Fig.3.3). The 'context' of scientific investigation has been described below with respect to contents from three units on soil, sound and water.

5.3.1.1 Context of Scientific Investigation - Soil

The teacher in order to realize the objectives on the unit soil intentionally created the context of scientific investigation. The objective of teaching soil to IV standard pupils was to enable them to observe the physical and biological diversity of soil. Accordingly lesson plans were planned (refer Appendix I.B 2.1) and taught through Discovery approach (refer Appendix I.B.4.a). In order to implement the lesson plans

in the classroom, the pupils' activities were organized into whole class activity and group activity.

During the whole class activity the discovery approach was (phase one) was centered on the teacher. The teacher orient the pupils about the activities, gives the demonstration of the activity, discusses the purpose of instructional sheet (refer Appendix I.B.3) and describes the importance of working in groups through activity cycle.

During the group, activity the discovery approach (phase 2 and 3) was centered on pupils and teachers. Pupils work on activity cycle with five different activities. (Refer table 5.1). The activities involved were school soil, garden soil, and grass soil, which corresponds to physical diversity of the soil. The activities on ants and earthworm correspond to biological diversity of the soil.

During these group activities, pupils actively seek evidence; work in groups, generate ideas to support their opinions/belief. Pupils test their ideas and take others ideas through discussion.

The classroom was different in the sense that pupils had the freedom to sit in the classroom or anywhere in the school ground. The classroom was organized to support and facilitate the interaction of pupils with pupil's materials and teacher. The teacher's role is to help the pupils to express and test their ideas, to reflect upon evidence and to question the way they carryout their investigations. The teacher evaluates the pupils ideas by following the assessment procedure (refer Appendix I B.5). The teacher uses self-evaluation pro forma (refer Appendix I.B.1) to reflect on the teaching strategies.

The summary of the work done, by different groups have been described through activity sequence followed in activity cycle. (Table 5.1).

Table 5.1 Activity cycle – Soil

Days	School Soil	Earth worm	Grass Soil	Garden Soil	Ants
1	G1	G2	G3	G4	G5
2	G5	G1	G2	G3	G4
3	G4	G5	G1	G2	G3
4	G3	G4	G5	G1	G2
5	G2	G3	G4	G5	G1

► G3

The representation of pupils drawing consisted of soil as black dot. The pupils listed the objects like stick, stones, paper, leaves and paper.

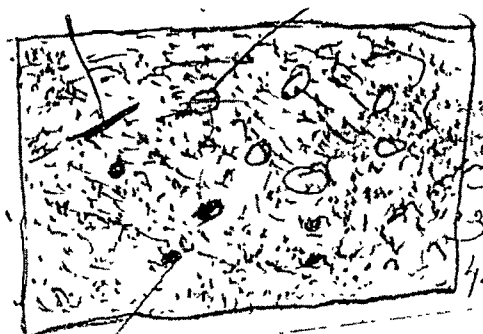


Fig. 5.9 Initial observation G3

The pupils have not answered the questions on comparing upper and lower layers of soil. Pupils also have not written differences between diagrams before the observation and after the observation. The diagrams of pupils after the observation is as follows

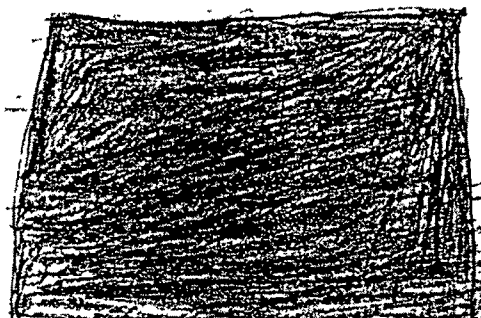


Fig. 5.10 Final observation G3

The soil has been represented as shade of blackened substance.

► G2

The initial diagram of the soil showed soil as representation of black mass of substance.

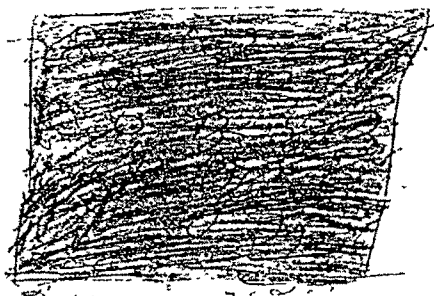


Fig. 5.11 Initial observation G2

The pupils listed varieties of objects of the soil, like small stones, roots, flowers, ants, etc. However, the pupils have not identified the difference between initial and final diagrams. Upper layer and lower layer have also not been identified.

The diagram of soil drawn after the observation is as follows

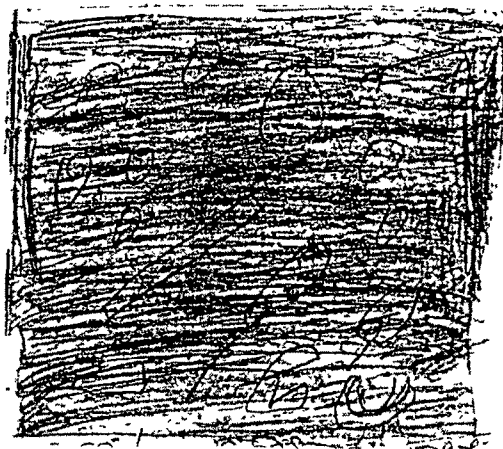


Fig. 5.12 Final observation G2

• Meaning Construction – School Soil


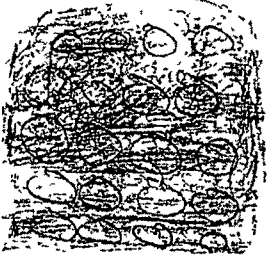
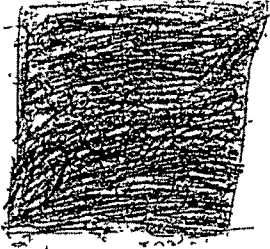
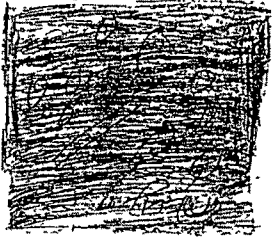


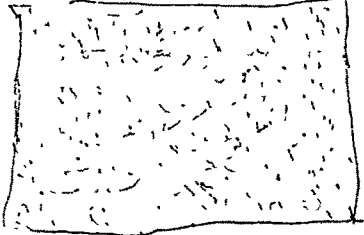
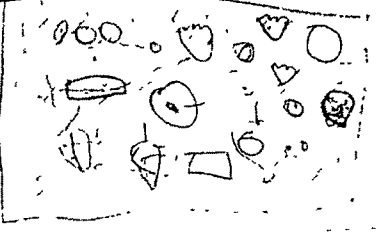
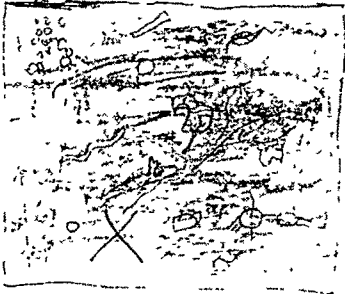
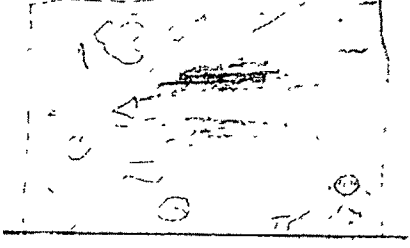
The meaning construction involved was to view the activities done by various groups. The represented on the soil before the commencement of the activity (Initial observation) and after the end of the activity (Final observation) have been represented by the given diagrams (Table 5.2).

The pupil's ideas have shown change in diagrams before and after the activity. This change in diagrams is an indication that process skills were put into use. The pupil's representation of after diagrams have facilitated observation especially in giving attention to detail of soil layers.

However, hand lens as a tool used by pupils has made a difference in observation soil in terms of attention to detail Ex. G1. However, despite the use of hand lens, pupils have not paid attention to details Ex.G3 pupils have not paid any attention.

Pupil's ability to identify the upper layer and lower layer was pronounced in G5 where pupils see colour as the basis of identification of different layers. Saying upper layer as coffee and lower layer as red colour.

Table 5.2 Soil – Comparative diagrams

Groups	Initial Observation	Final Observation
G1		
G2		
G3		
G4		
G5		

Earthworm

▣ Activity Description

The purpose of this activity is to observe earthworm in terms of shape, size, utility to soil etc. pupils carefully select the earthworm (with the help of the teacher) and transfer to a piece of white paper. Pupils use a hand lens to observe the movements of the earthworm, it's body, colour, utility to soil, etc. draw the diagram of the earthworm.

❖ Activity Sequence

G2 → G1 → G5 → G4 → G3

► G2

Pupils attempted to observe the earthworm movement. The diagrams have shown the movement of earthworm. Pupil has stated, *"earthworms were dancing, moving, or fighting with each other"*.

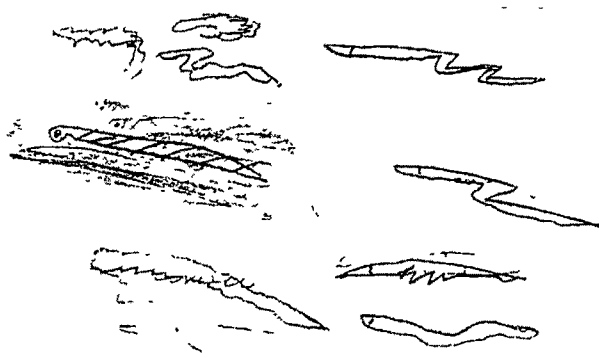


Fig. 5.13 Representation of Earthworm G2

► G1

For the pupils of this group observing the earthworm was not a pleasant experience. Pupils expressed fears of touching the earthworm. They used to test earthworm by pricking it with pencil tips. The pupils reported that earthworm suffers from '*pain*' and '*agony*' when pricked with pencil tips. Few pupils attempted to touch earthworm by hand and reported that it sticks to hand. The pupils have not answered the questions on earthworm shape and use of earthworm to plants. The pupils diagram representation of earthworm is as follows:

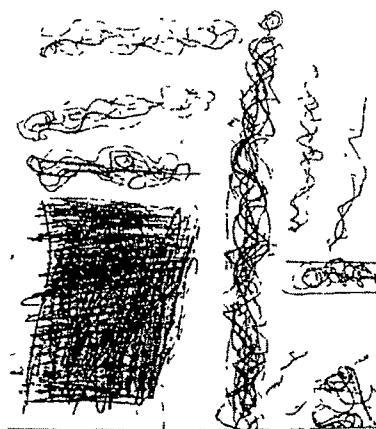


Fig. 5.14 Representation of Earthworm G1

► **G5**

In this group, pupils were apprehensive of touching the earthworm. Some pupils had fear of looking at earthworm and observing it from a close distance. It is in this context that teacher had asked one of the pupils to take the earthworm on the hand (perhaps to show that earthworm is harmless and to remove the fear among pupils) one of the pupils have shown in the following diagrams.

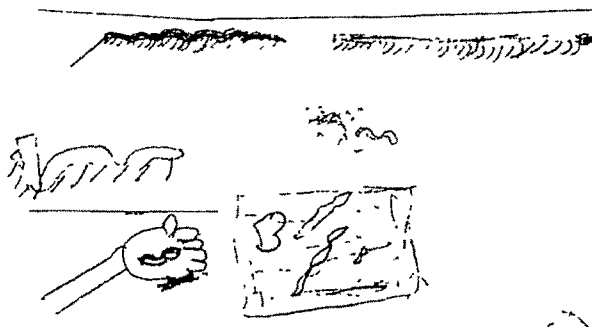


Fig. 5.15 Representation of Earthworm G5

Based on the observation pupils said that earthworms are of various lengths. They have 'nice' (smooth skin) on the body, (therefore it moves very slowly). The body is covered by soil. The soil is in coffee colour. To question on earthworm usage to plants pupils replied that, "*the presence of earthworm makes the plants to grow very well*". On earthworm breathing, pupils replied, "*outside air gets into soil and reaches the earthworm, so earthworm can breathe easily*".

► G4

The group stated earthworm observation by relating earthworm into a piece of thread stretched on the ground.

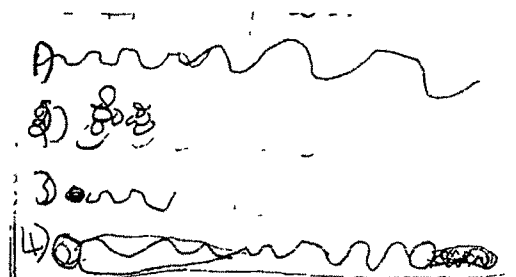


Fig. 5.16 Representation of Earthworm Initial observation G4

However as the group continued with the observation using hand lens, the usage of hand lens brought a change in the way of representing earthworm as follows.

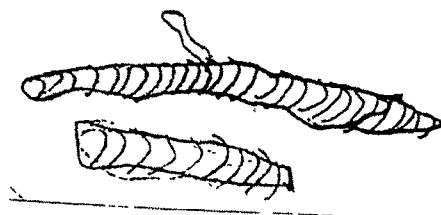


Fig. 5.17 Representation of Earthworm Final observation G4

When asked about the usage of earthworm to plants. Pupils said that they were not aware of the usage of it. While attempting to answer the question on how earthworm breaths, pupil replied – that *“earthworm bites the roots of the plant and gets air whenever the plants shakes, even the roots shakes resulting in getting air to earthworm”*.

► G3

In this group, there was a change in the diagrams during the initial observation as compared to final observation. This has been presented below

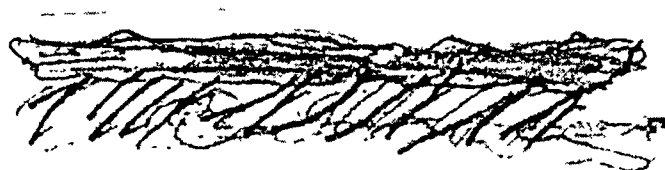


Fig. 5.18 Representation of Earthworm Initial observation G3

The initial observation indicating the earthworm has legs for movement.

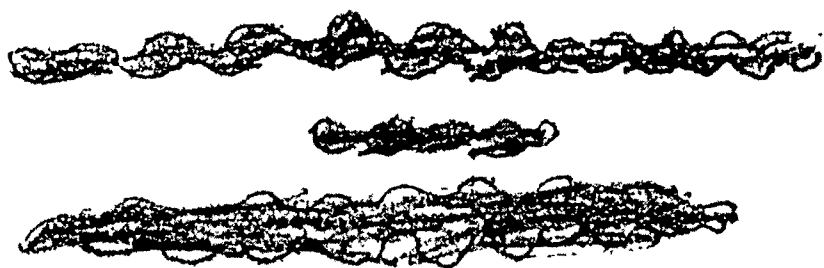


Fig. 5.19 Representation of Earthworm Final observation G3

But Final observation shows it moves through shaking the body. The group felt that earthworm breathe by clutching the roots of the plants.

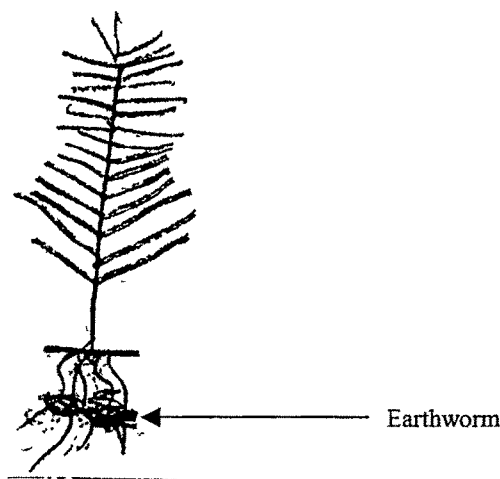


Fig. 5.20 Breathing of Earthworm G3-P1

Another pupil felt that “soil has holes in it and air coming from trees enters and reaches the earthworm”. This has been represented below.

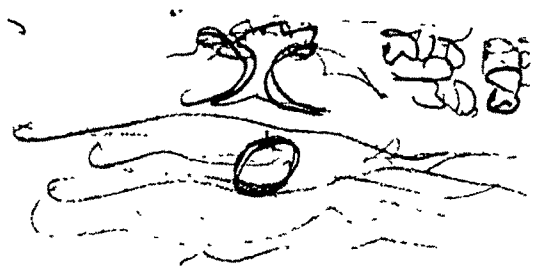


Fig. 5.21 Breathing of Earthworm.G3-P2

• Meaning Construction – Earthworm

The pupils way of observing earthworm seem to have two patterns where one pattern is that of giving attention to the physical features of earthworm as in the case of G4, G3, whereas another pattern is not giving enough attention to the physical features as in the case of G5, G1 etc. When pupils were asked to explain how does earthworm breath inside the soil, pupils gave varieties of answers:

G2 - *“earthworm do not require air, they breathe inside the soil”*

G1 - has not answered

G3 - *“soil has holes in it and air coming from trees enters and reaches the earthworm. Earthworm gets air by clutching the roots of the plants”.*

G4 - *“Earthworm stays by holding the roots of plants whenever plant shakes, root also shakes resulting in getting air to earthworm”.*

G5 - *“air from outside gets into soil and reaches the earthworm so earthworm can breathe easily.”*

However getting the pupils to give an explanation was not easy. Pupils were not taking initiative in answering; as a result teacher has to resort to probing. An example is presented below.

T- *How does the earthworm get air inside the soil?*

P1- *by dust*

T- *common, think and answer (silence)*

----- Teacher again repeated the Question

P2 - *when the plant shakes (stops)* (and looks at the teacher, teacher encourages common tell you, you are right...)

----- *Root also shakes and it [earthworm] gets air.*

Teacher created doubt in order to crosscheck the answer.

T- *Does roots really shake?*

P3 - *Supporting P2 when roots shake leaves shakes resulting in air that gets into soil. In the above example teacher's continued probing helped the pupils to come out with alternative ideas on earthworm breathing.*

Grass Soil

■ Activity Description.

The purpose of the activity is to observe nature of grass soil present in the roots. Pupils select the place in a school compound where grasses have grown. Pupils observe the nature of the place where grass has grown and pluck few grasses along with roots. They keep roots on a sheet of paper. Pupils observe the soil that is present in the roots of the grass with the help of a hand lens and then draw a diagram of soil.

❖ Activity Sequence

G3 → G2 → G1 → G5 → G4

► G3

The group three began the experiments with the purpose of examining the grass soil. They have listed varieties of objects in the grass soil like stones, ants, leaves, soil. One of the representations of the grass soil is presented below.

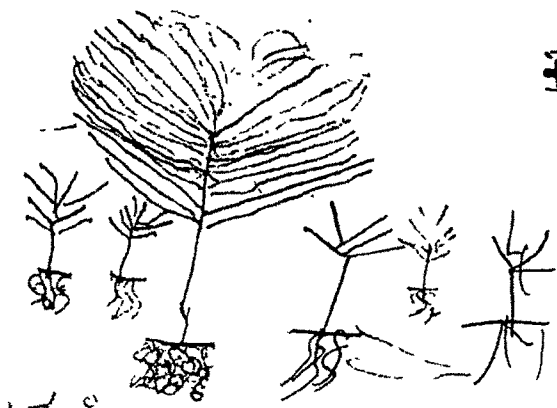


Fig. 5.22 Representation of Grass soil G3

The soil is presented as thin layer of stick and having branches extended from the thin layer. The grass soil has been shown as sticking to the roots. Pupils reported that grass soil sticks to bigger soil. However, pupils did not give the reason as to why stones are not sticking to the roots of grass.

► G2

The G2 had represented grassroots hidden beneath the soil surface. The following diagram shows that soil is holding the roots and supporting the plants

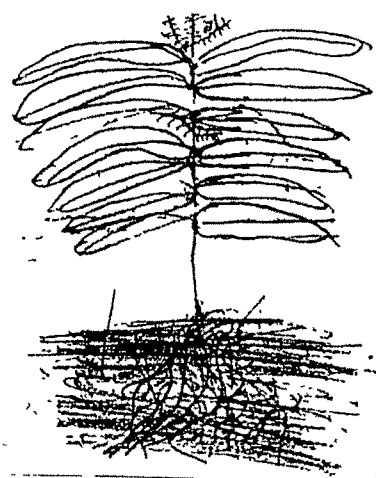


Fig. 5.23 Representation of Grass soil by G2

The pupil's observation reveals that *"grass roots soil is very moist. It has large roots. The small stones attached to it consists of Ragi"*.

► **G1**

The group started the work with the help of hand lens. This is depicted in the diagram below

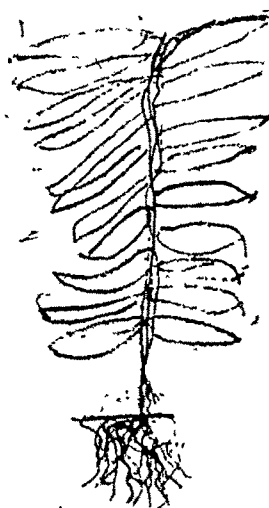


Figure 5.24 Representation of Grass soil by G1

The diagram depicts the leaves, stem and presence of roots below it. The pupils reported that soil is moist, that is why it sticks to the roots. When asked to write, about the absence stones in the soil A pupil replied that *"stones are heavy that is why it has not been sticking to the grass soil"*

► G5

This group to observe the grass soil has been represented below.

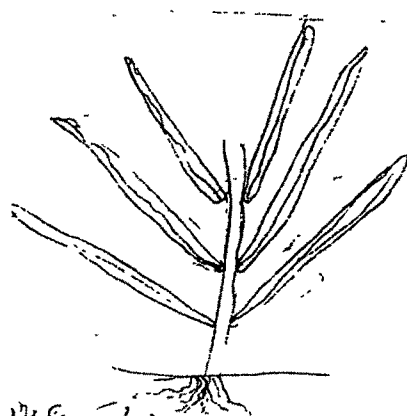


Figure 5.25 Representation of Grass soil G5

The diagram represents grass being spread or held together on the ground. The roots are being spread on being asked by the teacher to examine the grass soil. Pupils have reported that *grass soil is 'rough'* [describing the physical properties of grass soil]. When asked about non-presence of stones in the roots. Pupils replied that the *"rainwater is being absorbed by the moist soil. Since the stones are bigger in size they tend not to stick to each other"*.

► G4

The group has reported grass soil as follows.

