CHAPTER 3

Research Design and Methodology

3.1 Introduction

The last chapter provided an overview of the learning theories which form the basis of this study and engaged with the issues that define the Indian school education and science education context. The chapter concluded with a delineation of the framework and research questions. This chapter presents the research design and methodology. First the methodological basis for investigating the culture of school, home and classroom is set out; which then leads to a discussion of the research design. Followed by this is an account of the field work, observations, document study and analysis, and the tasks conducted with children, methods of data collection and the procedures adopted for analyzing the data.

As discussed in chapter I where the problem was introduced, and in chapter II where the theoretical background was laid out and the problem was refined and stated, this research study required studying contexts of science learning and children’s thinking with special focus on the axis of school vs everyday. Various sites and levels of understanding contexts and thinking could be identified as follows: (i) the socio-cultural life of the child outside the school in the home and the village, including activities and experiences of the material world, (ii) the nature of the school experiences, (iii) science education and learning processes as intended by the curriculum and textbooks and (iv) as they take place in the classroom, and finally, (v) the negotiations and thinking processes of children—individually and in groups.

3.2 Designing the Study

One of the ways to address the importance of context for children’s science learning is to study science learning in the settings in which it naturally occurs. This requires adopting and adapting the naturalistic research paradigm which is used in the social sciences to study communities, cultures, and social interaction. Naturalistic research methods were developed to study behaviors within natural settings. A naturalistic paradigm is not defined by the methods used or the place
where data are collected, but more importantly, a theoretical stance and set of research principles (Moschkovich & Brenner, 2000). The theoretical stance is the assumption that meaning is socially constructed and negotiated in practice. The research principles include considering multiple views, methods and disciplines, and studying cognition in contexts. The phases of a naturalistic research are revisited several times. The cycle of the research in a naturalistic study can be illustrated as follows.

![The cycle of naturalistic research](image)

**Figure 3.1** the cycle of naturalistic research (from Moschkovich & Brenner, 2000)

The naturalistic research framework adopted allowed for the research to be carried out in cyclical phases enabling context and learning to be investigated at various sites and at various levels, in mutually consistent ways. This framework allowed for three different methods to be undertaken to elicit mutually complementary dimensions of the research problem. Firstly, to understand the larger socio-cultural context in which children and their schooling was located, also to understand the school and the classroom processes of science learning. Secondly the curricula and textbooks which dominantly frame classroom processes and educational experiences. Thirdly, and finally, children’s thinking. The study had to devise ways of investigating both these dimensions—science learning in general and the learning of the conception of matter in particular, at all times concerned with the basic question of how the everyday world of the child enters into and interacts with the world of the school.

Given these different foci of interests, the study required that the research be carried out using different sets of methods in different phases. (A) In the first phase of the field study, an understanding of the field, the context of children’s everyday life, school and classroom life was developed using ethnographic style observations and field notes. (B) In the second phase, an understanding of the curriculum was obtained by undertaking a detailed study of the curriculum documents, textbooks, teacher’s manual, also attending sessions at the local cluster...
science teacher training program. (C) In the third phase of the research, more time was spent on investigating the classrooms as well as children’s thinking and conceptions using observations, worksheets and observation of the performance on special tasks along with Piagetian clinical interviews. (D) Finally the study of curriculum and texts as contexts was revisited.

These different methods were chosen in order to develop a holistic understanding of children’s learning of science in general and learning of the concepts of matter in particular, in the backdrop of their social-cultural background and the context of learning. In all these sites, mapping and understanding key features which may be characterized as distinctive of everyday/home life and those that may be characterized as distinctive of science learning and science itself, and their inter-action and relationships, were the key focus.

Thus the study consisted of the collection of data from the following four key sites:

1. The village and home: The socio-cultural context in which children and school are situated.
2. The curriculum and textbooks for science learning.
3. The school and the science classroom: as a socio-cultural and pedagogic space
4. Children’s thinking through their performance on tasks—written worksheets and activities—which were observed and probed using clinical interviews.

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The broad methods employed and framework used in each of these four sites is presented below.