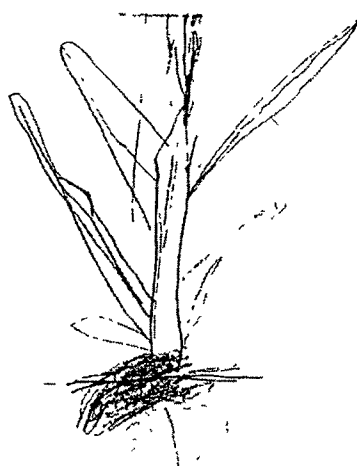


Figure 5.26 Representation of Grass soil in the root G4

The diagram depicts the grass soil present near the lower stem and also spread into roots

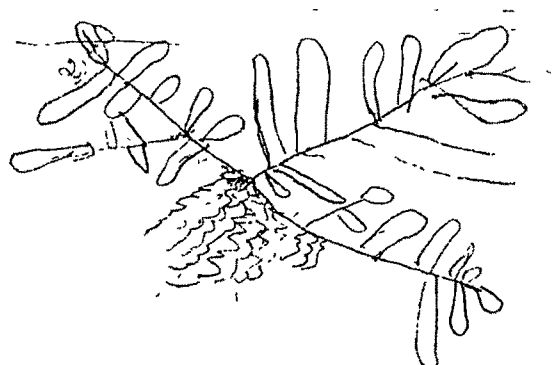
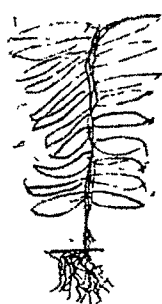


Figure 5.27 Representation of Grass soil G4

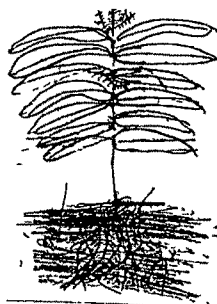
The grass resembles like herb with different lengths of levels. Pupils said that *soil is coffee in colour, rough [referring to the texture of soil], sticks to the roots. The soil contains small stones.*

- **Meaning Construction -Grass soil**

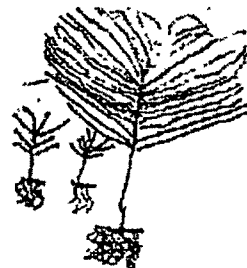
The representation of grass soil by different groups are given below.



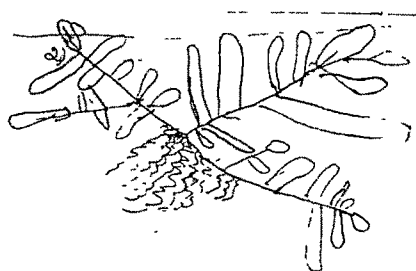
G1



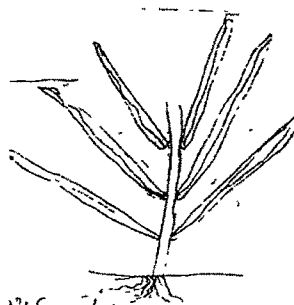
G2



G3



G4



G5

Figure 5.28 Representation of Grass soil by different groups

One of the purposes of the above diagram is to show how pupils have viewed grass soil. The focus of the activity was to examine the physical features of grass soil.

Pupils have given due importance to drawing stems and leaves as compared to the grass soil. The notable exception is by group five. Who used hand lens in order to represent roots of the soil. The diagram shows that the soil root containing soil particles clinging into root tips.

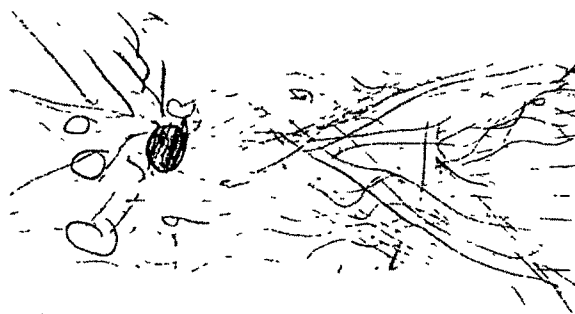


Figure 5.29 Roots of Grass soil G5

One of the interesting aspect is the groups have described the colour of grass soil as that of '*coffee colour*'. [Since coffee is also in dark Brown in colour] children are relating the brown colour with respect to coffee, which they drink in their homes and are familiar.

Pupils were asked to reason for the presence of small stones instead of big stones in the grass soil. The interaction between pupils and teacher is presented below

T- why only small stones are clinging to grass soil?

P1 – big stones are heavy (they cannot stick).

Whereas small stones are ('Thari') that is why they to stick to roots. The purpose of this activity is to observe garden soil in terms of physical properties such as colour, texture and constituents of the soil.. In the above example, pupils have reasoned that small stones are being smooth ('Thari') tend to stick to the roots.

The Garden soil

■ Activity Description.

Pupils take the garden soil, transfer into the glass jar slowly, and add water to it. Pupils and stir the mixture with the help of a wooden stick and leave the mixture for about 10-15 minutes. Observe the change in the glass jar. Let pupils record their observation in their notebook.

Activity Sequence

G4 → G3 → G2 → G1 → G5

► G4

The group reported two layer of soil (based on their observation of soil, which got separated into two distinct layers on addition of water).

Rough soil ('*Tari mannu*'), nice soil ('*nice mannu*') pupils were curious and were keen on conducting the activities with glass vessels. Pupils identified roots, small stones, grass, leaves etc as some of the objects present in the soil. On being asked by the teacher to give reason for the presence of two distinct soil layers pupils replied that "*'Sanna kallu' (Small stones) in the lower soil of went down because of weight, where as 'nice mannu' upper layer of soil was not having weight, that is why it was on the top of the soil.*"

► G3

The group described the soil, as '*nice swalpa thari*' meaning the soil is smooth but also rough. The soil is in red colour. Soil consists of 'nore'(froth) and it sticks to the hand. The soil consists of dust (kole) in it. The group listed the objects like leaves, paper, etc. The group did not give reason for the formation of upper and lower layer.

► G2

The group just listed the objects in their notebook. The group listed the objects like red soil, small stones, dust, leave small stick, etc. Pupils have reported that soil was '*nice*' because of the presence of white stones. However, the pupils have not given reason on presence of two layers of soil

► G1

One of the significant aspects of the group is to present their observation. Their observation is in the orderly manner.

The soil was moist as a result the dust did not come.

The soil was red in colour

when water was poured, it turns to 'coffee' colour.

The pupils reported, "*soil present below is 'rough' whereas the soil present above is 'nice'* The '*rough*' soil (lower layer) goes down because of weight and the '*nice*' soil (upper layer) comes up since it does not have weight".

► G5

The group has attempted to report the activity systematically. The group reported that '*once you put water into the vessel containing garden soil there is formation of froth. The colour of the soil turned into red The soil do not have chlorophyll, so it did not*

give any other colour. Except red the smell of the soil was similar to the smell of coffee.' The pupils listed objectives such as, leaves, roots and small stones.

- **Meaning construction**

Garden soil

Pupils were fascinated to use glass vessel to perform activity. The colour change that occurs when water is poured into soil made the pupils to remark that soil changes from 'red' colour to 'coffee' colour. The objects, like paper dust, wooden particles dried leaves, which float on the water, caught pupils attention. Most of the times pupils were seen playing with water than to perform the activity. Teacher has to remind them about the activity. During the activity, pupil's ability to make notes of observation was evident from G1, who had systematically recorded of observation. When pupils were asked to reason out as to why garden soil separated into two layers on addition of water. Given below is the interaction between teacher and pupils.

T- what happened when you poured water into the soil?

P1 – 'nice' soil came up 'rough' soil came down.

T- why did the " nice soil came up and rough soil came down"? (teacher formulated question using pupils ideas.)

P1 – small stones were there in the soil. It became 'rough' and went down because of weight. The 'nice' soil came up because it was smooth.

The above interaction tends to suggest that weight was the reason for the separation of soil layers.

Ants

▣ Activity Description.

In these activities, pupils were asked to make observation on the ants. It's physical features viz. Shape, size, colour etc. Pupils have to make two diagrams. One from their previous experiences of ants and another after observation pupils will compare both diagrams and identify the similarities or differences. Pupils ask write question on ants.

❖ Activity sequence

G5 → G4 → G3 → G2 → G1

► G5

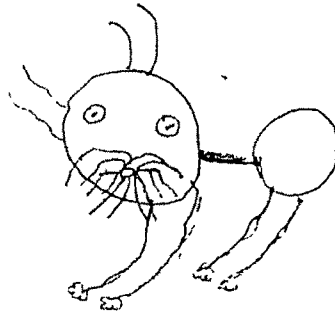


Figure 5.30 Initial observation G5

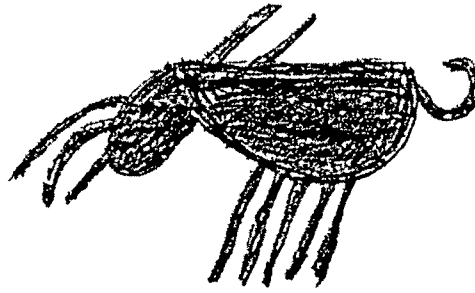


Figure 5.31 Final observation G5

Pupils observed the difference between initial and final observation as follows in initial observation ants had four legs, moustaches and no tails. Final observation ants had six legs, moustache, and had a tail. Pupils raised a question on the ants' activity. *Why does the ant stay in the soil?*

► G4

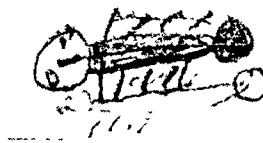


Figure 5.32 Initial observation G4



Figure 5.33 Final observation G4

In this group, it is difficult to identify the change initial and final observation. Pupils have not observed the differences between initial and final observation. Despite the presence of the ants, pupils have not modified their initial observation.

► **G3**

Pupils in this group have represented ants in different ways. Some of the diagrams have been given here under



Figure 5.34 No change in initial and final observation G3

There is no change in the initial and final observation of head, body and abdomen diagrams.

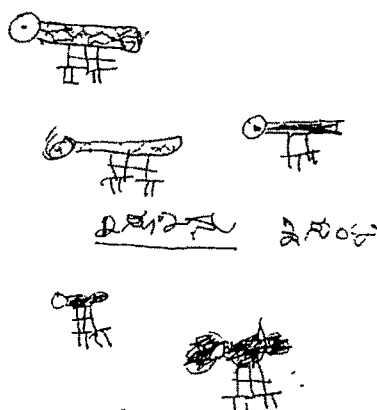


Figure 5.35 Some change in initial and final observation G3

There is some change in representation of head, body and abdomen in initial and final observation.



Fig. 5.36 Changes in the initial and final observation G3

There is a change with respect to representation of head, body, abdomen and legs of the ants in initial and final observation. However, pupils have not replied to question on writing the differences between initial and final diagram.

► G2

The representation of ants could be seen with two different types

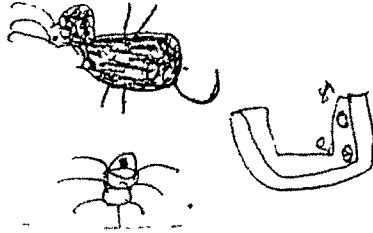


Figure 5.37 Representation of Ant G2

The initial and final observation makes a distinct change with respect to representation of head, body, abdomen and legs. The pupils have made observation on ants like-

Ants were small and red in colour.

Ants were going in and out of nests (gudu)

The pupils have made observations using hand lens, which made them to remark ants were looking big. The non-usage of hand lens as a tool had made them to look ants very small. Pupils reported that ants tend to run and bite. One interesting aspect is a pupil reporting, that “*there is no difference between initial and final observation*”. However, pupils wrote ants had no legs in initial observation but in final observation of ants, they wrote that ants consists of legs.

► G1

The group has presented ant through series of observations. The diagram below represents how changes in pupil’s ideas are brought about by repeated observation. The initial diagrams prior to observation showed ants with head, abdomen and with many legs. However, the final diagram after observation showed ants with distinct head, body and abdomen; the diagram has been represented below.

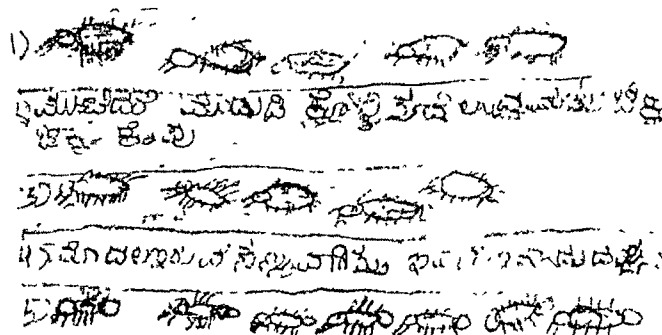


Figure 5.38 Representation of Ant G1

Pupils have observed that ‘if you touch ants it shrinks, it runs faster and makes holes on the ground’. One of the significant aspects of this group is to ask questions but they have answered it also.

1) How does the ants run?

Ants run very fast

2) Where does the ant build anthill?

Ants build anthill on the ground

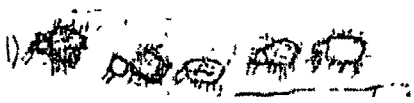
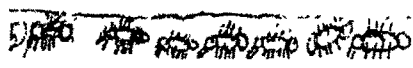
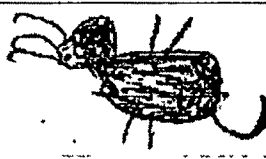

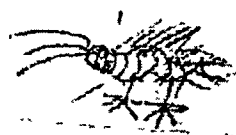


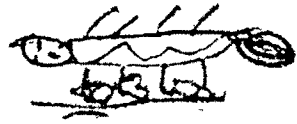
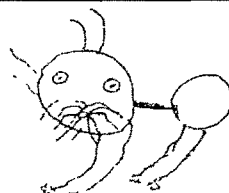
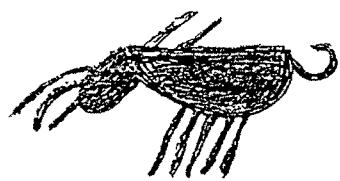
3) Where does the ants walk?

Ants walk on the ground, trees and also on the body.

• **Meaning Construction Ant**

Pupils were asked to write ants diagram, prior to the commencement of activity. In this activity, pupils have used their imagination to represent ants that could be seen in diagram listed in initial observation (Table 5.3).

Table 5.3 Ants Comparative diagrams -Initial and Final observation

Groups	Initial observation	Final observation
G1		
G2		
G3		
G4		
G5		

Pupils were asked to write ants diagram, prior to the commencement of activity. In this activity, pupils have used their imagination to represent ants that could be seen in diagram listed in initial observation. The pupil's ideas have been that ants consist of moustaches, legs like birds etc. After the pupil collected the live specimen from their habitat and made observation using hand lens. The observation from their diagrams indicated that pupils have strong beliefs about their previous but some change have been brought about in the representation of final observations. The change like distinct head, body and abdomen is evident in some of the diagrams.

When asked to identify the differences or similarities in their diagram. Pupils have not been successful in making critical observation. However, G5 has attempted to compare diagrams. Pupils' ability to raise questions on ants' observations have not found favour with groups. Only G5 and G1 have attempted to raise some questions on ants.

5.3.1.2 Meaning Construction - Soil

The purpose of meaning construction on soil involves employing process skill indicators (see appendix I.B.1.b), to identify the process skill employed by the pupil during the 'context' of scientific investigation. (refer procedure of data analysis in section 3.3.7.2) The pupils' ideas on soil seem to indicate the usage of following process skills.

Process skill in soil

- 1) Observation
- 2) Communicating
- 3) Questioning
- 4) Using materials and equipment
- 5) Hypothesising

These process skills have been described in detail.

Skill of Observation

Under the skill of observation following categories will be considered:

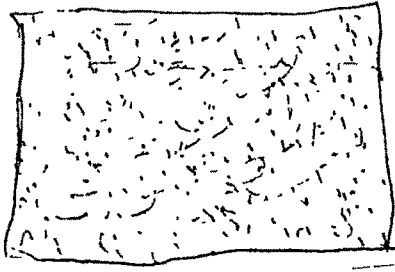
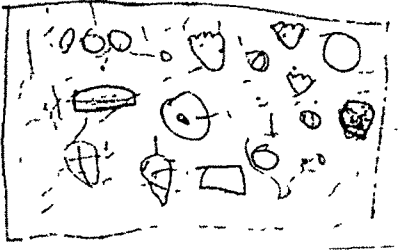


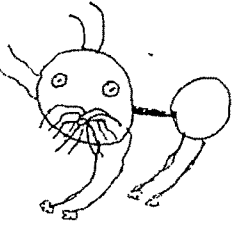
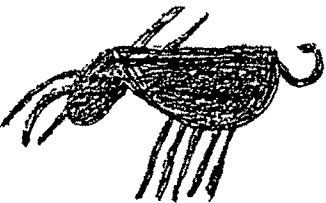
- 1 Change in pupils ideas
- 2 Retaining ideas

Change in Pupils Ideas

Before the commencement of activities, pupils were asked to draw the diagram from their previous experience, which is referred to as initial observation. After the end of

the activity, pupils were asked again to draw diagram based on observation, which is referred to as final observation. The change that brought in pupils ideas from initial to final observation can be seen from some of the select examples across various activity.

Table 5.4 Comparative diagram School soil, Earthworm and Ant





Group Activity	Initial Observation	Final Observation
G4 School Soil		
G5 Earth worm		
G5 Ant		

In the activity on school soil, initial observation shows that soil consists of dotted lines whereas final observation showed various objects like stones, leaves on the soil. In the activity on the earthworm, the initial observation showed legs where as the final observation showed it as without legs. In the activity of ants initial observation showed ants with five legs whereas the final observation on ants showed ants had 5 to 7 legs In all the activities pupils' diagram on observation are changing from their imaginative representation of observation to scientific representation of observation.

Retaining ideas

One of the aspects of pupil observation is that they retain the initial ideas despite the repeated observation. This has been presented in the table.

Table 5.5 Representation of Ant and School soil

Group activity	Initial observation	Final observation
G3 Ants		
G5 School soil		

The initial diagram and final diagrams of school soil and ants have almost remained same, despite the repeated observations.

Communicating Effectively

The pupil's ability to express their ideas has been presented with two categories

1. Linking one idea with the other
2. Systematic presentation of ideas

Linking One Idea with other

Pupils attempt to link one idea (derived from a previous activity) and relate to other idea of a different activity to communicate effectively. This has been depicted below:

Table 5.6 List of Groups Communicating Effectively

Sl. No.	Groups	Groups activities related
1	G1	Grass Soil and School Soil
2	G2	Ant and School Soil
3	G5	School Soil and Ant

➤ Grass Soil and School Soil G1

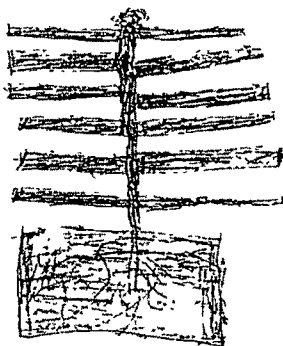


Fig. 5.39 Grass soil and School soil G1

The pupil ideas on grass soil and school soil have been related to each other while performing the activity on grass soil. Pupil depicted the diagram of grass followed by the roots embedded in the grass soil. The representation of grass soil is similar to the representation of school soil by the pupils.

➤ Ant and School Soil G2

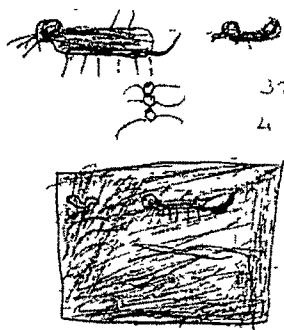


Fig. 5.40 Ant and School soil G2

In the activity of ants, pupil attempt to show position of ants on the soil. The representation of soil resembles the representation of school soil.

➤ School soil and Ant G5

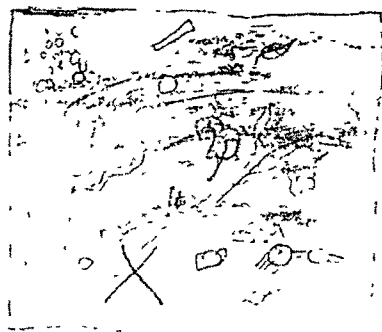


Fig. 5.41 School Soil and Ant G5

While performing the activity on the soil pupils have represented ant and listed along with objects present in the school soil.

Systematic presentation of ideas

This refers to the systematic reporting of the activities as against to unsystematic reporting. The orderly presentation of ideas was seen in-group one in the activity on grass soil.

The observation of G1 on grass soil is presented, as it is

- 1) *"The soil was moist, so when we poured it into the glass vessel dust did not come."*
- 2) *"First soil was 'red' in colour and when water is poured into it turns into 'coffee' colour."*
- 3) *"The soil present below is 'rough' where as the soil present above is 'nic' "*
- 4) *"The soil in the lower layer consisted of small stones and the soil in the upper layer consisted of leaves, coal, grass roots and froth".*
- 5) *"The "rough" soil (lower layer) goes down because of weight and the "nice" soil (upper layer) comes up since it does not have weight".*

Using Hand Lens- Attention to Details

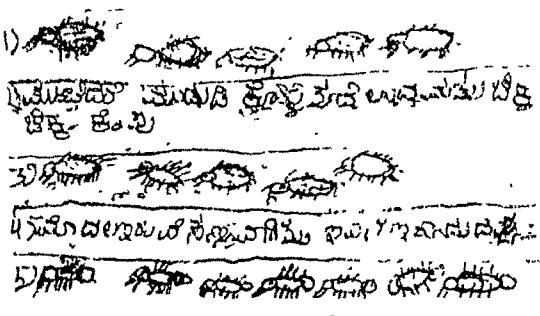
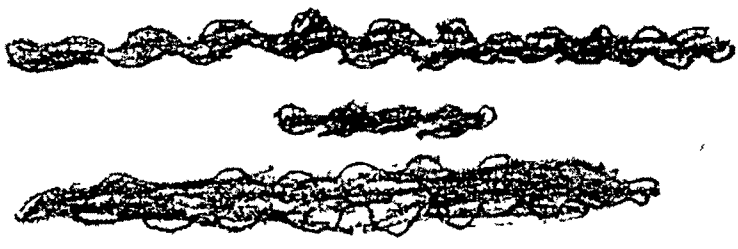
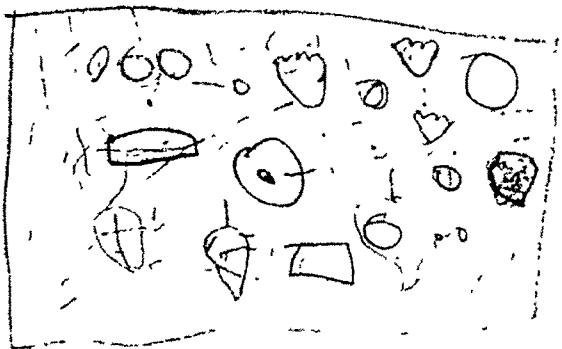
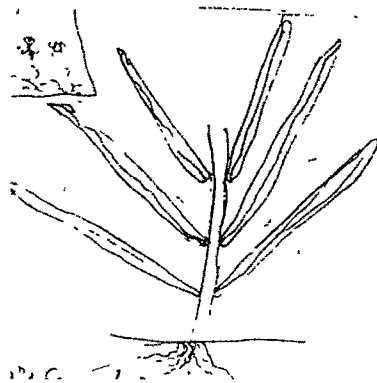
One of the features of the pupils is to give attention to details. The pupil's ability, to represent the specific physical features has been depicted in Table 5.7.

The diagram on ants depicts the progressive observations made by pupils. Pupils have represented the ant by giving attention to head, abdomen and tail portions. The diagram on earthworm was shown to have the body with crest and trough.

The diagram on school soil is enhanced by the usage of hand lens as pupils have given attention to various objects present on the school soil.

The diagram on grass soil shows how soil particles were being clogged to the root tips

Table 5.7 Attention to Details

Groups	Activity	Attention details
G1	Ant	
G3	Earth worm	
G4	School soil	
G5	Grass soil	

Hypothesis

During the hypothesis pupils attempted to formulate a tentative explanation (based on certain concepts) for certain activities. Some of the explanations have been derived from the activity on grass soil and earthworm.

➤ *An Explanation on the Breathing of Earthworm*

Pupils explained by stating that *“earthworms breathe by holding the roots of the plants when plant shakes roots also shake resulting in getting air to earthworm”*.

In this, example pupils have extended their knowledge of air and have related to earthworm breathing. Pupil's notion is that whenever wind is blown it shakes the plants, which in turn shakes the roots, which results in creation of air, which moves through the roots and reaches earthworm (and helps it to breathe).

➤ *Explanations into the Layers of Garden Soil*

In the activity on the garden soil, pupils were asked to explain to find out the reasons for formation of soil layers. Pupils explained that small stones were there in the soil. It went down because of the weight. *“The ‘nice’ soil came up because it was smooth”* (less weight as compared to garden soil).

➤ *Explanation on the Formation of Upper Layer in the Garden Soil*

Pupils keenly observed the upper layer of the garden soil. They labeled the soil colour as that of 'coffee' colour.

Given below is an interaction between teacher and pupil on the upper layer formation

T - I asked you, why few objects are floating on the water?

P1 - They are feeling 'cold' sir.

T - What is cold?

P1 - Cold means you put a blanket when it rains

Teacher repeated the questions

T - Why objects floats on the water?

Another pupil intervened

P2 - It is having less weight Sir.

In this activity, pupil (P1) could not understand that less weight is the reason for floating of objects. Instead, P1 tried to explain that objects feel cold inside the water so it comes out of it. This explanation shows imaginative ideas of pupils interferes in explaining the scientific activity

Questioning

When pupils were given an opportunity to ask questions, pupils were constantly asking questions. However, these questions were asked for the clarification of procedures involved in the scientific activity. The questions were on how to proceed with the activity. Nevertheless, when asked to write questions on related to particular activity pupils faced the difficulty in formulating questions. In the activity of ants all, the questions have been presented from G1 and G5.

Questions from G5 is as follows

Q-Why does the ants stay in the soil? (G5).

However, G1 asked the questions (*Q*) and they themselves have answered (*A*) it.

Q- How does the ants run?

A-Ants run very fast.

Q-Where does ant builds anthill?

A-Ant builds the anthills on the ground.

Q-Where does the ant's walk?

A-Ants walk on the ground, trees and on the body.

The pupil ideas on skill of questioning reveals that questions need to have answer.

5.3.1.3 Context of Scientific Investigation - Sound

The teacher in order to realize the objectives on the unit sound intentionally created the context of scientific investigation. The objective of teaching sound to IV standard pupils was to enable them to identify the different properties of sound in terms of amplitude, pitch and different medium, etc., accordingly certain lessons were planned (refer Appendix I.B.2.2) and taught through Group Investigation Model. (refer Appendix I.B.4.b).

In order to implement the lesson plans in the classroom, the pupils' activities were organized into whole class activity, and group activity in terms of activity cycle. During the Whole, class activity the Group Investigation Model centered on teacher, which corresponds to phase one and phase two of the model. The teacher orient the pupils about the activities, gives the demonstration of the activity, discusses the purpose of using instructional sheets (refer Appendix I.B.3) and describes the importance of using the materials, notebooks. The teacher emphasizes the importance of working in groups, through activity cycle.

During the Group activities, the model is centered on teachers and pupils. Which corresponds to phase two, three, four and five of the model. (The phase two of the model was overlapping with the whole group activities and group activities.) The group activities are organized in terms of activity cycle. The activity cycle was further divided into Part A, which corresponds to phase two and phase three of the model and part B, which corresponds to phase four and five of the model. Given below is the activity description of Part, A which is followed, by the activity description of Part B.

Pupils work in groups to seek evidence, to generate ideas to support their opinions/beliefs. Pupils test their ideas and take others idea through discussion.

The classroom was different in the sense that pupils had the freedom to sit inside the classroom or any where in the school ground The classroom was organized to support and facilitate the interaction of pupils with pupils, materials and teacher. The teacher's role is to help the pupils to express and test their ideas, to reflect upon evidence and to question the way they carryout their investigation. The teacher evaluates the pupils ideas by following the assessment procedure (refer Appendix I.B.5). The teacher uses self-evaluation pro forma (refer appendix I.B.1) to reflect on the teaching strategies The summary of the work done, by different groups have been described below The description is done by following the sequence through which a particular activity has been conducted through activity cycle

Part A

Part A corresponds to phase two and three of the Group investigation model. It consists of activities such as Game of foot, More and Less, In and Around, Wall and Air and Different Objects. The summary of the work done by different groups through activity sequence followed in activity cycle part A in table 5.8.

Table 5.8 Activity Cycle Part A

Days	Game of Foot	More and Less	In and Around	Wall and Air	Different objects
1	G1	G2	G3	G4	G5
2	G5	G1	G2	G3	G4
3	G4	G5	G1	G2	G3
4	G3	G4	G5	G1	G2
5	G2	G3	G4	G5	G1

Game of Foot

■ Activity Description

The purpose of this activity was to understand amplitude of sound varies with distance. In this activity, pupils were given a checklist. The teacher gave a demonstration on how to use the checklist during the activity. In this activity, pupils were asked to take fifteen steps and mark these steps from 0 to 15 on the school ground. The activity involves two pupils, where one pupil acts as a '*source*', while another acts as an '*observer*'. The role of '*observer*' is to record the sounds on the checklist with respect to each step. The role of '*source*' is to generate sound by clapping hand or by hitting a plate with a spoon.

The activity procedure involves *observer* to be stationary at step. While *source* keeps on moving from step one to step 15. In each step, the '*source*' clap the hand. The observer records the sound on the checklist using the symbols for sound clearly heard sound (✓), for mildly heard sound () for not hearing the sound (×). Pupils were instructed to make one entry in each step.

The pupils take turns, so that all the members of the group experience the activity. Pupils were asked to find answer to the questions like.

- 1) can you identify the step in which you did not hear any sound ?
- 2) What did you learn from this activity?

❖ Activity sequence

G1 → G5 → G4 → G3 → G2

The checklist prepared by different groups have been presented below

► G1

క్ర.సం.	ప్రతియోగి పట్టకం	నోట్	శబ్ద రికార్డింగ్
1	✓	□	
2	✓	□	×
3	✓	□	×
4	✓	□	×
5	✓	□	×
6	✓	□	×
7	✓	□	×
8	✓	□	×
9	✓	□	×
10	✓	□	×
11	✓	□	×
12	✓	□	×
13	✓	□	×
14	✓	□	×

Figure 5.42 Checklist G1

The groups have not recorded on the checklist as per the instructions and have not answered the questions.

► G5

క్ర.సం.	ప్రతియోగి పట్టకం	నోట్	శబ్ద రికార్డింగ్
1	✓		
2	✓		
3	✓		×
4	✓	□	
5	✓	□	
6	✓	□	
7	✓	□	
8	✓		×
9	✓		
10	✓		×
11	✓	□	
12	✓	□	
13	✓		
14	✓		
15	✓		

Figure 5.43– checklist G5

Pupils have made errors in recording the third, fourth and fifth steps. Pupils have specified that sound was heard because plate was hit with the tip of spoon.

► G4

ક્રમ નં	સાચી જવાબ	ખોટા જવાબ	જવાબ નહીં
1	✓		
2			
3			
4			
5	✓		
6			
7			
8	✓		
9			
10	✓		
11			
12	✓		
13			
14			
15			

Figure 5.44 Checklist G4

The recording of the group four was not appropriate pupils have made entries in all the columns of the checklist. The groups have not answered the question.

► G3

ક્રમ નં	સાચી જવાબ	ખોટા જવાબ	જવાબ નહીં
1	✓		×
2			×
3	✓		×
4	✓		×
5	✓		
6	✓		×
7			×
8	✓		
9	✓		
10	✓		
11			
12			
13			
14			
15			

Figure 5.45 Checklist G3

This group has not entered the data properly. The group had made the wrong entries but attempted to erase the incorrect entries, on hearing teacher instructions. The group did not answer any questions.

► G2

శ్రేణి గతు	సరియైన శబ్ద రికార్డింగ్	తప్పు శబ్ద రికార్డింగ్	శబ్ద రికార్డింగ్
1	✓		✗
2	✓		
3			✓
4	✓		
5			✗
6			
7	✓		
8			✓
9	✓		
10			
11	✓		✓
12			
13	✓		
14			
15	✓		

Figure 5.46 Checklist G2

The recording of the group was not done properly for in step one to three. The group did not answer any question.

• Meaning Construction – Game of Steps

In this activity teacher, instructions were not followed by all the groups except G5, who followed the instructions on recording in the checklist. All the groups have made in correct entries in the checklist. The probable reason could be that pupils were not familiar in using checklist or codes to record the observations and draw inferences based on the on the observation. Pupils seem to rely on their own senses to judge the sound rather than depending on their observation.

More and Less

■ Activity description

The purpose of this activity is to enable the pupils to identify the high pitch and low pitch of a sound. Pupils use plate and spoon to create different sounds by beating a plate with the help of a spoon. Pupils identify the reasons for different sound. The specific observation is needed to record the sound of a high pitch and low pitch. Pupils repeated the same activity by running the small piece of cardboard over a comb or by clapping the hand

❖ Activity Sequence

G2 → G1 → G5 → G4 → G3

► G2

Pupils in the group have reported that *'if you beat (plate with spoon) slowly sound will come if you beat (plate with spoon) fastly sound will come'*. When asked about to explain the reason for *'fast'* (high pitch) and *'slow'* (low pitch) sound. Pupils replied that *'sounds gets to plate and comes out'*.

► G1

Pupils used the words *'nice'* (low pitch) and *'thari'* (high pitch) Pupils have described *'nice'* and *'thari'* in the following way.

"First time rubbed with comb--- 'thari' sound came, second time rubbed with comb the 'nice' sound came". Pupils reported that in comb activity vibration came very less. During the activity teacher asked the pupils to vary the pitch of sound through hand clapping. Pupils reported after the activity that *"on clapping for the first time less sound(low pitch) was heard, on clapping for the second time more sound (high pitch) was heard."*

► G5

The group conducted the activities with comb, cardboard, spoon and plate. The group did not record the observation on each activity, instead attempted to explain the reason for the activity on spoon and plate. Pupils said *"the vibrations were less (referring to low pitch of sound), since we hit it very slowly. The vibrations were more since we hit it very fastly"* (referring to high pitch of sound).

► G4

The groups have done the activities with plate and spoon, clapping hands. When asked to explain the plate and spoon activity. Pupils said *"if you beat fastly you hear a loud sound (high pitch)* When teacher asked the pupils to perform the activity by clapping hands, pupils said that they did not understand the activity. Therefore, teacher gave a bell and asked about the reason for variations in the pitch of sound, to which pupils replied *"bell has lot of spines in it"*.

► G3

Pupils have done the activities with plate, spoon and comb. Pupils said that when we beat the plate with spoon. Sound came *'more'* (high pitch) for the first time and in the second time the sound came *'less'* (low pitch) but pupils could not explain the variation in the pitch of the sound.

• Meaning Construction – More and Less

In the activities on more and less pupils, attempted to record the sounds they heard while interacting with the activities. Pupil's attempts to explain the reason for the variation in the pitch of the sound remained futile except G5, which explained that it is *"because of vibrations"*.

On teachers initiative pupils ventured to offer some explanations they are presented as follows.

G2 → *"vibrations were responsible for the variations in the pitch of sound."* [on repeated probing of teacher]

G1 → *"Sound comes as rough and nice"*.

G5 → *"Vibrations were responsible for the variations in the sound"*.

G4 → *"Sounds are caused because of spine [needle] like substances"*.

G3 → Could not offer any explanations.

Pupil's ability to draw generalisation is limited to their experiences. Pupils have not been able to relate the various activities and offer an explanation as seen with G3. The explanation of G1 was drawn from the previous activity on soil. However G5 could able to relate and offer an explanation that *"vibrations are responsible for more and less sound"*.

In and Around

■ Activity Description

The purpose of this activity is to make pupils aware of different sounds and to identify the sources of these sounds in school environment. Pupils use their ears to recognize the sound and attempt to identify the source of this sound. Pupils in pairs do this activity, where one acts as a recorder and another acts as an observer. The observer ties a piece of cloth to his/her eyes and carefully listens to the sounds present in the school environment. The observer identifies the sounds along with the sources and the recorder list these sounds in a notebook. Later on pupils repeat the activity by changing the roles.

❖ Activity Sequence

G3 → G2 → G1 → G5 → G4

► G3

As a result the activities of the group was done be sub-grouped into the activities of boys and activities done by girls. The sub group consisting of boys reported that sounds of bus, auto, cycle, car, tempo, etc. The sub group consisting of girls reported that the sounds of scooter, vehicle, bore-well, plates, madam taking classes etc.

► G2

The activities of the group can be sub grouped into activities done by boys and activities done by girls.

The boys reported the sounds such as scooter, bus, car, auto, lorry and T.V.

The girls reported such as auto, cycle, scooter, tap, beating of plate, bus, etc.

In this group pupils tried to change the procedure of activity. Pupils attempted to listen to sounds by closing their ears. In this context teacher probed and asked one of the group member.

T- when you close your ear, can you listen to all the sounds. Why?

P1 – if we close the ears, the sound coming with speed can be heard and sound coming slowly cannot be heard.

[In the above example pupils attempted to tell that sound with high pitch can be heard than the sound with low pitch]

► G1

The group reported that sound of car, scooter, bus, cycle, jeep, iron, lorry, etc. when asked about the reasons of different sounds in school environment pupils replied that since the vehicle consume petrol to give different sounds.

► G5

The group did the activities in two different types. In the first type, sounds were recorded by covering the eyes the sound recorded were related car, cycle, scooter, lorry, bus, etc. In the second type, sounds were recorded by covering ears the sound recorded were bus, lorry, tempo, scooter, etc. During the activity teacher asked one of the pupils a question

T- You were playing with Madhu and Pasha In that situation, how can you identify the voices of madhu or pasha?

P1- Madhu shouts aye loo, and pasha shouts 'mooo'--- then we can identify who is shouting. [In this example pupils could relate that, sound coming from two people are not the same but different]

► G4

The group has listed the varieties of sounds, bus, jeep, lorry, scooter, car auto, sound of people, cycle, etc. pupils have repeated the activity twice by changing the roles of observer and recorder. However, pupils have not answered the reasons for different sound.

• **Meaning Construction – In and Around**

The purpose of the activity was to enable the pupils to be aware of sounds prevailing in the school environment. During the activity, pupils were asked to cover the eyes. So that, pupils can make use of their ears to hear various sounds. However, pupils did not understand the very purpose of the activity. This was evident when some pupils were playing with clothes tied to the eyes and making attempts to peep from the eye to verify the object from which sound are heard. Some of the pupils modified the procedure of the activity and started hearing sounds by covering ears with hands. In the activity in and around, pupils used ears as a means to observe sound. However, very few groups tried to cross check the recorded information. The pupils had difficulties to write the names of objects from which they had heard sound. Pupils were often seeking the help of teacher or fellow pupils to write the correct spelling of the words.

Wall and air■ **Activity Description**

The purpose of this activity is to enable the pupils to infer that sound travels through different medium. A tuning fork is made to vibrate by hitting it with a rubber pad. The vibrating fork is heard in air and through a wall (solid surface). Pupils were asked to identify and reason out the changes in the sound traveled through wall and air.

❖ **Activity Sequence**

G4 → G3 → G2 → G1 → G5

► G1

The pupils reported that when a vibrating tuning fork is heard near the ear (meaning in air) then it makes a 'Jumm-Jumm' sound. When a tuning fork is heard on the wall, then it makes a sound 'Tak-Tak' but pupils did not gave the reason for the change of sound in different medium. However, during the activity teacher asked the group

T- What is happening in the wall?

P₁ – Tun – Tun

P₂ – vibrations

P₃ – the stones insides the wall are shaking

Pupils' reply indicated that pupils are making attempt to related sounds to the vibrations or stones inside the wall are shaking to create sound.

► G3

The group reported that when heard in the air, tuning fork makes the “tur-tur” sound. When heard on the wall tuning fork makes “Jur-Jur” sound. In this context teacher asked the question as to *why there is a change in the sounds*, to which one of the pupil said.- *“wall is made of cement. So we hear a different but another pupils said that, wall is very hard so it makes ‘jur-jur’ sound”*. Teacher probed one of the pupil on the sound of tuning fork

T – why it makes sound like that?

P₁ – it just shivers

T – what is that?

P₁ – it [tuning fork] shivers in air.

P₂ – it just shakes because of vibrations.

P₃ – shivers because of vibrations.

In the above example, pupils are explaining that tuning fork shivers / shakes because of vibrations. This vibration is responsible for making sounds on the wall.

► G2

The pupils had varieties of way to describe the sound heard when tuning vibrates in air. Pupils reported the sounds such as ‘*Rho-Rho*’, ‘*Go-Go*’, ‘*Gur-Gur*’, ‘*Pur-Pur*’, ‘*My-My*’, etc. When tuning fork was heard on a wall, it makes the sound such as ‘*Tu-Tu*’, ‘*Gur-Gur*’, ‘*tata-tata*’. Pupils of this group did not explain the reasons for the change of sound on wall and air.

► G1

The pupils reported that, when vibrating tuning fork was heard in the air it made a sound like ‘*juvulu, juvulu*’. When vibrating tuning fork was heard in the wall it made a ‘*tur-tur*’ sound. This group brought a little modification in the activity. They touched the tuning fork with the hand and reported “*current is passing on the body*”

► G5

They were the last to perform the cycle of experiments. The vibrating tuning fork was held against the wall and people reported that it makes. 'chan-chan' sound when tuning fork was heard in the air it made 'jum-jum' sound.

During this activity teacher probed the group with different questions given below a sample of the questions.

T – Why does the sound of tuning fork differs in wall and air?

P₁ – sir, we hear different sounds in near the ear and on the wall.

T – why? ---- repeated the same question, two times

P₁ – Sir, tuning fork was vibrating, It was beating like harmonium, when it is hit on the wall it makes 'tuk-tuk' sound. Sir, that wall is made up of cement, so it makes 'tuk-tuk' sound.

In the above interaction, pupils are attempting to explain the reason for the change of sound in air and wall.

• **Meaning Construction – Wall and air**

The purpose of the activity was to identify the change in the sound when sound travels through different medium. The pupils could able to identify the different sounds, when tuning fork is allowed to vibrate in air and on wall. However, pupils could able to identify the change of medium in propagation of sound. When asked to give reason for the different sounds. Pupils attributed it to vibrations; one of them described it because of stones inside the wall.

Different objects

■ **Activity description**

The purpose of this activity was to list the sound produced by different objects and to explain the reasons for the cause of different sounds in different objects. Pupils select ten different objects in the school compound. Then pupils test each object, by hitting each object against each other. Then pupils and record the sound produced by it.

❖ **Activity sequence**

G5 → G4 → G3 → G2 → G1

► G5

Pupils selected the objects as per their choice. The recorded sounds are as follows.

<u>Objects</u>	<u>Sounds</u>
Stick	→ 'tun-tun',
Refill	→ tok-tok',
Button	→ 'gat -gat'
Stones	→ 'tak-tak'

Pupils of G5 reported, "*since they are different objects they make different sounds.*"

► G4

Pupils selected the objects as per their choice. The recorded sounds are as follows.

<u>Objects</u>	<u>Sounds</u>
Stone	→ 'tuk-tuk',
Small stone	→ 'tuk-tuk'
Glass piece	→ 'tiki-tiki',
Small stick	→ 'tak-tak'

On being asked for the reasons on different sounds, pupils replied by referring to a *small stick as 'strong'* – "*that is why sound was different*" (since the stick was strong which made a different sound than other objects)

► G3

Pupils selected the objects as per their choice. The recorded sounds are as follows.

<u>Objects</u>	<u>Sounds</u>
Stone	→ 'tuk-tuk'
Bangles	→ 'dag-dag'
Cover	→ 'kor-kor'
Seeds	→ 'dug-dug'

On being asked for the reasons on different sounds.. One pupil took two books and two pencils Holding one stick in each hand, the pupils crossed sticks to create sound and said "*if you beat like this it is different vibrations ---- this thing (stick) is long*". Pupils then took two books and then banged one book with the other to create sound and said "*if you beat like this, it will vibrate*"

► G2

Pupils selected the objects as per their choice. The recorded sounds are as follows

<u>Objects</u>	<u>Sounds</u>
Flowers →	'kor-kor'
Stone →	'gor-gor'
Bangles →	'tun-tun'
Stick →	'kut -kut'

Teacher asked the group to explain the reasons for different sound. Given below is the interaction between teacher and pupils.

T- why there were different sounds in each object?

(--- silence ---)

T – Do you agree that all objects make different sounds? Give reasons?

P – We don't know. (Group answer)

T – Does all the objects are same. What about stick and piece of bangle.

T – What material is used for the preparation of bangle?

P – Glass

T – What about the stick?

P – It is a piece of wood.

T – Why does the sound vary?

P – Since the bangle is made of glass

In the above example, pupils are attempting to link the sound of the object with the properties of the object.

► G1

Pupils selected the objects as per their choice. The recorded sounds are as follows

<u>Objects</u>	<u>Sounds</u>
Stones →	'tuk-tuk'
Cement →	'tap-tap'
Stick →	'chat-chat'
Flower →	'chur-chur'

During the activities teacher made sounds with books and sticks, pupils were asked to reason for the different sound .One pupil said
"This is [book] a hard object sir, If you beat vibrations will come more", but pupils did not say anything on the sound made by the stick.