3.3 The Socio-cultural Context of the Child and School: ‘Everyday World’

This part of the study attempted to engage with and understand the everyday life world in which children and schools are located. The focus was on understanding and describing the following:

1. The socio-cultural background of the children. What are the castes and communities from which the children come? What are the occupations of the parents and what are the overall socio-economic backgrounds of the families of the children? How the families of the children are positioned vis a vis schooling in general and the children’s school in particular. Are there aspects of gender or caste, etc. which intervene in shaping children’s engagement with schooling on the whole?

2. What are the forms of school available in the community and what is the nature of the relationship of the families of children with the school. How are the worlds of school and home related to each other?

3. What are the languages spoken at home? What are the social and family resources children have to draw upon in engaging with the school in general and with science education and science in particular?

4. What are the kinds of activities in which children engage, outside the school which afford them opportunities for learning of other kinds—in particular learning of crafts and occupations?

5. What is the material world in which children are immersed—as defined both by the geographical/ ecological particularities as well as the economic and cultural activities of the community?

In order to do this the methods chosen for use were naturalistic observations and informal interviews to be carried out over a period of several months. Time was spent to live in the village, gain access to homes of children and visit them there. Time was also to be spent in the company of children, from morning to evening. Care was to be taken to ensure that all areas of the village were visited
and all caste/community groups were also visited. Background information from census records was used to guide the researcher through the process.

The background of children was mapped according to caste, socio-economic class, religious group, language spoken and occupation of parents. Homes of the children, the involvement of adults and older siblings to education and school were noted. Gender related practices in the space of the family were observed.

In addition, the ways in which school and non-school situations may contribute towards understanding of the concept of matter was also noted. This involved examining children’s interaction and experience with the material world at different contexts both in and outside the school, the nature of and content of everyday knowledge about the material world. Children’s everyday world is surrounded by a wide variety of objects and materials, which they recognize, identify, distinguish and use for different purposes. They have rich experience of working with many materials and objects relevant to their daily lives. Also observing/participating in various practices and occupation in the community can also provide children with rich opportunity to become familiar with a vast array of materials, their properties and means of manipulating them.

### 3.4 Science Curriculum and Textbooks

This part of the study focused on understanding how the science curriculum and textbooks generally shape the child’s experience of learning science and the outcomes of learning science, by defining the contours of science pedagogy, inclusion and exclusion of content and evaluation. The key focus of this part of the analysis was to understand

1. **What are the major educational aims for the school science curriculum?**
   How are the questions of context, relevance and relationship with everyday life dealt with?

2. **What are the key principles based on which the contents of the syllabus and textbooks are to be selected and organized?** To what extent are constructivist theories drawn on, particularly to justify the selection and organization of content and on the question of context and meaning in learning?
3. How is the topic of matter dealt with in the middle school textbooks? What are the key concepts chosen and how are they dealt with? What is the sequencing and pacing and what are the instructional strategies used?

4. What are the linguistic and symbolic features of the books and how do they relate to the child’s home language, and to the language of science?

5. What activities and experiments are children expected to engage with, to what extent and for what purposes? (What are the discourses generated by these activities and how are they recontextualised in the science classroom?)

6. To what extent and how does the everyday life world of the child find representation in the textbook? What is the space created for engagement within the everyday world and what purpose is this meant to serve?

Three main documents were used for this part of the study:

1. The curriculum guidelines and framework as elaborated in the teacher handbook, SCERT websites and SCERT documents.
2. The teacher’s handbook
3. The state textbooks of science for grades IV to VIII.

The curriculum framework and teachers handbook were read primarily to understand the
1. Overall aims of science education being articulated
2. The principles of the curriculum particularly from the point of view of constructivist learning and meaning making, again with reference to the question of context and relevance of curriculum/school learning with everyday life.
3. Specific references to and recommendations regarding the child’s everyday world.

The Textbooks were subjected to content analysis of various kinds:

1. Broad chapterization of all the textbooks of science was first undertaken, along with the scope of each chapter in terms of number of pages.

2. Individual chapters that pertained to the teaching of concepts of matter were identified. The chapters, their concepts and sub concepts were listed in the sequence and hierarchy in which they were presented. Further detailed analyses were undertaken specifically for those chapters that dealt with matter.
3. The details of specific science terminology and language used were identified and listed.

4. The details of every single type of instructional strategy/pedagogy used was identified and listed: activities, experiments, projects, etc. The typology of these pedagogic strategies was taken from the teacher’s handbook and also as suggested by the textbook itself. These were examined for their open-ended vs. close-ended ness, in order to understand the extent to which the textbooks activities were directed at the bringing in the child’s everyday life into an active relationship with classroom processes/learning, i.e. providing opportunities for everyday-and-school knowledge interaction, or if they were directed at learning of the textbook content in itself.

5. Details of examples from everyday life—materials named as well as processes described, were listed chapter wise, in order to assess the extent to which the textbook itself invokes the everyday and the ordinary, and the place that it gives to these in relation to the learning of science/scientific knowledge.

Detailed lists of various attributes which were made were subject to categorizations and subject to simple counts to lend themselves to forming the basis to be able to respond to the following:

1. The treatment of the concept ‘matter’ in the textbooks in terms of content-progression, organized in each grade and across grade, concept connection, repetition and complexity. The related questions were when is the concept introduced? What are the major terminologies that are introduced and used in each grade? How the concepts are connected or linked within a unit, across the units in the same grade and across the units on matter in different grades?

2. What is the intended learning expected from units on matter? What are the pedagogic efforts, approaches and methods used by the textbook to engage and instruct the learner with concepts and ideas of matter?

3. What is the treatment of the concept of matter in the school curriculum especially with regard to the child’s everyday experience with and access to the material world?
The major aim was to understand the relationship between the everyday and school science learning. The questions pertaining to how science curriculum and textbook dealt with this school-everyday relationship were

4. How does the school science curriculum approaches the dimensions of ‘everyday’ and ‘school’—both as a source of knowledge and also as a context of learning?. To what extent does the textbook and curriculum take to supporting children to negotiate this transition? Related is the question of the extent to which the approach in the school science curriculum may be regarded as founded on constructivist principles of learning, and supportive of meaning making in science education? To what extent is the child’s everyday world (including culture and language) included and interacted with in the context of school? Is Gender or Caste or other sociocultural categories significant in differentiating children’s experiences of science education?

3.5 Context of the Science Classroom

The study focuses on the naturally occurring science classroom activity as one of the context. A science classroom is an important context for the teaching and learning of science, where a teacher and student are involved in multiple activities. In doing ethnographic methods to study learning in a science classroom, observations have been conducted not only across classroom cultures, but also across grades, curricular and educational experiences. The study functionally defines the classroom context as comprising of all the immediate environmental aspects that the teacher and students engage in: - the science classroom activities and experiment, the method of teaching, the physical setting of the classroom, text book, writing materials, concrete materials used, in particular the mode of teaching, conduction of experiments and the participation of teacher and children in the classroom. Focus was also on understanding the role of language, gender and social interaction—the interaction between teachers and children, and peer groups—happening at the classroom during the learning of science. The study also identified that communication/language use happening in the classroom between different members as important in the construction of the social context of the classroom. Attempt was also made to record in detail various activities in which the children participate in the context of the school. Science classes were observed in grade V, VI, VII and VIII, especially when the topic related to matter was taught.
3.6 Tasks and Clinical Interview

The examination of children’s understanding of science and conceptions of matter was done through two ways, one was by studying the nature of children’s interaction with a variety of materials and the other was by studying the nature of children’s explanations regarding the concepts that came under “matter”. Both aspects were used to follow children’s understanding of the concept with classroom learning of science, and also to examine the influence of social context of learning.

A set of seven tasks that included working with concrete materials and writing tasks, along with Piagetian Clinical Interview were employed to probe children’s understanding of these various aspects of the concept “matter”: properties, classification, states, change of state, structure, constituents and divisibility. The tasks were designed with the aim of systematically examining fifth to eight grade students understanding of the concept and engaging students in activities that allowed them to talk about their ideas of matter. One of the tasks was also performed at the context of the home to understand how home context and members influence children’s thinking. Following were the tasks

1. Writing definition, examples and properties of: -a) Matter b) substance, c) solid, d) liquid and e) gas to explore children’s knowledge of the terms substance, solid, liquid and gas; the meaning, definition, examples and properties.