• **Meaning Construction – Different Objects**

The purpose of the activity was to identify the sounds produced by different objects given below is the sound of common object reported by different groups.

Pupils had the difficulties to represent the sound of objects in words. The interesting point is each group had their own words to describe the sounds and often it is very difficult to comprehend the exact sound produced by the object as it is depicted in the following example of beating of sticks.

Groups		Sound
G1	→	'Chat-chat'
G2	→	'Kat-kat'
G3	→	-----
G4	→	'Tak-tak'
G5	→	'Tum-tum'

However, with respect to the beating of stone pupils identification of sound was more or less similar

Groups		Sound
G1	→	'Tuk-tuk'
G2	→	'Gor-gor'
G3	→	'Tuk-tuk'
G4	→	'Tuk-tuk'
G5	→	'Tuk-tuk'

Expect the G2 all the other groups have reported that when stones are beaten it makes 'tuk-tuk' sound. The above examples reveal that pupils could observe sound and report it as it is heard as in the case of sounds of stone Pupils could observe sound and report it in a variety of representation is in the case of sound of sticks.

During the course of activities, pupils were asked to explain the possible reasons for the sounds produced by different objects. The reasons given by different groups were represented here.

- G1 → “on beating vibrations will come ”
- G2 → “objects have different vibrations ”
- G3 → “beating creates vibrations ”

G4 → “objects are different so sounds are different.”

G5 → “different objects make different sound ”

The reasons attributed by different groups can be seen as follows. ‘Vibrations are responsible for different sounds’ as reported by groups G1, G2, and G3. ‘Objects are different so sound is different’ as represented by groups G4 and G5.

Activity cycle – Part B

The activity cycle part B corresponds to phase four and five of the Group Investigation Model. It consists of activities such as Telephone, Spoon, Clock, Like & Dislike and Near & Far. The summary of the work done by different groups described through activity sequence followed in activity cycle in table 5.9.

Table 5.9 Activity cycle Part B

Days	Telephone	Spoon	Clock	Like & dislike	Near & far
1	G1	G2	G3	G4	G5
2	G5	G1	G2	G3	G4
3	G4	G5	G1	G2	G3
4	G3	G4	G5	G1	G2
5	G2	G3	G4	G5	G1

Telephone

■ Activity Description

The purpose of the activity was to show that sound travels through solid medium. Teacher provides pupils with a telephone made with boxes (the sizes of the boxes are three times bigger than the size of matchbox). The boxes were connected with a thread of ten meters. Two pupils hold the each end of telephone and stand at a distance of eight to nine meters. Pupils send and receive verbal messages to each other through telephone. Pupils were encouraged to design the telephones.

❖ Activity Sequence

G1 → G5 → G4 → G3 → G2

► G1

Teacher demonstrated to the pupils on how to operate and use telephone. Pupils were found to be very excited in using it. It was seen that only few students were keen on dominating the usage of telephone as a result, conflicts aroused between the users and nonusers of telephone. Often teacher has, to intervene to resolve the fights. Pupils

completed the activity by taking turns. After the activity, pupils were asked to explain the working of telephone.

T – You heard the sound better with telephone than without it, can you think of the reason for it

(----- silence)

T – Can you think and give reasons?

T – How does the telephone works?

P1- The box has holes to which threads are attached

- T – What is the purpose of thread?

P2- Because you tied the threads

T – Of there was no thread then could you hear the sound?

P2 –No sir

In the above illustration, pupils seem to believe that thread is responsible for the sound in telephone.

► G5

The group started activities by exchanging greeting viz.- 'hello', 'how are you'? Etc. They started sending and exchanging words among themselves. one of the pupils was asked to explain the reasons for the sound heard in telephone. Pupil replied that "*thread (in telephone) contains a pipe inside it through which the conversation are heard*".

► G4

Pupils started the experiments by stating the difficulties and exchange of familiar words like 'cat', 'dog', 'hello', etc. when asked to explain the functioning of telephone. Pupils replied that '*we were listening in the telephone very clearly, since we speak loudly when we put the knots in the threads, we will not be able to listen to the sounds*'

A selected interaction between teacher and pupils is given below.

*P - Sir, you have made a hole (in the box) and have put a knot, (on thread)
so sound is heard*

T - Can you hear sound if knot is put?

P1 - If you put knot, sound will go to knot

P2 - If knot is there you will not be able to listen to sound

Another pupil said

P3 - If you put knot in the middle of the thread, you will not listen to sound

Teacher put the knot, allowed the pupils to experiment

Pupils were able to hear the sound with knot.

Pupils nodded head in utter disbelief.

P4 - *Sir, we will cut this thread and give a try then we will not be able to listen.*

In the above illustration, pupils proposed hypothesis with the help of teacher and tested the hypothesis. Pupils had difficulties in accepting that sounds are heard in spite of the presence of knots in the telephone but pupils came out with alternate ways of proposing hypothesis.

► G3

The group showed eagerness to work with telephone activity. Pupils felt that thread in the telephone is carrying sound. The group had interpersonal problems to work in a group as a result; they could not write reasons for explaining the working of telephone. Pupil's inter-personal problems persisted even after the teacher interference. Pupils were seen arguing about the control of ownership on telephone. As a result the purpose of the activity was not realised.

► G2

The group had difficulties to begin the activity, as everybody wanted to be the first one to carryout the activity. Those who did not get a chance to carry out activities were creating trouble but pupils have reported, *"When Pasha talked in the phone, I did not listen. When Madhu phoned, I heard his hard voice. When Rajesh talked slowly I heard his slow voice"*. pupils have attempted to link pitch of the sound as a factor to be considered in telephone activity. The high pitch of sound could be heard clearly as comparable to the sound with low pitch.

• **Meaning Construction – Telephone**

The purpose of the activity was to enable the pupils to know that sound travels through solid medium. Most of the pupils could able to relate that sound is traveling through thread. But did not conclusively say about sound is carried through solid medium. However, the explanations given by groups on the working of telephone is interesting.

G1 *"Telephone contains threads, which is responsible for sound"*.

G5 *"Threads has water pipe, inside it through, which sound travels"*

G4 *"knots in the thread are responsible for sound"*

G3 did not provide any explanation.

G2 *"Pitch of sound is responsible for carrying sound"*

The variety in pupil's explanations reveals that pupils have multiple ways of observing the telephonic activity. One of the features of the groups is the ability to experiment and showed eagerness to be independent. This was revealed in activities of G4. Where pupils challenged the teacher and tested the telephone activity by putting knot in threads.

The G5 related the previous experience to explain the telephonic activity. One of the pupils explained that *water pipes lying in her house consists of holes, which carries sound. Therefore, telephone has threads with holes to carry sound.* The G2 related to 'more and less' activity to explain 'Pitch of sound is responsible for carrying sound' in telephone activity. The G3 and G2 faced interpersonal problems on the sharing of telephone, which created conflicts and internal struggle for conducting the activity.

Spoon

■ Activity Description

The purpose of this activity is to enable the pupils to identify the sound of an object through a solid medium. In an activity pupils hang, a spoon (object) with a thread (Solid medium). The spoon is made to vibrate by hitting with another spoon. The sound produced by the spoon is heard through threads. In this activity, threads made up of plastic, twine, cotton etc. are used. Pupils identify the sound of spoon in each thread. Pupils classify the sound of spoon as heard through each thread.

❖ Activity Sequence

G2 → G1 → G5 → G4 → G3

► G2

Pupils reported that, *"they tied a thread to spoon and hit the spoon with another spoon, then it produces 'tan-tan' sound. When cotton thread was used it produced 'tun-tun' sound."* The group did not distinguish the sound carried through different threads.

► G1

The group attempted to record the sound and explained the reason for different sounds. The observation of the group is as follows:

"In white (cotton) thread we got more sound"

"In plastic thread we got less sound"

"In thick (twine) thread we heard little more sound"

"In colour thread we got little sound"

The pupils observation seems to relate the sound heard through different threads with respect to their own classification. The term more and less is used to denote high and low pitch of a sound. Later on pupils have explained the reason for different sounds.

White thread was round it gave '*Tun*' sound. Plastic thread was little away it gave '*Trin*' sound. The big thread was little away so it gave '*Tak*' sound. The colour thread was little round so it gave '*Tuk*' sound. The pupils reasoning seems to suggest that sound heard in each thread is different. The pupils did not explain in which thread the sound was clearly heard.

► G5

The group attempted to perform the activity with all the four threads. The group has provided explanations for two threads i.e. colour thread and twine thread. The group said that they do not know the explanation for the remaining threads. In the '*cloth stitching*' thread sound was heard very clearly. Since, "*there is a pipe inside the threads so the sound is heard clearly*". In the plastic thread the sound was little better since the thread was having the '*breadth*'. In this activity pupils have attempted to classify the threads in terms of sound heard and in terms of size of the thread.

► G4

The group did not show interest to perform the activity. They showed reluctance to begin the activity. After persuasion by the teacher, pupils began to take initiative in the activity. The group did not report the observations in the book, nor explained reasons for the sound in different threads. However, pupils said, "*plastic thread could carry the sound waves better than any other thread*".

► G3

The group had difficulties in organising the activities among themselves. But the timely intervention of the teacher helped the pupils to work on the activity. During the course of the activity, the group debated on which thread the sound is heard. Then the teacher intervention ensured the re-testing of the activities by the pupils.

The pupils reported that

"In the first white (cotton) thread 'Gor' sound came"

"In the second big (colour) thread 'Tun' sound came "

"In the third plastic thread 'Dan' sound came "

"In the Big thread (twine) spoon came"

In these activities, pupils have identified the threads in their own way. Pupils could able to identify the sounds heard in different threads. However, pupils could not provide any specific reason to explain their classification.

• **Meaning Construction – Spoon**

The purpose of this activity is to enable the pupils to identify the sound of an object through a solid medium. The sound identified by different groups with respect to different threads is presented in table 5.10.

Table 5.10 Identification of Sound

Sounds Produced					
Sl. No.	Group	Cotton thread	Colour thread	Plastic thread	Twine thread
1	G1	‘Tun’	‘Tuk’	‘Trin’	‘Tak’
2	G2	‘Tun’	‘Tun’	‘Tun’	‘Tun’
3	G3	‘Gor’	-	‘Dun’	‘Tun’
4	G4	-	-	-	-
5	G5	-	-	-	-

Pupil’s observation of sound produced by spoon through different threads revealed that G2 has recorded ‘*Tun-Tun*’ sound but have not identified the threads from which sound was produced. G3 has not identified the sound in colour threads, where as G1 has identified the sound in all the threads. The G4 and G5 have done the activity but have not recorded the observation in their notebook. The pupil’s observations are not consistent with the teacher instruction. Pupils have not systematically recorded the data on paper even through all the pupils had done the activities.

During the activity, pupils were asked to explain the reasons for the different sound produced by different threads. The explanations are given here under

- G1 *thread was little away / little round so it made sounds*
- G2 *hitting one spoon with another spoon will create sound*
- G3 *spoon was put and hit by another spoon*
- G4 *--- did not provide any explanations.*
- G5 *there is a pipe inside thread so sound is heard clearly*

The group of pupils has provided varieties of hypothesis to explain the sound heard during the spoon activity. The explanation was casual as spoon hitting causes sound as in G2 and G3 The explanation given by G5 was imaginative with *pipes*

inside the threads carrying the sound. G4 did not provide any explanation. The explanation of G1 was that, *thread was little away* is difficult to comprehend.

Clock

■ Activity Description

The purpose of the activity is to show air as the medium for carrying sound waves. A clock was switched on to produce (alarm) sound. Then clock was put in an airtight box. Pupils were asked to observe the sound and record it. Later on the sound of the clock was heard outside the box. Pupils were again asked to observe the sound and record it. Later on pupils were asked to compare the sound heard they have in the airtight box and outside the box. Pupils were asked to give explanations on the pitch of sound.

❖ Activity sequence

G3 → G2 → G1 → G5 → G4

► G3

The G3 were the first to begin the activity. On hearing the sound inside the box, pupils were puzzled to find the pitch of sound is varying. Pupils seem to think that clocks breaths. Pupils said if *“you open the box sound came more and when you close the box it could not breathe, so sound came less”*. During the activity, pupils were probed on the reduction of sound of the alarm clock. Below a sample of interaction is presented

T - *Why did the sound become less?*

P- *Since lid was closed*

T- *What happened to clock?*

P1- *it could not breathe, sound could not come out*

P2- *since we closed it very fast, clock did not like it*

T- *Does clock breath?*

P- *Yes if you give coil the spring, it(Clock) looks like breathing*

Teacher again probed the group

T- *“Does clock breaths, does it have life?*

P1- *But air comes*

P2- *It (clock) has key and cells are present*

Few pupils disagreed on clock's breathing, whereas few of them agree that clock breaths. *"It feels like animals and has likes and dislikes"*. Later on pupils said it breaths since it has key and cells are present.

► G2

The group attempted to present the data in a systematic way.

→ *You put on the switch it started 'kui-kui'.*

→ *When you close the box, sound was less.*

→ *When you open the box, sound was more.*

Since the box was closed, there was no air, so sound was heard less. When the box was opened, air came so sound was heard more.

► G1

The group has presented their ideas as follows: *"clock was taken and rotated it made 'Trin-Trin' sound"*. When teacher probed them about the sound they said *"that the way we need air, similarly the cells (in the clock) need air"*.

(meaning cells in the clock needs air for movement)

Another explanation was given during the activity is presented here.

T - *When the box was closed?*

P1- *Since we closed the box tightly, sound (of alarm) came very less*

T- *What is the reason?*

P1- *When you take the clock outside it makes more sound. When the clock is put inside (the box) and door (lid) is closed the air is held inside.*

In this explanation pupils are attempting to provide an explanation for the sound of clock through more (high pitch) and less (low pitch) of sound.

► G5

The group said the air moves the clock, which is blocked when the box is closed. Few of the pupils disagreed with this and said *"it is the cell that moves the clock"*. Pupils reported that – *"when the box was closed, the air did not come so sound was not heard. When the box was opened the air was moving freely so sound was heard"*.

► G4

The group was the last one to complete the activity. Pupils said that since the box-containing clock was opened, so more sounds were heard. When the box is closed then the air is less so sound was not heard. During the activity teacher probed a pupil regarding sound.

T *Why did you hear the less sound in the box?*

P *since there was air in the box so the same was heard like 'kee-kee'*

T *How do you know that there was air in the box?*

P *Sir, when you open the box, there was air moving in and out. All the surrounding air goes into the box and makes 'kim-kim' sound. When you close the box air is less inside the box as a result It makes 'kim-kim' sound."*

In this explanation pupils are attempting to provide an explanation for the sound of clock through presence of more air and less air

• **Meaning Construction – Clock**

The purpose of the activity was to enable the pupils to understand that air is the medium for carrying sound. However, from the activity of the groups it reveals that the pupils have identified air as responsible for the change of sound, but did not say convincingly that air is the medium for carrying sound waves. Given below are the responses of various groups about the variations in the pitch of sound.

G3 *The clock breathes. If the box is, opened sound came more. If the box is closed, sound came less. If you coil the spring, it resembles like breathing. It feels like animals and has likes and dislikes.*

G2 *The box was closed there was no air so sound was heard less
When the box was opened, air came so sound was heard more.*

G1 *"When the clock is outside it makes more sound when the clock is inside it makes less sound."*

G2 *When the box is open the air moves in and out so more sound.
When you close the box, air is less inside so less sound.*

G4 *When the box-containing clock was opened more air, so more sound
When the box is closed less air, less sound*

Pupils have also reported that the presence of air or movement of air is responsible for more or less sound. However, pupils do not think air is the medium through which sound travels.

Like and Dislike

▣ Activity Description

The purpose of this activity is to enable the pupils to experience the sound in terms of likes and dislikes in the school environment. Pupils will list the sounds they hear in

the school environment. The pupils classify the sound they heard in terms of likes and dislikes. Pupils give reasons for choice of sound in terms of like and dislike.

❖ Activity Sequence

G4 → G3 → G2 → G1 → G5

► G4

The group has listed the likes and dislikes as given below:

<u>Likes</u>	<u>Dislikes</u>
Bus	Scooter
Auto	Cycle
Lorry	Jeep
Vehicle	sound of people talking
Sound of air	

Teacher probed on the pupil's choices by asking

T *why do you like the sound of bus?*

P1 *bus goes very fast. So I like it.*

T *why did you not like the sound of scooter?*

P1 *scooter goes very slowly.*

The G4 has used speed as criteria to differentiate sound as likes and dislikes.

► G3

The group has listed the likes and dislikes as given below:

<u>Likes</u>	<u>Dislikes</u>
Lorry	Scooter
Bus	Cycle
Car	Bullock cart
Tempo	Auto
Jeep	

When asked about the criteria for differentiating the sound pupils replied that

'Lorry and bus goes very fast'

'Jeep and car goes comfortably, so I like them'

'Scooter and cycle do not go very fast so I do not like them'. Pupils used speed as criteria for liking/disliking sound.

► G2

The groups has classified sound in terms of likes/dislikes as follows.

<u>Likes</u>	<u>Dislikes</u>
Tempo	Cycles
Scooter	Auto
Jeep	Bus
Car	Lorry
Claps	sound of people
Bangles	

The group reported that *tempo sound comes very nicely, so they like it/. Cycle sound would not come properly. It makes 'Tak-Tak' sound*, so they do not like it.

► **G1**

The groups has classified sound in terms of likes/dislikes as follows:

<u>Likes</u>	<u>dislikes</u>
Lorry	scooter
Tempo	cycle
Bus	auto
Car	jeep

Pupils gave reasons for their choice by saying “*lorry is bigger than cycle. It has tyres. It goes very fast*”. Therefore, pupils like it. “*Cycle is smaller than lorry, it has chain, It moves slowly*”. Therefore, pupils do not like it. Pupils have classified the movement of vehicles as fast moving or slow moving to express liking and disliking.

► **G5**

The groups has classified sound in terms of likes/dislikes as follows:

<u>Like</u>	<u>Dislike</u>
Cycle	tempo
Scooter	Bore well
Bus	iron sound
Lorry	screaming sound
Sound of trees	

The group attempted to explain reason for each and every object. However some of the explanation given by one of the pupils on selected objects is presented here.

“I like lorry sound since if you sit in the lorry it moves on rough roads so I like it The plants make a ‘sur’ sound, which gives air to us and protects us so I like it If

people shout then, headache will come, so I do not like the sound. Bore well makes 'Dur-Dur' sound so I do not like that”.

• **Meaning Construction – Like and Dislike**

The very purpose of like and dislike is to understand the pupil choice of sounds and the reason for their choice. A comparative account of likes and dislikes of the entire groups are presented below:

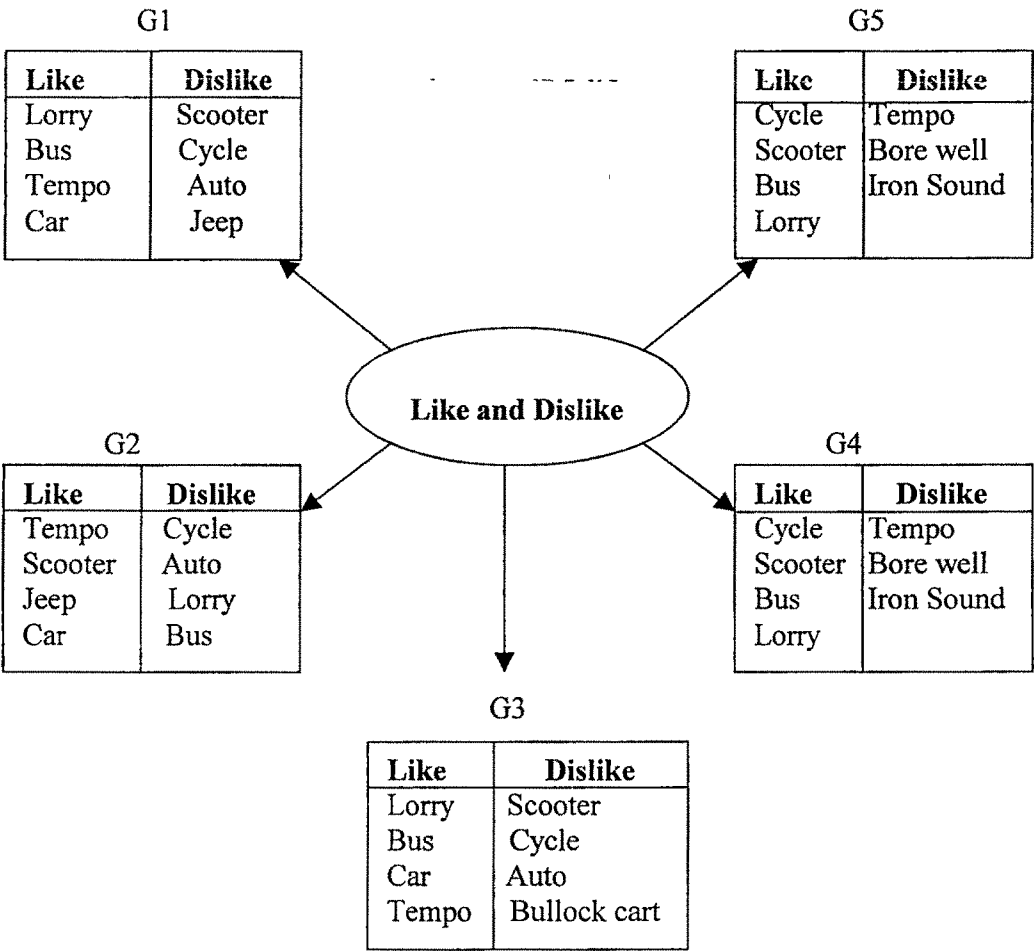


Figure 5.47 Like and Dislike – A comparative account of all the groups.

All the groups except G2 have liked the sounds of lorry and bus. The pupils reasoned that *lorry and bus moves very fast so they liked it* All the groups except G5 have disliked the sounds of scooter and cycle, since they move very slowly they have not likes it Pupils' criteria of liking or disliking the sound have been classified using the speed of the vehicle.

Near and Far

■ Activity description

The purpose of this activity is to enable the pupils to identify the relationship between sound and distance. Pupils make sounds in the school compounds. The place from where pupils are making sound is termed as '*source*'. The place from where sound is being recorded by pupils is termed as '*observer*'. The observer remains static whereas source keeps on moving. The pupil who is a source makes a sound (either by clapping or shouting) near to the observer and far away from the observer. Observer records the sounds heard. In the end pupils, explain the reason for the sound heard near and far, in relation to the distance.