2. Piagetian Clinical Interview to examine children’s concepts of :-a) Substance, state, properties, structure and constituents of matter

3. Open ended classification of materials which was conducted at the context of the school; also home

4. Ranking a range of solids

5. Devising a method to change the state of a given substance

6. Explaining processes: Dissolving sugar in water, heating candle, ice, camphor and iodine

7. Telling what a grain of sand or a drop of water consists of.
The classification task was conducted at context of the home and school. The classification task was video and audio recorded. The tasks are introduced in detail in the later chapter along with the report of the findings. The details of each task is included in Notes A given at the end of this chapter.

The Piagetian clinical interview was used to probe children’s conceptions of matter, and explanations and reasoning strategies regarding various aspects of the concept. Piagetian Clinical interview is used in science education research in studies that examine the cognitive aspects of science learning, and also for studying the nature and extent of children’s scientific knowledge. Clinical interview methods can help to gain insight into aspects of a child's thought and detailed mapping of understanding of scientific concepts (Ginsburg, 1997). Its chief goal is to ascertain the nature and extent of an individual child’s knowledge about a particular domain by identifying the relevant conceptions he/she holds and the perceived relationships among those conceptions. Piagetian clinical interview method involve intensive interaction with the individual child, i.e. an extended dialogue between the adult and child, careful observation of the child’s work with “concrete” intellectual objects, and flexible questioning tailored to the individual child’s distinctive characteristics. One of the important features of the clinical method is using the interview to elicit and collect specific kinds of information. The other is allowing the child to take lead role and talk more and more freely (Posner & Gertzog, 1992). The interview format provides intensive experience on the problem or task at hand in a one-to-one interaction with the interviewer whose primary aim is to come to understand what the child thinks, and why and how he/she arrived at those ideas.

The rationale for using Piagetian Clinical Interview was that the method is flexible in allowing a researcher both to probe the areas of the knowledge domain of particular interest and to let the child speak freely while constantly checking his/her spontaneous remarks. Clinical Interview method also allows for an informal experimentation and testing. This method allows in offering a certain problem situation to the child in which the child will be encouraged to articulate his/her thinking. The interviewer without correcting or providing clues to the child, merely guides the child to explain his/her thoughts. Activities and tasks using concrete material were provided to children in groups of two/three to perform as a part of the clinical interview to map children’s explanations.
The tasks and activities were designed in such a manner as to probe into students understanding of a concept and how they link their understanding to out of school context. Opportunity to experiment in a new situation was provided to examine how children can deal with a new situation/problem.

The interviews were audio recorded. The classification tasks were video and audio recorded. Detailed notes were also taken. Notes A at the end of the chapter give a detailed picture of the tasks that were designed towards conducting the task based Piagetian Clinical interview with children.

### 3.7 Field Work

#### 3.7.1 Field Work Phases and Data Collection

The study took place over 17 months of field work in a village in Kerala. The pilot phase of the study that included initial visits to the school and community, ethnographic observations of the school, science classroom and village was done for a period of five months during the months of September 2006 to May 2008. The main field work for the study, that included administration of the tasks and Piagetian clinical interview was done for a period of 10 months during the 2007-2008 academic year.

Phase 1 (September 2006-March 2007): During the phase 1 of field work ethnographic observations were made in the contexts of the village, school, and science classroom.

Prior to the 2nd phase of the fieldwork, time was spent in analyzing the textbooks and curriculum and also in developing and piloting the tasks to be administered.

Phase 2 (June 2007-May 2008): During the phase 2 of the field work, worksheet based tasks and Piagetian clinical interviews were conducted with a selected set of children in the context of the school and home. During the initial two months (June-July-2007) short/random visits and observations were done. Later from August 2007 to May 2008 field work was done on a continuous basis.

Phase 3: After beginning the process of analysis, the review and study of textbooks, curriculum and context were revisited.
3.7.2 Choice of the Research Site

The school chosen for the present study was identified based on initial visits to the school, interaction with the principal, science teacher and other members of the school, socio-cultural groups comprising the children. The fact that this was a school where classes are held regularly was important. The main criteria that were kept in mind while choosing the school were: - a government school where children from diverse backgrounds study, classes are held regularly, and children’s language and the language of teaching and learning of science are familiar to the researcher.