❖ Activity sequence

G5 → G4 → G3 → G2 → G1

► G5

Teacher intervened, instructed one of them to stand near the flag post and clap (source), and asked the pupils to record the sound (observer). Later on same pupil (source) was asked to make sound near school compound. The observer recorded the sound.

The recorded observations are as follows:

"It (sound) was not heard near the compound. It (sound) was heard near the flag post".

During the activity teacher asked one of the pupils

T *Do you hear the sound?*

P1 *No sir, we cannot hear*

T *Why?*

P1 *It is at a distance*

T *What did you learn from this activity?*

P1 *If (object is) near the sound is heard, (object is) far the sound is not heard.*

In the above conversation, pupils are able to provide explanation in terms of near and far

► G4

The group tried to make sound from various distances like tree, bore wells, etc., Pupils reported that '*It (sound) was heard very less near the bore-well, near the compound sound was heard very slowly*'. Pupils said '*if we have distance then sound*

is heard” meaning that, if (source) is near then sound is heard properly if it (source) is far, it (sound) is not heard properly

► G3

The group did the activity in a different way instead of moving ‘source’ away from the ‘observer’, the observer started moving from ‘source’ the observation of the pupils have been stated here.

“When I stand near, the sound it came fastly. If I stand back, sound came very little when I went very back the sound was not heard”.

Teacher could not make sense of pupils’ observation so he probed one of the pupils.

T – *Why did you hear less sound?*

(Pupil did not answer. Teacher modified the question)

T- *Why did you hear more sound?*

P – *Sir if you beat near, (source) sound is heard more. If you go far (from source) the sound is not heard.*

► G2

The group said *“first time (near the source) when they clap they heard the sound. When they clap near bore well they heard the sound very slightly. When they made sound near the gate, they did not hear anything”.*

In this situation teacher pointed towards a tank which is 20 to 30 meters away from the school.

T – *Suppose if you climb the tank (pointed to a water tank situate near the village bus stand) and make sound, can we hear sound?*

P1 – No

T - *Why?*

P1 - *Since it (tank) is at a distance*

In this example, pupils are able to predict that as the distance increases the sound decreases

► G1

The groups tried different ways to test the sounds in terms of near and far they are presented below.

“When clapped from a little distance less sound is heard. When clapped from a distance no sound is heard”. The group tried to shout and test the sound of shouting from various distances. *“When a member of a group shouts from a shorter distance, more sound is heard When a member of group shouted for the second time then little*

sound is heard. When a member of group shouted for the third time then no sound is heard". In the above activity, pupils have attempted to design the activity on their own. Instead of clapping hands, pupils have used their voice to generate sound. The data also indicates the pupils way of listing the observation in terms of numbers.

- **Meaning Construction – Near and Far**

The purpose of this activity was to enable the pupils to identify the relationships between sound and distance. The activities undertaken by all the groups have indicated, "if sound is near it is heard properly. If sound is far it is not heard properly". The groups have shown the ability to predict that sound varies with distance this was demonstrated that by one of the group. Pupil showed the ability to design the activity there by supplementing the teacher choice of activities.

5.3.1.4 Meaning Construction – Sound

The purpose of meaning construction on sound involves employing process skill indicators (see appendix I.B.1.b), to identify the process skill employed by the pupil during the context of scientific investigation. (refer procedure of data analysis in section 3.3.7.2) The pupils' ideas on sound seem to indicate the usage of following process skills.

- 1) Observation
- 2) Communicating
- 3) Hypothesis
- 4) Pattern and Relationship
- 5) Predicting
- 6) Measuring and calculating
- 7) Designing and Making.

Each process skill is described in detail.

Skill of Observation

Under the skill of observation, following categories will be considered

- 1) Change in pupil's ideas, and retaining ideas.
- 2) Identifying difference between different objects
- 3) Identifying similarity between different objects
- 4) Using senses (other than eyes)

➤ *Change in Pupils Ideas/Retaining Ideas*

During the beginning of the activity all, the groups were asked to give the definitions of sound. The pupil's ideas have been presented as 'Before'. At the end of activity the groups were again asked to define sound. The pupil's ideas have been presented as after.

By comparing the definitions of 'Before' and 'After' the pupils ideas have changed/or being retained be identified.

Table 5.11 Definition of Sound before and after activity

Groups	What is sound? Pupils ideas	
	Before	After
G1	Shouting Noise Shabdavedi*	Car sound Bus sound Cycle sound
G2	Shouting Cry of a calf Shabdavedi*	Vibrations Shouting -----
G3	Sound of cracker Shabdavedi*	Sound of vehicles Vibrations
G4	Sound of an arrow Cracker sound Noise of pupils	Noise Vibrations Bus and car
G5	Sounds of bus and lorry Talking Shouting loudly	Vibrations Sounds of bus and lorry

Shabdavedi – A word used in IV std Kannada textbook. The word means one who can shoot arrow in the direction of the sound.

Pupil's way of defining sound was compared with 'Before' and 'After' definitions of sound on comparison it was found that pupils of various groups have changed or retained the ideas. The change of ideas with respect to defining sound can be seen in all the groups. Most prominent is the G1 where ideas have been changed in 'After' as compared to 'Before'. In the remaining groups i.e. G2 to G5 the change of ideas is seen to be defining sound as vibrations. However, the pupils have retained the

ideas even after completion of all the activity cycle this is evident in G2 where sound (idea) has been defined as shouting, and as G5 have retained ideas on bus and lorry.

Another aspect of the group is that they did not retain the ideas and seem to have rejected the ideas on sound. The idea ‘*Shabadvedi*’ as seen in G1, G2, and G3 has not been seen in the ‘*After*’ definitions of sound.

➤ *Identifying differences between different objects*

Pupil’s ability to identify differences between different objects was prominent in the most of the activity. However an example has been described here from the activities of different objects.

T – *How does the stone sounds?*

P1 – *‘Tuk- Tuk’*

T – *How does the stick sounds?*

P1 – *‘Tye-Tye’*

T – *Why does the stick does not sound like stones?*

P1 – *Vibrations*

T – *What kind of vibrations?*

(Modified question)

T – *Do sticks and stones have different vibrations?*

P1 – *Yes it is different*

T – *Why?*

P1 – *Since stick is not stronger than stone.*

In the above example, pupil have said that, ‘*stone is stronger than stick*’. So degree of strong ness is the criteria for differentiating the objects stick and stones.

➤ *Identifying the Similarities Between Different Objects*

Pupil’s ability to identify similarities between different objects was seen in the activity of like and dislike. An example from the activity is chosen from G3.

Likes	Dislikes
Lorry	Scooter
Bus	Cycle
Car	Auto
Tempo	-

When pupils were asked for the reason for classifying various objects into likes and dislikes. Pupils said that

“Lorry and bus are similar, because they go fast ----- . Scooter and cycle do not go very fast, so I do not like them”. Pupils have used speed as the criteria to link different objects like lorry and bus, scooter and cycle.

➤ *Using Senses Other than Eyes*

During the activity of in and around, pupils were provided an opportunity to use ears as the source to hear sounds. Pupils were used to view objects through their eyes. When they got to use ears to observe sound, they were cross checking the sounds with friends are verifying with their own eyes.

Communicating Effectively

The purpose of this activity was to identify the relationship between evaporation of water and temperature. Pupils take two plates containing two drops of water in each plate. One plate is kept in shade (less temperature) and another plate is kept in sunlight (more temperature). Pupils count the numbers and record the number at which water got evaporated in sunlight and shade will be compared. Pupils use numbers to decide, whether evaporation is faster in sunlight or in shade.

The skills of communicating effectively consist of following categories.

1. Linking one idea with another.
2. Systematic recording of ideas.
3. Keeping notes on observation.
4. Listening to others ideas and responding to them.

➤ *Linking one idea with other ideas*

Pupils tend to link one idea [derived from previous activity to relate another idea of a different activity]. This has been depicted as follows: In the activity of more and less GI way of testing with comb and cardboard was interesting pupils used the words ‘nice’ and ‘thari’. [The nice (soft) and thari (rough) were used by the pupils to differentiate the upper and lower soil layers in the activity of garden soil] to describe the actions in this activity

➤ *Systematic Presentation of Ideas*

Pupil’s ability to present the idea in a systematic way was seen in the activity of different objects.

17-9-99 ಶಿಬಿರ/ ಗಾಯನ, ನರ್ತನ, ಮ್ಯಾಚ್

ನಿರ್ದೇಶನ	ಮಾಡಿದ ಕೆಲಸ
1) ಕಲ್ಲು	ಮೃದುವಾದ ಶಬ್ದ
2) ಗಾಳಿ	ಮೃದುವಾದ ಶಬ್ದ
3) ಕಲ್ಲು	ಮೃದುವಾದ ಶಬ್ದ
4) ಮಣ್ಣು	ಮೃದುವಾದ ಶಬ್ದ
5) ಮಣ್ಣು	ಮೃದುವಾದ ಶಬ್ದ
6) ಮಣ್ಣು	ಮೃದುವಾದ ಶಬ್ದ
7) ಮಣ್ಣು	ಮೃದುವಾದ ಶಬ್ದ
8) ಮಣ್ಣು	ಮೃದುವಾದ ಶಬ್ದ
9) ಮಣ್ಣು	ಮೃದುವಾದ ಶಬ್ದ
10) ಮಣ್ಣು	ಮೃದುವಾದ ಶಬ್ದ

Figure 5.48 Different objects G1

In the activity, pupils have listed two columns in one column the objects and in the other sounds made by them. The order of presentation of pupil's idea is systematic. Some the objects listed by G1 is presented in the activity on different objects.

➤ *Keeping Notes on Observations*

Pupils had shown ability to keep the notes on the observation an example from G1 is presented here.

17-9-99 ಶಿಬಿರ/ ಗಾಯನ, ನರ್ತನ, ಮ್ಯಾಚ್

1) ಮಣ್ಣು	ಮೃದುವಾದ ಶಬ್ದ
2) ಮಣ್ಣು	ಮೃದುವಾದ ಶಬ್ದ
3) ಮಣ್ಣು	ಮೃದುವಾದ ಶಬ್ದ
4) ಮಣ್ಣು	ಮೃದುವಾದ ಶಬ್ದ
5) ಮಣ್ಣು	ಮೃದುವಾದ ಶಬ್ದ
6) ಮಣ್ಣು	ಮೃದುವಾದ ಶಬ್ದ
7) ಮಣ್ಣು	ಮೃದುವಾದ ಶಬ್ದ
8) ಮಣ್ಣು	ಮೃದುವಾದ ಶಬ್ದ
9) ಮಣ್ಣು	ಮೃದುವಾದ ಶಬ್ದ
10) ಮಣ್ಣು	ಮೃದುವಾದ ಶಬ್ದ

Figure 5.49 Near and Far G1

The English version is presented below
(Refer translation procedure appendix VII)
"When clapped for the first time sound was heard loudly".
"When clapped for the second time sound was heard less loudly".
"When it was clapped for the third time sound was heard less clearly".

Usage of Checklists

The pupil's ability to use checklists to record the observation did not work well. Since pupils had difficulties in recording the observation. The description of this is presented in the activity of Game of foot.

➤ *Responding to other Ideas*

Pupil's ability to respond to other ideas, there by adding their ideas to the already existing ideas during discussions has been presented below.

T – *How sounds are heard during Ganapathy festivals?*

P1 – *Vibrations was more they had given more sound --- there was wire and knot*

P2 – *Sir they had put wire until that end, so sound was very good*

P3 – *Current sir' – they had given single fuse connection*

P4 – *Sir there is a speaker box, so sound come*

In the above example, the pupils are responding to each other thereby skill of communication is being enhanced.

Hypothesis

In the hypothesis pupils attempted to explain an idea with a help of a concept. Pupil's explanations have been considered from the activities on Telephone and Clock.

➤ *Telephone*

During the activity pupils were asked to explain how sound is carried through threads for which all the five groups have made a fair attempt to answer. However, the answers of G5 seemed to give a unique explanation they said '*thread contains a water pipe inside it through which the conversation is heard*'. One of the pupils used the finger to depict a hole and said that '*water pipes in her area also are of the same size and sound is heard through water pipes*'.

➤ *Clock*

In the activity on the clock, pupils were asked to explain the reason for change in pitch of the sound in the box and outside the box. One of the groups attempted to explain the change in pitch of the sound is due to breathing of clock. The interaction is presented here

T – *Does clock breaths?*

P – *Yes sir*

T – *How?*

P – *We rotate it make 'tu-tu' sound*

T – (focused the question) *You said that clock breathes. Does it have a life?*

P1 – *Yes, air comes through it*

P2- *It has one hole in it.*

P3 – *It has keys and has cells in it.*

T – *Why did the sound become less?*

(-- -Silence ----)

P1 – *when clock does 'tu-tu', then there will be a small hole, then air comes slowly.*

In this example, pupils are attempting to explain that clock breaths and is responsible for the variations in the pitch of sound.

Predicting

In predicting pupils used evidence to relate to the occurrence of the event.

In the activity of Near and Far pupils made sound near and far away from the source.

During the activity, teacher asked a pupil of G3.

T – *Why did you hear less sound? Why did you hear more sound?*

P1 – *if you go near, the sound is heard more. If you go far, sound is not heard*

Then teacher pointed towards a tank, which is 30/40 meters away from the school and asked.

T – *Suppose, if you climb the tank and make sounds from the top of the tank, can you hear sounds?*

P1 – *No*

T – *Why?*

P1 – *Since it is at a distance*

In this example pupil were able to predict the occurrence of an event from the evidences they collected during the far and near activity.

Pattern and Relationship

In pattern and relationship, pupils attempt to find the trends in observations. This trend has been depicted in the activity on different objects. During the activity on sounds of different objects, pupils were asked to explain the possible reasons for the sounds produced by different objects. Example from G1 and G4 are presented

Table 5.12 Different Objects

Groups	Object	Sounds	Trends in observation
G1	Stone	‘Tuk-tuk’	On beating vibrations will come
	Cement	‘Tap-tap’	
	Stick	‘Chat-chat’	
	Flower	‘Chur-chur’	
	Leaves	‘Gur-gur’	
G4	Stones	‘Tuk-tuk’	Objects are different and sounds are different
	Glass piece	‘Tik-tik’	
	Pencil	‘Tek-tek’	
	Pen cap	‘Dun-dun’	
	Stick	‘Tak-tak’	

In the case of G1 the trend in observations is not consistent with the data collected as beating creates vibrations is difficult to test from the given evidence. So pattern and relationship viewed by the pupils is in consistent with trends in the observations. In the case of G4, the observation of pupils and the trends are consistent.

Since different objects produces different sound is verifiable from the evidence

Measuring and Calculating

Pupils used the non-standard measure to conduct an activity on Game of steps. Pupils used their feet to take 30 steps and marked each step on a straight line. Each step was marked with numbers one to thirty. However, pupils were not consistent, while taking measurement as the length of feet was varying in the measurement.

Designing and Making

In designing and making pupils reviewed the procedure of the activity and modified with an alternative. In the activity of near and far pupils changed the procedure of clapping and used shouting as a means to produce sound.

5.3.4.5 ‘Context’ of Scientific Investigation – Water

The teacher in order to realize the objectives on the unit water intentionally created the context of scientific investigation. The objective of teaching water to IV standard pupils was to enable them to understand the relationship between water evaporation with respect to variables like temperature, air, surface area etc. accordingly certain lessons were planned (refer Appendix I.B.2.3) and taught through Group Investigation Model. (refer Appendix I.B.4.b). In order to implement the lesson plans in the classroom, the pupils’ activities were organized into whole class activity, and group activity in terms of activity cycle.

During the Whole, class activity the Group Investigation Model centered on teacher, which corresponds to phase one and phase two of the model. The teacher orient the pupils about the activities, gives the demonstration of the activity, discusses the purpose of using instructional sheets (refer Appendix I.B.3) and describes the importance of using the materials, notebooks. The teacher emphasizes the importance of working in groups, through activity cycle.

During the Group activity, the model is centered on teachers and pupils. Which corresponds to phase two, three, four and five of the model. The group activities are organized in two parts. The part A consisted of activities through activity cycle, which corresponds to phase two and three of the model. (refer table 5.13) The part B consisted of activities taught through without the use of activity cycle (refer table 5.14). Which corresponds to phase four and five of the model.

Pupil’s work in groups to seek evidence, to generate ideas and to support their opinion. Pupils test their ideas and take others idea through discussion.

The class room was different in the sense that pupils had the freedom to sit inside the classroom or any where in the school ground The classroom was organised to support and facilitate the interaction of pupils with pupil’s materials and teacher. The teacher’s role is to help the pupils to express and test their ideas, to reflect upon evidence and to question the way they carryout their investigation. The teacher observes pupils behaviour, while performing activities, record pupils opinion on activities. The teacher evaluates the pupils ideas by following the assessment procedure (refer Appendix I.B.5) The teacher uses self evaluation pro forma (refer appendix I B 1) to reflect on the teaching strategies.

The important aspect of activities on water is an emphasis on using numbers as a data source to relate variables under consideration and arrive at conclusion on relationship between variables.

The activities on water involve pupils to compare rate of evaporation under different conditions. So measurements of time using ‘stop clock’ is one of the accepted standard measure to record the time under which evaporation takes place. The non-availability of ‘stock clock’ made the teacher to use non-standard measure of measuring time. One such method involved is to ask the pupils to count the number from 101 onwards from the beginning till the end of activity. Pupils record the numbers at which water got evaporated.

[Note: The number counting employed, consists of three digit numbers. Since verbal counting of three digits number approximates to a one second on a stopwatch.] The summary of the work done, by different groups has been described through activity sequence followed in activity cycle part A in table 5.13. Given below is the activity description of Part, A which is followed, by the activity description of Part B.

Part A

The part A corresponds to phase two and three of the Group Investigation model. It consists of activities on Water evaporation, with respect to the variables like Temperature, Air, and Volume of water, Surface area and salt.

The activity cycle for different groups has been represented in the table below.

Table 5.13 Activity cycle on water part A

Days	Water Evaporation and				
	Temperature	Air	Water	Surface area	Salt
1	G1	G2	G3	G4	G5
2	G5	G1	G2	G3	G4
3	G4	G5	G1	G2	G3
4	G3	G4	G5	G1	G2
5	G2	G3	G4	G5	G1

Water evaporation and Temperature

■ Activity description

The purpose of this activity was to identify the relationship between evaporation and water temperature. Pupils take two plates of the same size In each plate two drops of

water is added. One plate is kept in shade (less temperature) and another plate is kept in sunlight (more temperature). Pupils count numbers and record number at which got evaporated. Pupils repeat the same procedure for two or three trials. Pupils compare the numbers from shade and sunlight to decide on whether water evaporates faster in sunlight or in shade

❖ Activity sequence

G1 → G5 → G4 → G3 → G2

► G1

Pupils had difficulty in recording numbers, at this stage teacher intervened and showed the pupils to prepare tables by taking the readings collected from shade and sunlight

Water Evaporation		
Trials	Shade	Sunlight
1	241	115
2	251	121

Pupils were asked to study the table and to explain the reason as to why the readings in shades and sunlight were different. One of the pupils replied that in *"sunlight water evaporates faster and in shades there was no sunlight and water disappeared slowly"*. Pupils have represented this in diagrammatic as follows.

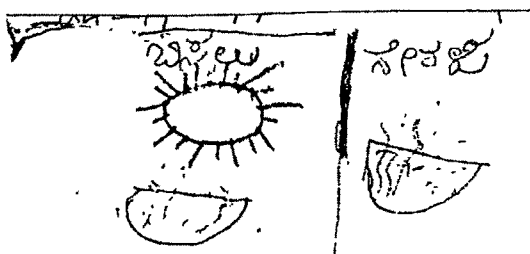


Figure 5.50 Water evaporation and temperature G1

However pupils were having difficulty in using number and using it to explain the relationship between water evaporation and temperature.

► G5

The group started the activity by dividing themselves into two sub groups. One sub group carried out the activities in the sunlight and another worked in shade. The group, which worked on the shades, reported in the following way

- 1) In 191 (water)----- got evaporated
- 2) In 201 (water)----- got evaporated

Pupils reasoned that “*water got evaporated because of air*” The group, which worked on the sunlight, reported that (water evaporated) “*It (water) went at 180, It (water) went at 140, ----, etc.*”

Pupils reasoned that “*plate got hot because of suns temperature*”. So water evaporated fast. This has been represented by the pupils diagram as follows.

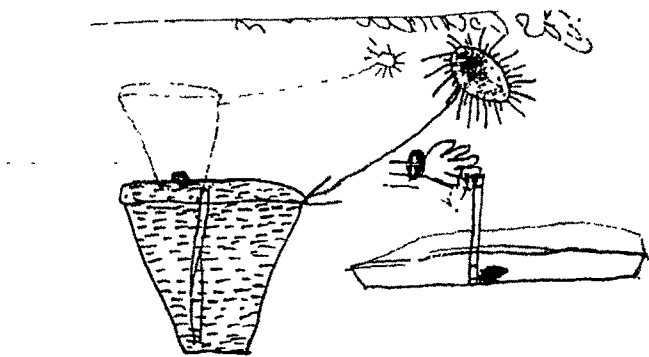


Figure 5.51 Water evaporation and temperature G5.

In this activity pupils had difficulties in comparing the set of data. So teacher helped the pupils to prepare the table.

Water Evaporation

Trials	Sunlight	Shade
1	180	141
2	140	201
3	143	109
4	163	200

But pupils had difficulties in comparing the data using numbers pupils reported that by comparing numbers as “*180 got evaporated in sunlight*”.

“*191 got evaporated in shades, pupils concluded the activity by saying that “it (water) evaporated faster in sunlight and “it does not evaporate faster in shade”.*

► G4

Pupil started the activity by dividing themselves into two groups. This group could not prepare the table to compare the data despite the instructions and examples from the teacher. Teacher intervened and prepared the tables so that pupils can compare the data

Trials	Sunlight	Shade
1	250	350
2	250	396

When asked to compare the data pupils reported in an ambiguous way as follows. *"Sun's heat dried away, and that is why we say that shade is the reason. In shade it (water) did not dry, that is brighter sunlight. So it became more."* When teacher asked the question as why did not water evaporate faster in sunlight than in shadow? One of the pupils replied that *air is sucking it (water)*.

Pupil's diagrammatic way of representing the idea of evaporation is as follows.