3.7.3 Gaining Access

In the pilot phase of the study, a few schools in Ernakulam District were visited to find out the possibility of conducting the study. The entry to this particular school was easy as I was introduced to the principal by an alumnus of the school. First I met the school principal and explained about my research and my preference for choosing the school for research and data collection. The details and plan of work to be conducted at the school was provided to the middle school and high school science teachers. The principal and teachers were happy that I chose this particular school for a research work, especially when it was a school where children from middle to lower middle class background study. Many of them expressed their concern that there is hardly anyone in the larger community, who consider there is something interesting happening in a government school. They trusted that a researcher’s presence at the school may change this perception and

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attitude of people towards the school as it makes them believe that something interesting and meaningful is happening in the school so that it has been chosen for a research study.

Direct access to community situations was difficult initially. Before beginning the pilot phase of the study, few days were spent in the field assessing the various possibilities for research and conduction of tasks at children’s home. As a result, exploratory contacts were made with some community members through the teachers and children. Several informal visits were conducted to children’s homes during the pilot phase of the study, to establish a rapport with children’s mother, sisters or women members of the family; later during the phase II, the researcher managed to get access to the home to conduct the Classification task.

3.7.4 Sites and Objects and Subjects of Study

Firstly the whole village, in particular, the homes and community life of the children who attended the government school was a site of study.

The school itself, and within the school, the key sites of the study were grades V to VIII of the school. Class observation of the science classes were conducted in these grades. The classes were taught primarily by two teachers in the school.

The curriculum followed, and the textbooks, supported by the teacher hand book were objects of study. Children’s note books and various records which were a part of their science education were also gathered and studied.

Finally the children from grades V to VIII were studied. Detailed discussions, interviews and tasks were carried out with about 80 children, 20 from each of the four grade grade of V, VI, VII and VIII i.e. children between the ages of 10 years and 14 years. The tasks were conducted with children of different grades and gender. Classroom observation and worksheet based tasks were conducted in the whole class setting. The task based Piagetian clinical interview was conducted with a selected group of children. The students were selected so that students with a broad range of interests and school attainment levels were chosen for the tasks. Approximately 15 to 20 children from each grade participated in the task. The tasks were conducted in groups with two or three children in each group.
3.7.5 Data Collection

The main tools used for collecting the core non-textual/documentary data for this research were observations, conducting tasks with children and clinical interviews. Focal participants were observed in the various contexts of their lives, including their school classrooms, homes and recreational activity spaces. A certain amount of data was collected while observing children outside the classroom during play, gardening activities etc. Observations were also made on occasions such as world environmental day, science exhibitions and fairs at school etc. Children’s notebooks, science diary, examination answer sheets; seminar and projects reports were also analyzed. Classroom observations were done during science lessons, as the researcher sat along with the children in the back bench making observation notes in a field notebook. However majority of data was obtained during the science classroom observation and clinical interviews.

Field Notes were kept through the period of the field work. These included observation notes, and scratch notes that were made from a) observation of the various activities of the school, b) observation of the science classroom, c) conversation with teacher and various members of the school d) visits to children’s home and interaction with parents and other members of the home and community e) casual conversation with children and other participants both in and out of the school.

Data sources included (1) field notes from observations of children in various contexts (2) Video recordings of children doing classification task (3) transcripts from both ethnographic and clinical interviews (4) written notes and worksheets produced by participants and interviewing represented the major means of collecting data for this research study. Interviews were designed while considering the various ages of the students involved. The data was obtained through participant observation and in-depth interviewing, a naturalistic approach involving an interpretative understanding of student’s

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experiences and formal instruction. Piagetian Clinical interviews were utilized in this cross-grade study to examine the level of students thinking and understanding in accordance with the grade. The researcher audio taped each interview and children were interviewed in a quiet corner area of a computer room. The classification task was video recorded. All audio tapes were transcribed for analysis.

Other data source include Kerela SCERT website, Teacher hand book, Children’s Science note book, Science Diary, Children’s seminar and Project report, Examination Answer sheet, Annual School Report, and Photographs

3.8 Analysis

There exist different approaches that have been developed to analyze the qualitative data. The template approach replicates the method of data analysis as suggested by Miles and Huberman (1994). In their view, qualitative data can be and indeed must be reduced for both descriptive and explanatory purposes. According to this, data reduction refers to the process of selecting, focusing, simplifying abstracting and transforming the data that appear in written-up field-notes or transcriptions.