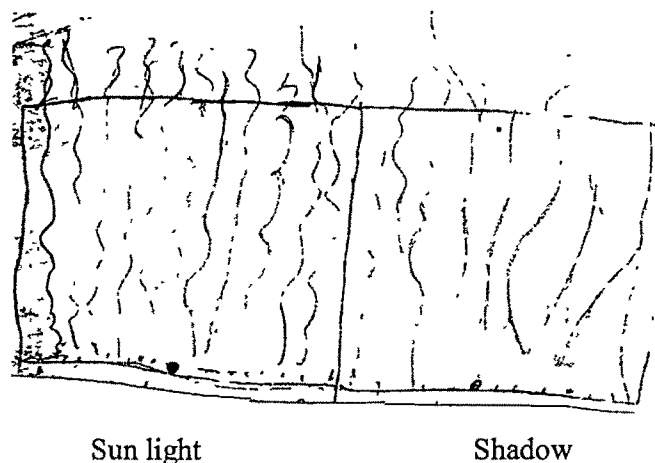


Fig. 5.52 Water evaporation sunlight and shadow G4.

Pupils diagram shows a drop of water evaporating faster in sunlight (by representing more number of lines which signifies more water is evaporating.) than in shade.(where less number of lines which signifies less water is evaporating.)

► G3

Teacher found that the group worked on the shade had miscounted the numbers. So the activity was repeated in the presence of teacher and pupils recorded the reading as 600. Teacher helped the pupils to prepare the table as follows.

Sunlight	Shade
250	600

Teacher asked

T – *What is happening to water in sun's light?*

P1 – *Water was getting dried up faster*

T – *Why is that so?*

P1 – *Because of heat it dries faster,*

P2 - *When plate was kept in sunlight the water got dried up faster due to sun's heat
Shades there were no sun's heat So water dried faster*

The pupil's diagrammatic representation is as follows

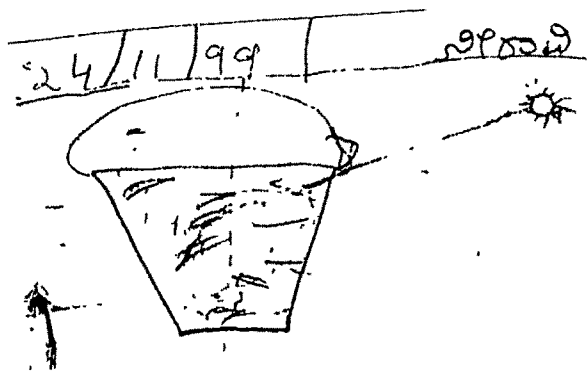


Fig. 5.53 Evaporation in sunlight G3

Pupils have not been able to relate their diagrammatic ideas with their explanation.

► G2

Pupils divided themselves in two subgroups. One group worked with sunlight and other on shades.

The pupils took initiative to prepare the table for comparing the data on sunlight and shades is as follows.

Water Evaporation		
Trials	Light	Dark
1	126	241
2	152	231
3	187	240
4	210	253

When teacher asked to compare one of the pupils responded as follows

“In sunlight it [evaporation] goes fast, “In shadow it [evaporation] does not go fast”.

The pupil’s ideas have been corroborated with their diagram as follows

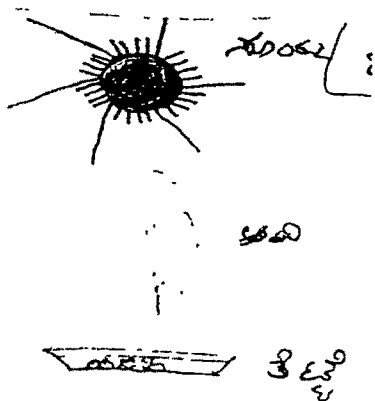


Fig. 5.54 Evaporation in light and shadow G2

- **Meaning construction – water evaporation and temperature**

The purpose of the meaning construction is to report as how pupils have related water evaporation in bright sunlight and shades (different temperature). During the activity pupils used numbers to record data and to compare the readings of shade and sunlight. Pupils were not comfortable in using the numbers to take reading some of the pupils showed the seriousness and where as other were playful during the activity. The pupils had difficulty in reading numbers as greater or smaller and making sense of evaporation using numbers. The pupils could not link their observation of using numbers to draw valid inferences. In most of the occasion pupils used to make sense of data from their previous experiences rather than drawing conclusion using numbers.

Pupils had difficulties in recording numbers in a orderly way despite the teacher's intervention pupils continue to record numbers in their own specific way like *241 dried away 200 got evaporated. Number 207 dried up, first time it went at 143.* Only G2 have recorded data without receiving much help from the teacher.

Where as other group required the teacher help to tabulate the data. Pupils have varieties of explanations for water evaporation like '*air is sucking the water*' '*sun heat is responsible for evaporation*', '*sun's heat makes evaporation*'. It indicate that water evaporation is related to variable like air and Sun's heat.

Water evaporation and Air

■ Activity description

The purpose of this activity was to help the pupils to identify the relationship between presence of Air and Evaporation. During this activity pupils draw two squares on the ground. The squares are of equal area. The squares are then rubbed with wet cloth. One of the squares is allowed to dry on its own, whereas the other is dried using a hand fan. Pupils attempts (two/three) trial to ascertain which of the square dries faster. Before the commencement the teacher will demonstrate the activity to the pupils. Pupils are taught to count and record the numbers till the water dries up. Pupils use the numbers to decide whether water dries (evaporates) faster with fan or without fan

❖ Activity sequence

G2 → G1 → G5 → G4 → G3

► G2

Pupils of this group have recorded the numbers in the following way.

Water Evaporation

Trial	Hand Fan	Without Hand fan
1	125	155
2	115	163
3	119	163
4	154	160

Pupils reported that when hand fan is used, water evaporates very fast. In this juncture, teacher called one of the pupils to read the table

T In the table under fan the number is 125 and without fan the number is 155.

What did you understand from this?

P It (water) is drying in air

T when does the water dries faster?

P when you use fan the water evaporates faster

Pupils' diagrammatic representation of the idea is given below



Fig. 5.55 Water evaporation and air with fan G2

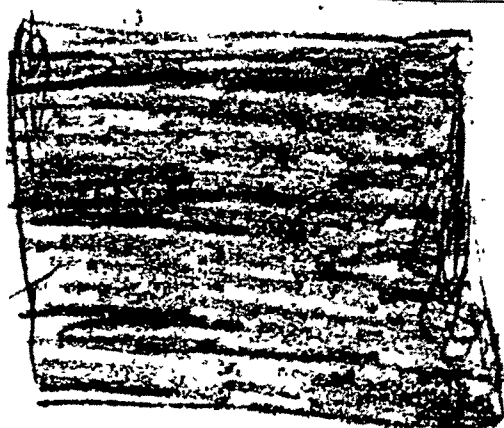
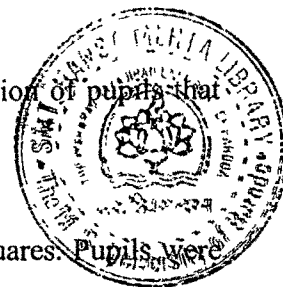


Fig 5.56 Water evaporation and air without fan G2



From the diagram it is very difficult to support the conclusion of pupils that water evaporations is faster with fan.

► G1

Pupils in the group made two subgroups corresponding to each squares. Pupils were able to take the reading separately using number counting. Teacher had to intervene to help the pupils in preparing and reading the table.

Water Evaporation

Trial	Hand Fan	Without fan
1	130	243
2	150	277
3	142	240
4	153	230

Teacher used the table and showed the pupils that numbers with fan were less number as compared to numbers without fan. Pupils replied that when fan used air came as a result water dried faster. When air is not there it would dry very slowly. Pupil's ideas have been represented through their diagrams.

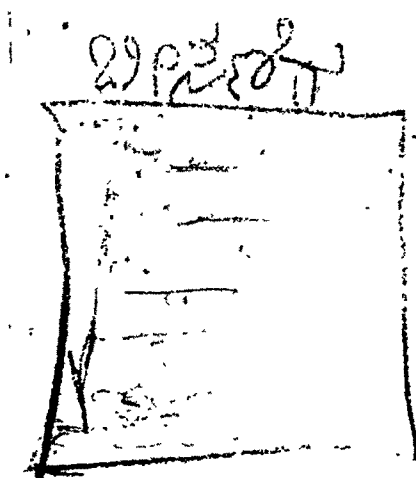


Fig. 5.57 Water Evaporation and air G1

In the diagram with fan depicts that using fan water is getting evaporated faster as indicated by less shades

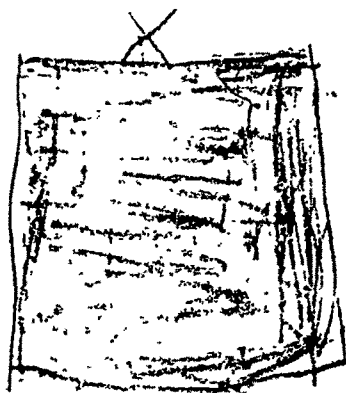


Fig 5.58 Water evaporation and air without fan G1

In the diagram without fan water is drying very slowly. This is indicated by black shades for the presence of water. The symbol (x) indicates diagrams without fan.

► G5

Pupils started the work by making two sub groups. One for working with square using hand fan and another without using the hand fan. During the activity the hand fan was broken into two pieces. The group who was not working with the hand fan brought this to the attention of teachers. The teacher inquiry into the incident made the sub groups to blame each other and resulted in verbal fights. It took some time for the teacher to calm the students and focus them on the activity. Teacher has to intervene to make pupils to write data in the table.

Water Evaporation		
Trials	Hand Fan	Without fan
1	114	123
2	120	140
3	134	150

When pupils were asked to explain about evaporation of water using hand fan, pupils said that *"evaporation has squeezed into air which is coming from the fan"*. (This statement means that air coming form fan has made water vapours to squeeze, there by causing evaporation.) Pupil's diagrammatic representation of the idea has been presented below.

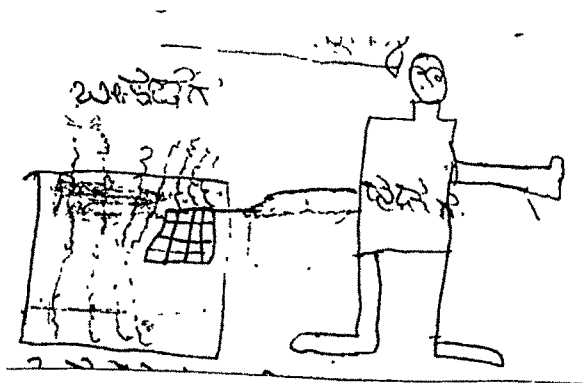


Fig. 5.59 Water evaporation and air with fan G5

In the above figure pupils are showing the position where they stand while using the fan during water evaporation. In the diagram thin line indicates water vapors. Fan is being used to cause water evaporation.

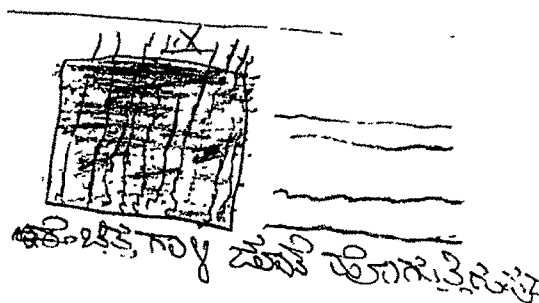


Fig. 5.60 Water evaporation and air without fan G5

In the above figure lines have been used to represent water evaporation along with the direction through which water is getting evaporated.

► **G4**

The group divided into two sub groups for performing the activity. One of the sub-groups was to work with hand fan and another without it. At this juncture a boy belonged to sub group (without fan) wanted to use fan. This resulted in a fight and argument among pupils. Teacher has to resolve the fight by allowing the boy to use the fan. Thus pupils started the activity and recorded the readings. Teacher has to intervene in helping the pupils to prepare table.

Water Evaporation

Trial	Hand Fan	Without fan
1	120	170
2	119	185
3	130	172

When teacher asked the pupils to explain the findings at 120 (Fan) and at 170 (without the fan). One of the pupils explained that *"we are using the fan as a result it (water) got dried up at the number 120; there was no air so it (water) got dried at number 170"*. During end of the activity teacher asked the *"role of fan in water evaporation"*. One pupil answered, *"If we use the fan it carries the air faster"*. Pupil's diagrammatic representation with fan and without fan is presented below.

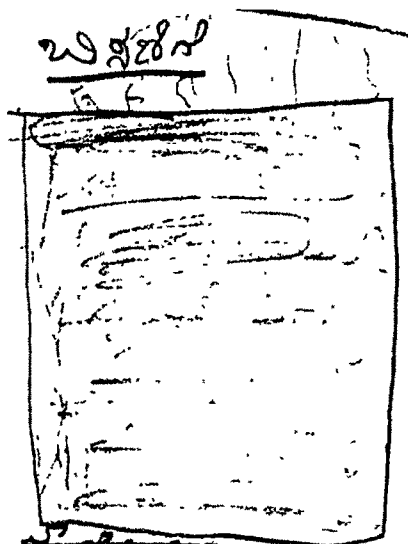


Fig. 5.61 Water Evaporation and air with fan G4

In the above diagram pupils have represented less shades to indicated that rate of water evaporation is very fast



Fig. 5.62 Water evaporation and air without fan G4

In the above diagram the darkened regions signifies the water is not yet evaporated and rate of evaporation is very slow.

► G3

The group three was the last to complete the activity. During the initial stages teacher has to remind the pupils to divide into two subgroups. Pupils conducted the activity

and recorded the numbers (Refer Photograph B in appendix). Teacher has to intervene to help the pupils to prepare the table.

Water Evaporation		
Trials	Hand Fan	Without fan
1	112	120
2	114	116
3	112	117
4	129	150

When asked to read the table the pupils who had worked without fan said, “since they did not had the fan, the water did not dry fast”. However an interesting observation was made by one of the pupils. He said, “Since air from fan creates vibrations and as a result waters gets dried up”.

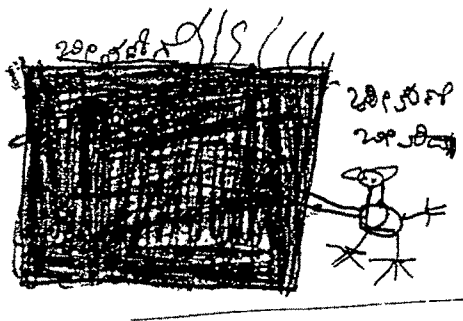


Fig. 5.63 Water evaporation and air with fan G3

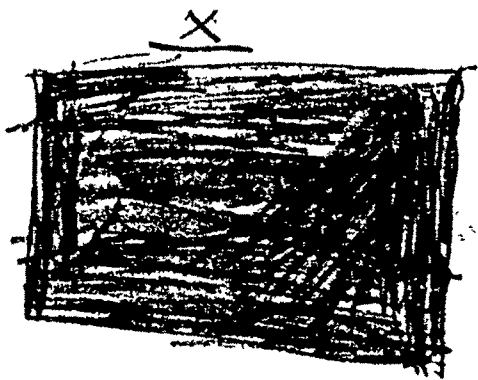


Fig. 5.64 Water evaporation and air without fan G3

The diagram with fan depicts pupils using fan for water evaporation. Water is seen to be evaporating as smoke. The diagram without fan depicts fan is not being used as a result the water is not yet evaporated

• Meaning Construction - Evaporation and Air

The purpose of meaning construction is to report as how pupils have related water evaporation with respect to air. Pupils of all the groups had difficulties in beginning the activity as a result teacher has to orient the group, divide them in to sub groups, manage the conflicts among sub groups. Teacher had to prepare tables for the pupils to compare the data using the hand fan and without the hand fan. Teacher faced the difficulty in making the pupils related their observation to numbers. However pupils do not seem to use numbers, while drawing conclusion, except G4 which used the numbers to relate it to the water evaporation. Pupils seem to view that 'presence of fan is making evaporation faster'. 'The air coming from the fan is causing the water to evaporate'. However G3 had viewed that 'air is creating vibrations which helps for water evaporation'. Overall in the activity all groups have identified that air is responsible for water evaporation.

Evaporation and Water

▣ Activity description

The purpose of the activity is to enable the pupils to identify the relationship between volume of water and water evaporation. Pupils take a plate and add a drop of water on the plate. The plate is kept under sunlight. Pupils count the numbers. The number at which water is evaporated is recorded. The same procedure is repeated by increasing the drop of water viz 2, 3, 4. Pupils record the numbers and observe the numbers at which water got evaporated.

❖ Activity sequence

G3 → G2 → G1 → G5 → G4

► G3

Pupils of the group had done the work individually so all the pupils had different readings. So the whole activities were repeated and with teacher instructions to conduct as a group activity and to increase the volume of water for each trials.

Pupils worked as a group. Teacher helped the group to prepare the table

- 1) 126 (*It [water] dried very fast*)
- 2) 140 (*It [water] dried very slow*)
- 3) 160 (*It [water] dried very late*)

(Note: 1, 2, 3 represents the amount of water drops and the number represents the at which water got evaporated).

When asked about their observation, pupils reported a change in numbers. But were not able to relate it to the evaporation and increase in the volume of water.

► G2

Pupils started the activity as a group. They took the plate and kept on changing the water drops under the sunlight. The data obtained by the pupils are as follows:

Water Drops	
1	140
2	160
3	128*
4	162

When asked for the reasons for the first and second drop, pupil said it is because of more amount of water. When asked to explain the reason for number 128 at drop (3). Pupils said that *“sunlight became more so the evaporation became faster”*.

► G1

The group started with the help of teacher instructions. However pupils recorded the number in their ‘own’ way as

- 1) 271 water number got dried up
- 2) 207 water number got dried up
- 3) 215 water number got dried up

During this juncture teacher intervened and prepared the table.

Drops	evaporation
1	271
2	207
3	215
4	121

Pupils tried to explain the reasons for each of the drop as follows:

- 1) *If less water, water fast dries away*
- 2) *If more water, water will not get dried up*
- 3) *If it is in the shadow without suns heat it dries.*
- 4) *It dries because of the sun’s heat.*

The pupil’s explanations of the activity indicate that pupils were not clear in their explanations. Since it is very difficult, to comprehend the meaning from pupils’

observation. Further pupils written statements did not match with the observation presented in the table.

► G5

The group five have given different reasons in reading the data (table), which has been presented below:

Drops	Evaporation
1	130
2	132
3	134
4	145
5	138

One of the reasons given by pupil (P1) for the table

"In 130 we put one drop so it (water) went at 130"

"In 132 we put one drop so it (water) went at 132"

Pupils have read the table as it is, but has not related the number of drops to water evaporation. In another explanation by a second pupil the table was viewed as

"In one drop I expanded it, so with air it went fast"

"Second drop went like that"

This explanation of pupils brought that pupils have viewed air as one variable causing evaporation. During the activity teacher asked the explanation as to why in drop No.1 the evaporation was at number 130. Pupils replied that in water evaporation is due to clouds, air, sunlight etc. but pupils did not relate this explanation to the increase in the volume of water.

► G4

The group did the work in a cohesive manner, they could able to relate the activity with its purpose, and the data collected by pupils are as follows:

184	First drop
286	Second drop
290	Thirddrop
295	Fourth drop
300	Fifth drop

"We put the first drop. It (water) dried at number 184."

"We put two drops; it (water) dried at number 286"

In this pupils have shown the ability to read the data but have not related it to their explanation. This was evident when teacher asked one of the pupils

T Identify the number which is smaller in the table

P1 fourth one is less

T check (first one is less or the fourth one)

P1 first one (pointed towards the first one)

T why it was less is less?

P2 since we kept one drop. Later we kept four drops (for evaporation).

• **Meaning Construction – Evaporation and volume of water**

The purpose of the activity was to facilitate the pupils to relate water evaporation with the volume of water. In the initial stages pupils had difficulty in recording numbers, relating it to the volume of water and preparing tables. So teacher intervention was essential to facilitate the pupil's efforts during the activity. Pupils showed the ability to read the data and related water drops to numbers. However pupils could not relate water drops and evaporation to the volume of water. Pupil's explanations on water evaporation were on presence of clouds, sunlight and air. These explanations were irrelevant since it did not relate with the purpose of the activity. Pupils faced difficulties in observing the trends in reading the data in the activity.

Water and Surface Area

▣ **Activity description**

The purpose of the activity is to help the pupils to see the relationship between water and surface area. The activity is done in two parts. In the first part, pupils take a drop of water each in measuring cylinder, cup and plate. All these objects are kept in sunlight. Pupils observe in which of the objects water evaporates at the earliest. In the second part, pupils take two pieces of cotton clothes of equal size. Pupils add two drops of water in each of the clothes. One cloth is spread on the ground, whereas another cloth is folded four times and kept on the ground. Pupils verify in which cloth water dries up. Pupils relate the evaporation of water with surface area from the activities on part A and Part B.

❖ **Activity sequence**

G4 → G3 → G2 → G1 → G5

► G4

The group four was first to begin the activity. Teacher gave a demonstration of the activity. Pupil's observation is as follows:

"It (water) dried faster in plate, in measuring (cylinder) water drops were there", when asked to assign reasons:

Pupils said that *"they kept less water and sunlight was more so water in the cup dried faster"*. In the measuring cylinder, *"it (water) did not get bright sunlight and it (water) got dark so it did not dry"*. Pupils' usage words bright sunlight and got dark does not seem to explain the activity. Pupils tried an activity with hand cloth and said, *"If you keep it (hand cloth) openly it dries up. If you keep it (hand cloth) by folding four times then it will be moist"*.

► G3

Pupils had brought a plastic cup and used that in the activity. The activity was done in two trials. The pupils had assigned numbers in the order in which evaporation.

I Trial

- 1) Cup
- 2) Plate
- 3) Plastic cup
- 4) Long pipe (measuring cylinder)

II Trial

- 1) long pipe (measuring cylinder)
- 2) Plate
- 3) Cup
- 4) Plastic cup

Pupils have not offered any reasons for their choice of results.

However on second part of the activity pupils said *"the hand cloth did not dry when folded four times. The hand cloth dried when folded two times."*

Pupils could not link the evaporation with the (surface) area of the hand cloth.

► G2

Pupils started the activity with teacher instructions. The reading of the pupils on plate and cup are as follows:

Plate	Cup
491	291
137	126

Pupils just read the table without offering any explanations.

"In the first trial the water at the plate got evaporated at 491"

"In the second trial the water at the plate got evaporated at 137"

"In the first trial the water at the cup got evaporated at 29"

T - Why it is not happening in the cup?

P1 - Sir, since cup is long as a result sun heat will not fall.

These interactions have been reported by pupils as follows:

“The sun’s heat went nicely to plate, but for the cup sun’s heat was not there. Cup was at height (compared to plate) even though the light is there it will fall on the cup but not directly to the water”

In the above explanation pupils have implicitly said that surface area affects the evaporation. Pupils are describing the shape of the cup in form of height to relate it to the variable on surface area. For the activity on hand cloths, pupils said in the cloth (folded two times) the air comes and goes as a result the cloth dries. Pupils have not said anything about cloth (folded four times).

• **Meaning Construction – Water evaporation and surface area**

The purpose of the meaning construction was to view how pupils have related to the variables on water evaporation and surface area. In general pupils of all the groups except G1 and G5 had difficulty in observing this particular relationship.

In the initial stages G2, G3 and G4 pupils could not present the data in an organised way. Pupils faced difficulties in reading the data using numbers. In-group three, pupils could not make use of data as it was giving inconsistent trend. Pupils had used the experience gained in the activity of evaporation and volume of water. Pupil’s difficulty was to identify the variable in seeing the relationship. However the work done by G1 and G5 is significant. The G1 made a reference to the flatness of plate and spherical (round) shape of the cup. This was related to water evaporation. The G5 made a reference to plate and cup in terms of height and explained that “how sunlight is causing evaporation”. The G1 and G5 attempt to relate the data to the sizes / shapes of the materials used are one of the significant changes.

However all the groups had a similar difficulty of relating the activity on folding hand cloth? Pupils have reported, *“If less folds - water evaporates quickly”, “If more folds – water does not evaporate quickly”*

Pupils have merely stated their observation and have not related water evaporation with surface area of cloth.

Water Evaporation and Salt Water

Activity description

The purpose of the activity is to help the pupils to see the relationship between evaporation of water and evaporation of salt water. Pupils take equal quantity of ordinary water (prepared by pupils) and salt water on different plates. The plates were kept in the hot sun. Pupils count number to record the point at which ordinary and salt water evaporates.

Activity sequence

G5 → G4 → G3 → G2 → G1

G5

In the initial stages teacher gave instructions to pupils and explained them as to how to begin the activity. Teacher helped the pupils to prepare salt solutions in a cup. Pupils collected the (bore well) water in another cup. The plates were kept in the hot sun. Pupils reported that salt water evaporates first and ordinary water evaporates later on. When pupils were asked to explain, one of the pupils gave an interesting answer. One pupil said *“it is because Kempanna who kept on spilling water”*. Another pupil reported differently and said, *“that salt water also went first and Ordinary water also went first”*.

(The reasons given by the pupil imply that salt and ordinary water both have evaporated at the same time). But when probed by the teacher, pupils said *“In salt water, there we had put one spoon of water (on the plate) in ordinary water we put two spoons (on the plate) that is why salt water went evaporation”*.

G4

The group started the activity by preparing the salt solution. Pupils were seen playing with saltwater and drinking it too. Other pupils complained to the teacher, which forced the teacher to act and intervene. Teacher has to warn all the group members and explained the activity and procedure involved in it. Pupils repeated that *“water evaporated 228 in cup and salt water dried (evaporates) at 230 in cup”*. Pupils’ observation is presented below.

Ordinary water	Salt water
228	230
250	245

Teacher asked one of the pupils to read table. Pupil replied that in both cups water had dried quickly. He said *“both the salt evaporates and water had equal water so it dried (evaporated.) (since) both (cups) were kept in bright sunlight”*. (Pupils have tried to link volume of water, sunlight to support the water evaporation of salt water and ordinary water).

► G3

The pupils of this group have not completed the activity. The incompleteness of the activity was due to various reasons. The pupils started the activity in the shade. Teacher objected to pupils choice of place and asked them do it in a place where bright sunlight is present. Pupils did not like it and moved reluctantly to the with more Sunlight place. Pupils stated the activity but did not count the numbers (perhaps rebelling against the teacher’s instruction). Pupils were seen talking and playing with each other. Teacher’s repeated instruction went in vain as pupils did not complete the activity.

► G2

The activity of the group was remained incomplete since groups were fighting from the beginning of the activity. The trouble seems to have started on addition of salt into water. The teacher had instructed the group to add 1 or 2 spoon of salt. Pupils have added four spoons of salt, the conflicts started with those who were following teacher instructions and others who were not really following the teacher’s instruction. Pupils counted the numbers but have not recorded it. But pupils with their incomplete work reported that salt, water dries faster as compared to ordinary water.

► G1

This group attempted to follow teacher’s instructions but could able to do only one trial. Pupils reported their observation in the form of a table. The table is presented below

Ordinary	salt
525	522

According to table, the ordinary water got evaporated at the number 525 and salt water got evaporated at the number 522. Pupils have not able to see the relationship nor offered any reasons for water evaporation.

- **Meaning Construction – Water and Salt**

The purpose of the meaning construction was to report on how pupils have viewed the relationship between evaporation of salt water and ordinary water. Pupils had various difficulties in relating to numbers of salt water and ordinary water. Pupil's difficulty with the usage of number was quite evident. Pupil's ability to use numbers in water evaporation did not make much sense to them. All the groups had difficulties in making sense of the data. Pupils did not show the keenness to count the numbers, since evaporation was taking more time. As a result pupils were indulging in play, quarrels, among themselves. Pupils' conflict reached to an extent that where they started attributing the other pupils responsible for water evaporation. Repeated teacher instructions did not seem to bring any changes while reporting the activities. One such case was G5 where pupils said that *"rate of evaporation is same but on the note book pupils recorded that salt water evaporates quickly"*. Another aspect, which was observed, was pupil's ability to link various factors to explain the evaporation of salt water. It was evident in G4 where pupils reported that *"volume of water and sunlight are involved in evaporation of salt and ordinary water"*.

Context of Scientific Investigation water – PART B

The activities in this stage correspond to phase IV phase V of the Group investigation model. During this phase teacher challenges the pupils by asking them to repeat the activities done in the activity cycle. The challenge before the pupils was to plan, design, execute and conclude the activity on their own. The teacher role was, to motivate the pupils to undertake the activities by helping them to focus on the activities by listening, giving ideas and facilitating classroom discussions.

In this phase there was no activity cycle for conducting activities. All the five groups conducted the same activity on given a day. The activities of the pupils are presented here.

Table 5.14 List of activities on water Part B

Days	Activities
1	Water evaporation and Temperature
2	Water evaporation and Air
3	Water evaporation and Water
4	Water evaporation and Salt

The activities on water evaporation and surface area remained incomplete. So this particular activity has not been included.

Water Evaporation and Air

Note: The group three and group five were not allowed to perform activities by the teacher, as they had not brought the materials required for the activity. However they were allowed to observe the performance of other groups.

► G1

Pupils took a cup and hand clothe. Pupils added equal amount of water in the cup and hand cloth. The cup and cloth were placed on a ground, under (less temperature) shade. Pupils kept some distance between cup and hand cloth. They used cardboard to dry the water in the cup and hand cloth was untouched.

	Cup	Hand cloth
1	372	492
2	-	-
3	-	-
4	-	-

Pupils said since the water was less, “it evaporated fast (the water was) more in hand cloth some water was moist”. However pupils did not relate air is responsible

for water evaporation. Pupils were asked about the reason for conducting the activities. Pupils replied that --- it is to identify whether water dries with air or without air.

► **G2**

In this group pupils selected a piece of land within the school compound. Pupils took a plate and kept it near the piece of land. Then pupils added four spoons of water each to the plot of land and to the plate Pupils used a cardboard to dry the water in the plate and the water on the plot of land was left as it is. Pupils started to count the numbers from 101 onwards till the water in the land and in the plate evaporates. To the surprise of the pupils water did not dry in the plate even after five to ten minutes. Pupils did not record any observation in their note book.

► **G4**

In this group pupils drew two squares on the ground. One square was drawn using a small scale and another square was drawn using a long scale. Pupil's squares were of different sizes. One square was small and the other was big. Pupils took a black and green hand cloth. The hand cloth were soaked in water and squeezed. The green hand cloth was used to wipe the small square and the black cloth was used to wipe the big square. Pupils used cardboard (as a fan) to give air to small square and big square was not given air at all.

Pupils reported that since in "*smaller (square) cardboard was used so the number came to 230. In the bigger (square) air was not there so the number came to 296*". Pupils' observation seems to suggest that since air (generated through cardboard) was used during water evaporation the number came to 230 and since air (cardboard) was not used the number came to 296.

• **Meaning Construction – Water evaporation and air**

The purpose of the activities was to enable the pupils to plan and perform scientific investigation. Pupils showed eagerness and curiosity to do scientific investigation. Pupil's ideas were creative, but needed a constant effort by the teacher to focus on the theme of the activity. One such incident took place with pupils of G4, where pupils thought of using juices of flowers and leaves for water evaporation.

T – You have to perform the activity, but do not repeat the way I have done

P1- Sir, I will take a leaf on that will keep two flower and four leaves. I will see which one will stick

T – But you have to do an activity, involving water evaporation and air.

P1 – (Pupil argued) --- Sir, I will smash that (flower and leaves) it were aspect of leaves and flower) will dry ---

T – ‘No’ (but reluctantly said yes) and permitted to pupils to do.

However pupils did other activities presented in (G4). Pupils showed keenness to search for the idea. One pupil brought std III textbook, showed a picture of evaporation, and said that he would do the activity.

The various activities done by the pupils showed that pupils had difficulty in identifying variables and recognising the very purpose of the activity. For water evaporation and air pupils failed to control the variables like sunlight, surface area etc. Pupils also realised that some of the ideas can be tested and some cannot be tested. One such case happened with G2, where pupils did not get the results, since they had not controlled the variables.

Pupil’s usage of written language and spoken language to communicate activity showed the discrepancy in G1. When asked by the teacher pupils replied that “*air is responsible for water evaporation*” but pupils written ideas were that water was responsible for evaporation. Pupils did not use the number effectively to relate it to the activities.

Water Evaporation and Temperature

► G1

Pupils of G1 took two plate, one spoon, one mug, salt and two spoons. Pupils collected water in a mug. . In one cup they prepared salt solutions by adding more salt. In another cup they prepared salt solutions by adding less salt. Thus pupils prepared salt solutions of different concentrations in each cup. These salt solutions were taken in two different plates with the help of a spoon. Where one plate containing more salt solution was kept in shade and another plate containing less salt solution was kept in sunlight. Pupils started counting the numbers and their reading in Bright sunlight and shadow is as follows.

Bright light	Shades
410	243

Pupils concluded that, “*salt water (containing less salt) dried (evaporated) slowly, since it was (not) in bright sunlight*”. However pupils did not write anything about evaporation in bright light

► G2

The group began the activity by taking two cups, two plates, one spoon and one stick. The pupils kept, one cup and one plate in the sun and shade (inside the classroom). [Pupils divided the group in to two sub groups. One group worked under the sunlight and another worked under shade] such that each sub groups compiled their observation as follows.

Shade	Sunlight
275	258

Pupils did not write any reason to explain the relationship between water evaporation and temperature.

► G3

The group began the activity by collecting two cups, two sticks and two cardboards. Pupils divided the group into two sub groups. One group worked under the sun, and another worked under shade. Pupils kept a cardboard in the shade and in sunlight. Pupils collected water in the cups and with the help of stick then put a drop of waier simultaneously on the cardboard kept in sunlight and shades. Pupils started counting the numbers pupils took three trials as follows.

Sunlight	Shades
126	133
150	154
180	184

Pupils concluded that when (activity is done) in bright sunlight “*it (water) dries (evaporates) faster*” when [activity was done] in shades “*it (water) dries (evaporates) later*”.

► G4

Pupils of this group carried out the activity differently. Pupils collected a plant (in the school compound), plastic cover and a thread. The plant was covered with a plastic sheet and tied with the thread. Then the covered plant was taken and tied to the flag post in the school compound (Refer Photograph D in appendix III). The flag post was chosen, because of its position in the area of bright sunlight. Pupils started counting the numbers from one onwards. When water droplets started appearing within the plastic sheets then the pupils stopped the counting and have recorded the number 575.

Pupils did not keep any plants in the shade. Pupils did not relate their activity with water evaporation and temperature.

► G5

The group five took two sticks, two cups and two small plates. The group collected small amount of water in the plate and in the cup. These were kept in bright sunlight.

Pupils recorded the number the numbers at which water got evaporated as follows.

It (water) dried (evaporated) at 137

It dried at 134

It dried at 141

It dried at 88

Pupils have not reported whether water got dried through cup or through plate. Pupil's have not done to activity in shade.

• **Meaning Construction – Evaporation and Temperature**

The purpose of the activity was to enable the pupils to design and plan the scientific investigation on evaporation and temperature. Pupils in their enthusiasm to conduct the activity had forgotten the very purpose of the activity of controlling different variables. However pupils of G3 made an attempt to relate with the purpose of the activity. Pupils belonged to all the groups had difficulty in identifying and controlling the variables.

In G4 and G5 pupils did not collect the data from the shades. Pupils attempt to design the experiment referring the other source was evident during the activity of G4. Where the pupils brought a III standard. textbook to show and conduct the activity on water evaporation.

Water Evaporation and Water

► G1

Pupils took three cups of water each cup containing different quantities of water. Pupils kept one cup in shadows, second cup containing little amount of water and third cup containing more amount of water were kept in bright sunlight. Pupils counted numbers for each cup of water. They are presented below.

Shadows	Little (Bright sunlight)	water	More water (Bright sunlight)
153	300		436

Pupils concluded that “*water in shadows evaporated slowly ... little water in the sunlight evaporates very fast the more water in the sunlight evaporated very slowly*”.

► G2

Pupils took two plates, two cups, two spoons, sticks, sugar and salt. Pupils prepared salt, salt-sugar solutions separately into each cup. Pupils put these solutions into the plates with the help of spoon. Pupils wanted to see which of the solutions dries fast in the sun. Pupils reported their observation in the form of a table.

Trials	Salt water	Sugar-salt water
1	Evaporated at 147	Evaporated at 178
2	Evaporated at 186	Evaporated at 162

Pupils reported that *salt water dried (evaporated) faster. Sugar-salt water did not dry (evaporate) faster.*

► G3

Pupils of this group took one cardboard, one spoon, two cups, turmeric and vermilion. Pupils made a solution of turmeric and vermilion in the cups by adding water with the help of a spoon. They dropped each solution one by one on a cardboard. The cardboard was kept under bright sunlight. Then numbers were counted from one onwards The number on which the solutions got evaporated is given below.

125 – Vermilion

176 – Turmeric

183 – Turmeric

Pupils did not conclude on water evaporation and volume of water. But pupils were not aware of the reason for the choice of vermilion and turmeric solution.

► G4

The G4 called their activity as cup and spoon. In one cup salt was put in another cup turmeric was put. Then water was added to it to make into salt and turmeric solutions. Then the salt solution was kept in the sunlight and turmeric solutions were kept in shade. The pupil’s observations were recorded in a table as follows.

Bright sunlight	Shadow
250	300

Pupils said *“we kept the salt water in bright sunlight so it (water) evaporated at 250 was kept the turmeric water in the shadow so it (water) evaporated at 300”*. Pupils usage of turmeric and vermillion is interesting since these are used at home and temples for performing religious worship.

► G5

The group five took three cups, one matchbox, one spoon and salt water. Pupils did the activity in two parts. In one part pupils prepared salt solutions by adding water and salt. Pupils took a drop of water on a matchbox and dried it in the sunlight. Pupils reported that *“it (water) dried (evaporated) at 211”*. In the part two, pupils took a plant and immersed in the salt solutions. Pupils kept the plant in the sun and after some time reported that *“it (plant) did not dry (evaporate) at all”*. In this activity pupils are thinking that plant contains water. So instead of using water in the activity they instead used plant as a replacement to water.

• Meaning Construction – Water Evaporation and Volume of Water

The purpose of this activity was to enable the pupils to design and plan the scientific investigation so that pupils identify a relationship between evaporation and volume of water. When the pupil's work is closely examined, it appears that pupils have not been able to identify the variables related to the activity. Pupil's idea on the activity seems to change colour of water or to add salt or sugar water in order to carryout the testing. The G1 pupils seem to understand the purpose of the activity since they attempted to identify the variable as little water and more water.

Pupil's activity also revealed that pupils do not seem to use numbers to arrive at conclusion. Pupils are using their previous experience to arrive at a conclusion.

Water Evaporation - Salt and Water

■ Activity description

This was performed differently as compared to the other previous activities.. During this activity the teacher distributed the materials required Teacher provided each group with a stick, two cups and two bottle caps Teacher prepared salt solutions required for each groups. Pupils were instructed

1. To take small amount of salt water and ordinary water separately in two cups.
2. To take five drops of saltwater and ordinary water separately in two bottle caps
3. To keep two bottle caps under sunlight

4. To count numbers till the water evaporates.
5. To record the number at which water evaporates

As per the teacher instructions all the groups carried out the activity. Teacher collected the readings from all the groups and presented it on the black board as follows.

Groups	Salt	Water
G1	306	636
G2	362	516
G3	412	428
G4	440	529
G5	405	509

Pupils were asked to read the table but pupils had difficulty so teacher showed an example , teacher asked the groups as to why did salt water evaporate faster than the ordinary water? To this question the answer provided by various groups are as follows.

- G1 – *“Salt water flies with sun’s heat and another pupils reported that ordinary water drinks salt water”* (pupils have reported that water flies with sun heat and ordinary water tendency to drink salt as the reasons for water evaporation.)
- G2 – *“Salt water dried because of sun’s heat and water evaporates (ordinary) because of sun’s heat”*. (pupils have reported that salt water and ordinary water evaporates due to heat form the sun) ,
- G3 – *“if salt is added water dries (evaporates) faster if we did not put salt to ordinary water so, it will not dry(evaporate) faster”*. (Pupils have reported that addition of salt to water increases the rate of evaporation)
- G4 – *“The salt water contain salty things which drinks water so number becomes (during water evaporation) and less. The ordinary water does not contain salty things that is why the number (during water evaporation) was more”*. (The presence of salty things in salt water facilitates evaporation).
- G5- *“The salt water is being pulled upwards by both sun’s heat and air. The ordinary water does not have the (pulling) so numbers have reduced”*. (Heat from the sun and air exerts a pull on salt water there by causing evaporation.)

• **Meaning Construction Salt and Water**

During this activity teacher attempted to give directions to pupils efforts by providing the necessary materials for conducting the activity. Pupil's efforts were recognized by preparing a table on blackboard from the readings of all the groups. However pupils had difficulties in reading numbers to a question for evaporation of salt water faster than the evaporation of ordinary water.

To a question on evaporation of salt water faster than the evaporation of ordinary water. The initial attempt to answer the question was based on their previous experience. *"sun heat or combination of sun heat and air is causing the water evaporation"*. However, pupils modified their answer based on an evidence and reported that *"In salt water, salt is absorbing water (so evaporation is faster) than the ordinary water"*

However, pupil's difficulties with numbers continued. During one of the interaction the teacher asked a pupils of G2 to look numbers 306 and 636 in the table and asked then why the salt water did evaporate faster than ordinary water to which the pupils replied *"If the number is less that means water evaporation is more' and pupils related the number to water evaporation"*.

5.3.1.6 Meaning Construction – Water

The purpose of meaning construction on water involves employing process skill indicators (see appendix I.B.1.b), to identify the process skill employed by the pupil during the context of scientific investigation. (refer procedure of data analysis in section 3.3.7.2) The pupils' ideas on water seem to indicate the usage of following process skills.

- 1) Observation
- 2) Communicating effectively
- 3) Hypothesis
- 4) Planning and Performing Investigations
- 5) Measuring and calculating using numbers.
- 6) Manipulating materials
- 7) Prediction
- 8) Finding pattern and relationship
- 9) Designing and making

The process skills used by pupils have been described in greater detail.

Observation

Under the skill of observation the following criteria will be considered

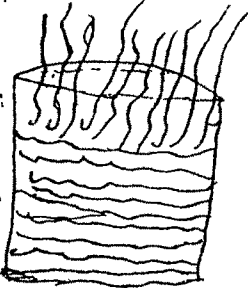
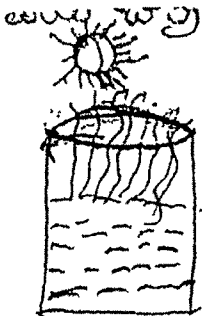
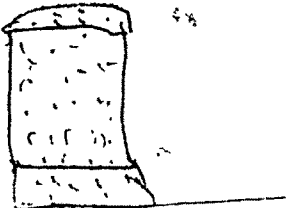
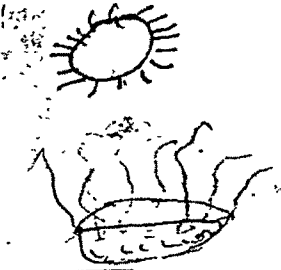
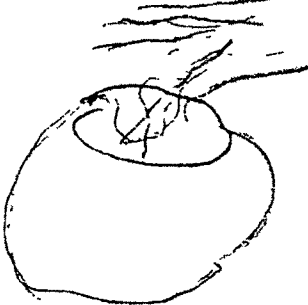
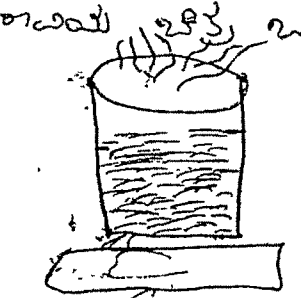
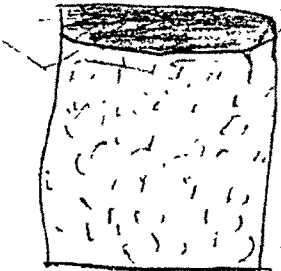
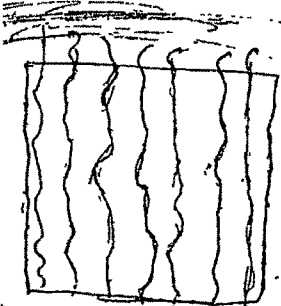
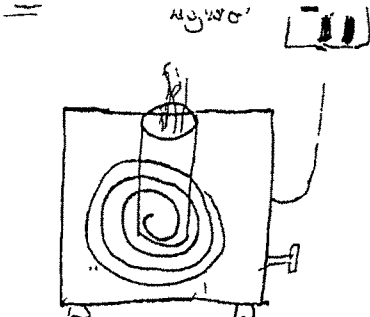
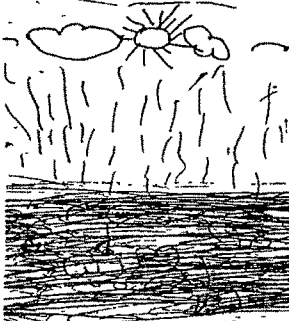
Change in pupil's ideas

➤ *Change in pupil's ideas*

In the beginning of the activity, the pupils were asked to define/draw about water evaporation. These ideas have been presented as 'initial' observation. At the end of activity all the groups were asked to define/draw about water evaporation. The pupil's ideas have been presented as 'final' observation (Table 5.15). The skill of observation is understood in terms of change in pupil's ideas or retaining pupils ideas by comparing the definitions/drawing on evaporation.

Pupil's ideas on water evaporation were compared with initial and final diagram. The change is seen with respect to viewing evaporation as an event as a result of heating water through stoves or through direct sunlight. This is quite evident in the G1 and G2 diagrams. The same idea has been highlighted by G4. The G4 describes evaporation as heat given from but under the direct sunlight heat falls on the water directly to cause evaporation. Pupil's ideas extended beyond the direct sunlight, but also include other water sources like river. This was evident in the way G4 has described as heat falling on a river. The final observation diagrams of G5 showed that water is getting evaporated from a river.

Table 5.15 Water evaporation Initial and Final Observation

Groups	Initial Observation	Final Observation
G1		
G2	 ಮುಂಜಿರು, ಹಸಿಯುರಿ	
G3		
G4		
G5		

Communicating effectively

Pupil's ability to communicate effectively has been considered with respect to

- 1) Linking one idea with another
- 2) Systematic recording of ideas
- 3) Listening to other ideas and responding to them.

➤ *Linking one idea with another*

Pupils link an idea in previous situation to explain the present situations. During the activity on water evaporation and air the pupils of G3 were asked to explain how air is causing water to dry? The pupil's responses are presented below.

P1 Sir, we learnt new information

T What?

P1 Vibrations

T Where are vibrations?

P1 When air moves with vibrations

T Where are vibrations?

P Sir, inside air vibrations are there, when air comes very close it not causes vibrations.

Pupil responded that “*air is causing vibrations and making water to dry*” (evaporate). Here pupils used the term vibrations derived from the unit sound to explain water evaporation.

During the activity on water evaporation and temperature, Pupils were asked to design an activity on their own. During which pupils of G3 showed an ability to link the present activity to an activity conducted by their teacher in III std. (where teacher has showed then an activity on respiration of plants). Pupils covered a plant with plastic sheet and kept the plant in a region of maximum sunlight. After some time pupils showed the water droplets on the plastic sheet. Pupils concluded that it is sun's heat, which is causing water evaporation.

➤ *Systematic recording of pupil's ideas*

During the activity on water evaporation pupils showed the ability to record the data systematically through diagrams. Pupils represented their their positions from where observation was done.

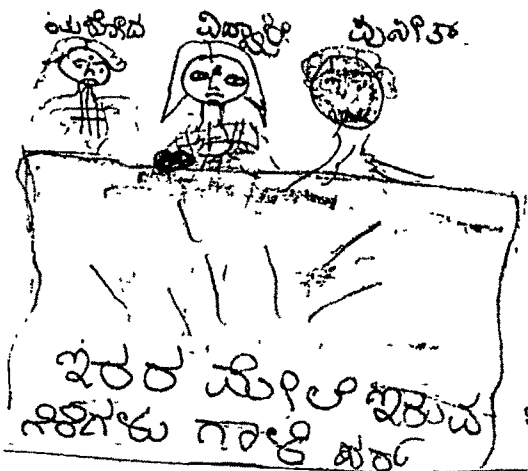


Fig. 5.65 Recording of water evaporation without fan G5
Depicts the diagram where pupil observing water evaporation without fan.

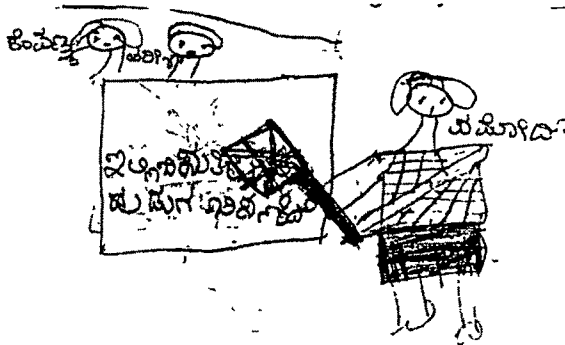


Fig. 5.66 Recording of water evaporation with fan G5
Depicts the diagram where pupils are observing water evaporation with fan.

The pupils attempt to systematically record the data on water evaporation and water is presented from their note book.. The data which is in kannada language was translated into English language.(refer Translation Procedure Appendix VII).

ನೀರಿನ ಮಟ್ಟದ ಬದಲಾವಣೆ ಮತ್ತು ನೀರಿನ ಮಟ್ಟದ ಬದಲಾವಣೆ

ನೀರಿನ ಮಟ್ಟದ ಬದಲಾವಣೆ ಮತ್ತು ನೀರಿನ ಮಟ್ಟದ ಬದಲಾವಣೆ

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ನೀರಿನ ಮಟ್ಟದ ಬದಲಾವಣೆ	ನೀರಿನ ಮಟ್ಟದ ಬದಲಾವಣೆ
250	300

ನೀರಿನ ಮಟ್ಟದ ಬದಲಾವಣೆ ಮತ್ತು ನೀರಿನ ಮಟ್ಟದ ಬದಲಾವಣೆ

ನೀರಿನ ಮಟ್ಟದ ಬದಲಾವಣೆ ಮತ್ತು ನೀರಿನ ಮಟ್ಟದ ಬದಲಾವಣೆ

ನೀರಿನ ಮಟ್ಟದ ಬದಲಾವಣೆ ಮತ್ತು ನೀರಿನ ಮಟ್ಟದ ಬದಲಾವಣೆ

Fig. 5.67 Water evaporation and water

The English version is presented below.

"The name of our experiment is cup-spoon.

We will take two cups and spoon.

One cup we will take salt to another cup we will add turmeric.

Then we will see minutes and give reasons.

Sunlight	Shade
250	300

We kept salt water in sunlight, so it dried at 250. We kept (water) in shades that are why it dried at 300."

Pupil's ideas to link to one another and responding to their ideas them were evident in the activities on water evaporation and surface area. During the activities teacher took two-hand cloth and rinsed them with water. One hand cloth was folded into two folds, whereas another hand cloth was folded into four folds. Both the Hand clothes were kept in sunlight. The cloth with two folds had dried faster as compared to cloth of four fold. Teacher asked the group to identify the reason for the same.

Given below is the pupil's discussion to respond to each other.

P1 Sir, since water is there, the four fold will not dry and two folds will dry.

T Does everybody would like to give the same answer

P2 Sir you had closed it that is why it did not dry.

P3 Sir if you put to tree it will not dry (interrupted by P4)

P4 if four folds are there it will not dry, if two folds are there it will dry.

P1 Sir (in) four folds water stays there.

Hypothesis

In the hypothesis pupils attempt to explain an idea with a help of a concept. During the activity on water evaporation and surface area, pupils observed that water in the plate was evaporating faster than the water in the cup. When teacher asked the pupils to provide an explanation the following conversation took between teacher and pupils of G5.

T Why did water dry in the plate?

P1 Since the rays comes very fast and it falls straight so that is why, it (evaporation) happens. It (water) evaporates and goes in to the clouds.

T Why did it (evaporation) not happen in the cup?

P1 Since cup was long, so sunray does not fall inside the cup

T Does rays were not falling inside the cup?

P1 Sunlight falls straight, since it is long, sunlight was falling on the other side of the cup.

P1 Sunlight was falling straight on the plate that is why it dried.

T Does the sunlight was not falling on the cup?

P1 No Sir, it was not falling clearly, it was at a height.

In the example pupils have hypothesised on the evaporation of water. The pupil's are attempting to relate sunlight and height (used in relation to surface area) of the cup to the water evaporation.

During the activity on water evaporation and air, pupils were asked to explain why the presence of fan is making the water to dry, In order to explain pupils have drawn a diagram.

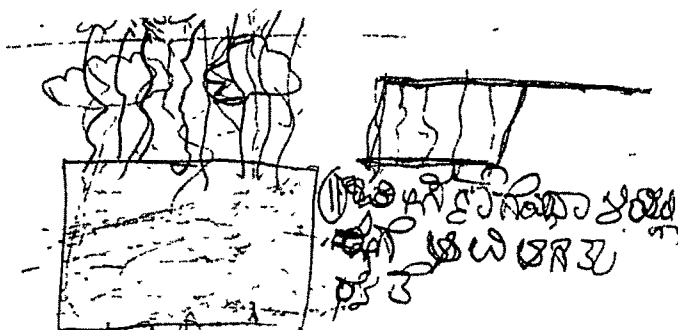


Fig. 5.68 Evaporation and air with fan G3

Pupils showed that fan is Getting air so water is getting evaporated.

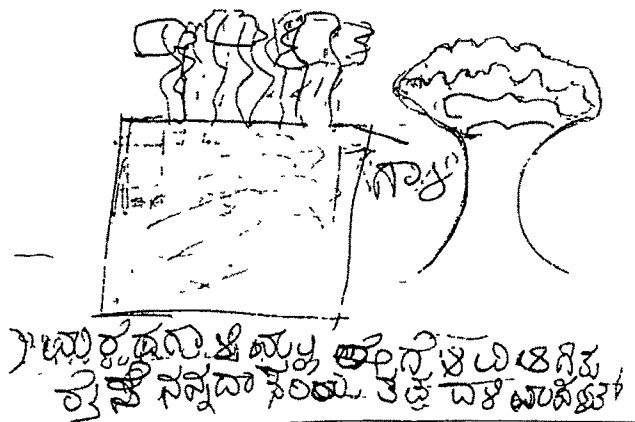


Fig.5.69 Water evaporation and air without fan G3

Diagram water is Evaporating without fan Pupils hypothesised that presence of tree is causing air, which in turn evaporates water.

Predicting

In predicting pupils used evidence to relate it to the occurrence of an idea. This was evident in the activity on water. During the activity pupils were asked to explain the relationship between water evaporation and volume of water. One such conversation took place between teacher and pupils.

T Which number is less, first one or fourth number?

P1 This one sir (indicating the finger to the first)

T Why did it become less?

P1 Sir, one drop was there, and then sunlight came so it later on dried. When five drops were put the number became more.

T When we put one hundred drops of water. Does it dry quickly or slowly?

P1 It will dry slowly, since water drops are around one hundred drops. It will not dry faster

In the above example pupil predicted that, *“if the volume of water is increased evaporation does not happen very fast”*.

Finding Pattern and Relationship

Pupil's way of using pattern and relationship consists of identifying an association between one variable and another. Pupil's ability to identify variables and associating variables with each other's seems to be varying. Pupil's ability was seen in identifying the variable under consideration within an activity. In most of the activities pupils identified the variable that is evaporation of water. But pupils had difficulties in associating their variables with other variables. In the activity on evaporation with temperature, pupils have said that apart from sun water, air is also 'sucking' the water.

In the activity on evaporation and air pupils, identified air is causing vibrations, However they also attributed sunlight water evaporation, thereby relating it to the more than one variable.

In the activity on water and surface area pupils had difficulties in relating evaporation to surface area. One of the groups could able to relate it to the surface area (height) of the cup. However, there were the cases when pupils attempted the association of one variable in the activity on water evaporation with volume of water, where few pupils like G3 said that *“since volume of water is more the evaporation will be less”*. In the activity on water evaporation and salt solution pupils identified the salt solution as evaporating faster than the ordinary water.

➤ *To identify the trends in observation*

Pupils had a difficulty in preparing and systematically recording the data through tables. So in most of the activities teacher was intervening to help the pupils to observe the trends in an activity. The pupils had difficulties in using numbers. Since these numbers were coming in the way for the pupils to view the trends in an observation. This was evident in most of the activities, where pupil's verbal account of the observations did not match with pupils written observations. One example of pupils table and their verbal account has been presented here.

In the activity on sunlight and shade, pupils of G5 took the help of teacher to prepare the following table:

	Trial	Sunlight	Shade
1	180	191	
2	140	201	
3	143	109	
4	103	200	

(Note: number denotes the point at which water got evaporated)

But pupils' recording of the first trial is present below

It dried at 180 in the sunlight

It dried at 191 in the sunlight

Pupils' concluded that "*it (water) evaporates faster in sunlight and it does not evaporate faster in sunlight*". In the above example pupil arrived at the conclusion just by looking at the data from the first trials of the activity and they did not bother to verify the data from other trials.

Planning and performance of Investigation

➤ *Deciding on the Equipment/Materials.*

In the activities pupils were asked to plan and perform the investigation. In most of the activities it was evident that pupils planned the activities forgetting the very purpose of it. Pupils of G4 Presented an activity on water evaporation and salt-water pupils compared vermilion and turmeric instead of ordinary and salt water. The vermilion and turmeric may not contain the salt only!

Another example was evident in the activity on water evaporation and temperature. The purpose of the activity required the pupils to test their ideas in shade

and sunlight so that pupils can compare the data. However pupils tested only with sunlight forgetting to conduct the activity in shade.

While planning the activities pupils seems to bring a change in the materials without bothering to understand the purpose of activity. Pupil's way of deciding the equipment or materials seems to bring the change without bothering about the purpose of the experiment. Another aspect of the planning process is seeking the 'approval' of teacher. In most of the activities pupils ask the permission or approval before deciding the materials.

Measuring and calculating – using numbers as a non standard measure

In the activities of water evaporation pupils were asked to record numbers at which water evaporates by using hand count or verbal count (instead of clocks which may not be easily available for pupils). However, pupils faced difficulties in reading the numbers and relating it to the purpose of the activity. Pupil's difficulties were in comparing numbers from one variable to another. Identifying the greater and smaller numbers and relating it to the data. In most of the cases pupils were not using the numbers to arrive at the conclusion. However in the certain activities like water evaporation and volume, water evaporation and salt in (Part B), pupils could able to use the number in arriving at the conclusion.

➤ Showing accuracy in Measurements

Pupils do not seem to be much particular about the accuracy of the activity. In some of the cases pupils had miscounted numbers or seem to indulge in the mischief thereby not showing the seriousness in recording the number. In one situation particular group (G3) showed recording of numbers in four different ways for an activity on evaporation of water.

P1-Dried at 200

P2-Dried at 176

P3-Dried at 154

P4-Dried at 195

So pupils' data seemed to be varying, but pupils do not seem to be aware that change in numbers could hamper the purpose of investigation.

5.3.2 Acquisition of Process Skills

The sub section 5.3.2 data regarding the acquisition of process skills is presented in terms of change in pupils' ideas during the instructional programme. The procedure adopted for data analysis and interpretation is presented in Fig. 3.4. This sub section presents data in terms of change in pupil's ideas and meaning construction with respect to soil, sound and water.

The change in pupil's ideas results through interactions with the teaching-learning experiences provided by the teacher. The teacher's initiatives result in conceptual learning where pupil's ideas are modified through instruction, with respect to activities in soil, sound and water.

The analysis of change in pupils ideas have been presented with respect to each activity in soil, sound and water. The meaning construction involve considering pupils ideas within the 'context' of scientific investigation.

5.3.2.1 Change in pupil's ideas - Soil

The change in pupils ideas have been identified with respect to

- Representation of ideas.
- Identification of soil layers.
- Extension of idea on 'Moistness'.

➤ *Representation of Ideas*

Pupils carry their own pre-existing ideas on objects/events when pupils represent these ideas; they tend to be drawn from their previous ideas. These ideas on objects/events tend to change during instruction. In the activity 'soil', children representation of ideas on soil, ants and earthworm have undergone a change This has been described in table 5.2.

➤ *Identification of Soil Layers*

In the activity on 'school soil', pupils used the colour, and texture of the soil as criteria to identify the upper and lower soil layers. However, in the activity on 'garden soil', pupils used colour, texture and weight as the criteria to identify the upper and lower soil layers. Thus pupils have modified their criteria from colour and texture to colour, texture and weight while identifying the soil layers (garden soil).

➤ *Extension of Idea on 'Moistness'*

In the activity on school soil, pupils described the lower layers of soil as moist. (The 'moist' would mean that soil is not dry but wet). However, in the activity on grass soil, pupils described grass soil is *"moist and binding to the roots of the grass soil"*. Thus pupils have modified meaning of the idea of moistness from (which is wet in the school soil) to the one, which binds the roots of the grass soil.

5.2.2.2 Change in pupil's ideas – Sound

The change in pupils ideas have been identified with respect

- 1) Representation of ideas on 'Sound'
- 2) Proposing a hypothesis on spoon and plate
- 3) Testing Hypothesis on telephone
- 4) Supplementing the teacher activities

➤ *Representation of ideas on Sound*

Pupils were asked to define the meaning of sound before and after the activities on sound. Pupil's ideas of sound have been represented in the table 5.12. Pupil's ideas before the activity were guided by their previous experiences related to the sound in their environment. As a result, pupils' ideas were centered on sounds of different objects/living things. However, after the activities pupil's ideas were centered on viewing sound as vibrations. Thus pupil's ideas of defining sound in terms of different objects/living things have been changed to define sound as 'vibrations'.

➤ *Proposing a hypothesis*

During instruction, pupils tend to propose hypothesis to explain the occurrence of an event. The pupil's hypothesis tends to be derived from the previous experiences on the event.

In the activity on spoon and plate pupils identified the pitch of the sound in terms of more and less sound. *"If you hit the spoon, fastly more sound will come"*. *"If you hit the spoon slowly, less sound will come"*. However pupil's response was similar in the activity on 'clock' but pupils worked on the idea of more and less to propose a hypothesis.

Pupils reported that *"If you close the box less sound will come if you open the box more sound will come"*, when teacher probed the pupils for a suitable explanations, pupils reported in terms of breathing of clock, which is responsible for more and less sound.

Thus pupils have used the idea of more and less (gained from the activity on spoon and plate) in the activity of clock to propose hypothesis to explain the event.

➤ *Testing Hypothesis*

Pupils tend to propose hypothesis in order to explain the occurrence of event. When teacher invites pupils to test the hypothesis, pupils react in their disbelief when their ideas are not confirmed by the test.

In the activity on telephone, pupils of G4 proposed a hypothesis that *“if the knots are put in the thread, sound in the telephone is not clearly heard”*.

Pupils believed that sound will go to the knot and will not be heard through the thread. Teacher asked the pupils to test their ideas in the activity. So a knot was put in the thread and pupils started testing hypothesis. When pupils discovered that sound is heard even though knot is present in the thread forced them to revise their initial hypothesis. Pupils showed utter disbelief, when their idea was not confirmed by testing of hypothesis. This made pupils to propose another hypothesis that *“if we cut the thread and tie the thread then sound will not be heard.”* Thus pupils have attempted to modify the earlier hypothesis as a result of testing hypothesis.

➤ *Supplementing the teacher activities*

When opportunities are provided, pupils bring their own ideas to supplement the teacher's activities. In the activity on in and around, teacher had suggested the pupils to tie their eyes and use their ears to make sense of the different sound present in and around the school. However pupils attempted to close their ears with the hand in order to classify the loud sounds and soft sounds. Thus modification by the pupils to close their ears, while hearing different sound supplemented the teacher activities.

In the activity on near and far teacher had suggested the pupils to use clapping hands at near and far places to understand the concept of sound varies with distance. However pupils modified the teacher activities by suggesting the shouting of names at near and far places. Thus modification by the pupils to shouting of names instead of clapping hands to supplement the teacher activities.

5.3.2.3 Change in pupil's ideas – Water

The change in pupils ideas have been identified with respect to

- Representation of ideas on water evaporation
- Proposing hypothesis
- Supporting hypothesis based on evidence
- Identification of variables during water evaporation

➤ *Representation of ideas on water evaporation*

Pupils were asked to define the meaning of water evaporation before and after the activities. Pupil's ideas of water evaporation have been represented in the table 5.16. Pupil's ideas on water evaporation were guided by their previous experiences. Before the activity pupils viewed, water evaporation caused through heating water on a stove. However after the activity pupils viewed the water evaporation caused through direct sunlight.

Thus pupil's idea on causes of water evaporation has changed from heating in a stove to exposure to direct sunlight.

➤ *Proposing hypothesis*

Pupil's attempt to propose explanations to the events they observe were based on what they see through their senses. However pupils perceive the explanation in terms certain concepts there by bringing scientific explanations.

In the activity on *water evaporation and air* all the pupils belong to different groups reported that *air is causing water to evaporate*. However pupils of (G3) attempted to go beyond the explanation of air is causing water to evaporate. Pupils in this group reported that *air consists of vibrations and makes the water to dry (evaporate)*. Thus there is a change in formulating hypothesis from mere observation to observing with the aid of a concept.

➤ *Supporting Hypothesis based on evidence*

Pupils tend to give explanations to occurrence of events. When challenged by teachers, pupils do not agree with teacher, instead support their explanations with valid evidence. This has been represented below.

In the activity on *water, evaporation of salt and water* pupils attempted to give various explanations as to why salt water evaporated faster than the ordinary water. When teachers challenged pupil's explanations, pupils of the G4 attempted to provide evidence in support of their explanation. Pupils of G4 had reported that *salt water contain salty things which drinks water so number becomes less (meaning evaporation becomes faster)*. To support their explanations pupils showed wet salt as evidence' [In evaporation of saltwater, water got evaporated first, leaving salt behind which was wet. Thereby, making the pupils to think that salt has salty things drinks water].

Thus pupil's tendency to support their explanations has changed from providing no evidence to providing evidence, to support their hypothesis.

➤ *Identification of variables*

Pupils, while performing the activities have identified variables to provide explanations.

→ *Relating variables*

In the activities on water evaporation and surface area pupils had the difficulties to relate the relationship between the two variables. Pupil's tendencies were to record the numbers at which water got evaporated. However pupils of G1 (group one) made a reference to the flatness of the plate and spherical (round) shape of the cup was related to water evaporation. Thus pupil's ideas have changed from not relating the variables to relating the variables on water evaporation and surface area.

→ *Interaction of variables*

Pupils while performing the activities have observed the interactions of multiple variables in an event. In the activity on water evaporation and volume of water, pupils were expected to relate the interaction of variables on water evaporation and volume of water. However pupils have related water evaporation to clouds, air, sunlight, etc.

The pupils have related water evaporation to various other variables, which are relevant but were not considered in the activity. In this activity pupils have gone beyond the scope of the activity to relate the interaction of several variables in water evaporation. Thus pupil's ideas on water evaporation have changed from relating one variable to multiple variables.

5.3.2.4 Meaning Construction Change in pupil's Ideas – Acquisition of Process Skills

The pupil's ideas in the activity soil, sound and water have undergone change. The change of pupil's ideas can be seen in terms of ideas getting modified or rejected in the process of conceptual learning. The teacher initiatives in providing the learning experiences have brought a change in the way pupils conceptualise the ideas in soil, sound and water. The change in ideas strengthens the case of conceptual learning. This learning happen as a result of usage of process skills has facilitated in pupils proposing or testing hypothesis, providing explanations and strengthening the explanation through evidence, modifying criteria of observation, extending an idea to link to the new situation etc. the usage of process skills and change in ideas there by causing conceptual learning. Thus conceptual learning or conceptual development indicates the acquisition of process skills (Harlen,1993) with in the instructional programme