The data collected was analyzed chiefly by using the methods of data reduction suggested by Miles and Huberman. ‘A fairly classic set of analytic moves’ as outlined by them were employed:

- giving codes to the initial set of materials obtained from observation, interviews etc.
- adding comments, reflections, etc. (commonly referred to as ‘memos’)
- going through the materials, trying to identify similar phrases, patterns, themes, relationships, difference between subgroups, etc
- gradually elaborating a small set of generalizations that cover the consistencies that are discerned in the data
- linking these generalizations to a formalized body of knowledge in the form of constructs or theories
For the study, besides keeping field notes, all the interviews were tape recorded and the classification tasks were video recorded. Thus the final data mainly consisted of audio and video recordings of interviews and tasks, worksheets and field notes. Before analysis, the recorded data collected through these methods was transcribed and edited. All the interviews were transcribed word for word and subsequently analyzed.

Data analysis involved analysis of the worksheet, reading through the interview transcripts, and notes. Analysis began by categorizing and organizing the raw data, analyzing transcripts for themes, establishing criteria for analysis and situating the analysis within the theoretical framework. Thus it involved a systematic process and a method for reduction of data by categorizing, analyzing specific statements, patterns and emerging themes.

The qualitative data obtained from the interviews, classroom observations, and field notes was coded and classified to define categories and organize them according to the concepts inquired. Data from different sources were handled differently, based on the type of data involved—textbook content, classroom observations or worksheets and interviews with children—within the broader principles of qualitative analysis outlined above. The analysis was entirely driven by the main aim of the study: to reveal what are the different conceptions of matter expressed by student in light of the social context of learning.

Curriculum and textbooks were analyzed based on the framework evolved, and examining contents to classify and illustrate various aspects of the framework. Classroom observations were analyzed using the framework to help to identify the chief characteristics of the classroom as were relevant to the objectives of the study. Themes which were identified for both classroom observations and the study of textbooks emerged both from the examination of content as well as from the key research questions of this study. Coding and classifying in order to allow themes to emerge was followed, along with applying the framework on the content.

The data obtained from interviewing children was analyzed for children’s conceptions of matter in light of age, gender, socio-cultural and school factors. Interview transcripts were categorized into substance, solid, liquid and gas, properties of matter, states of matter, change of state, and constituents of matter; and these areas of children’s conceptions were examined across grade levels. The context of learning was characterized by factors such as school culture, science
Following the data coding processes, patterns or themes were identified which allowed to the creation of a coherent explanation of various aspects of children’s matter conceptions in the background of the social context of learning. Constant comparison methods of analysis, a process of data analysis that combines category coding with the simultaneous comparison of all observed events were employed to reach upon children’s conceptions of matter, understanding of science learning and the influence of everyday world and the world of school.

3.9 Conclusion

The above account of the research methodology may suggest a rather more systematic process than the one that occurred in fact. Whilst the principles underlying the methodology are capable of clear enunciation, their translation into specific research practices was by no means straightforward. Ideals had to be balanced against the constraints of doing research in a situation and other practicalities. Notwithstanding the above, the researcher was certainly aware of the limitations of the research design. At a practical level the study was time consuming, requiring far more time for the conduct, transcription and analysis of the interviews than had originally been anticipated. Nevertheless, in spite of these limitations the research yielded an enormous amount of rich data which are useful for the present study.

This chapter has outlined the research design and methodology adopted for this study. It identified four main spaces for study: the everyday context, the curriculum and textbooks, the classroom and children’s conceptions. Questions that formed a framework for investigation for each of these areas were developed. Each of these required different methods to be used, data were in different forms and requiring different methods for analysis.

The chapters that follow present the findings of the study grouped into four chapters. Chapter four presents an account of the contexts—the context of Kerala, a profile of the village and the school. Chapter five presents the analysis of science textbooks. Chapter six presents an analysis of the science classroom. Chapter seven and chapter eight present the findings pertaining to children’s understanding.
Notes A

TASK 1: Classification

Classify the given objects and materials, and explain the criteria for classification.

Aim

1. To examine children’s classification of a wide range of materials that are in different states, form, various shape and particle size, made of different substance, with different functions and properties.

2. To elicit children knowledge and understanding of various aspects of the concept matter as a basis for learning of the concept from the science class and everyday material world: - conceptions, reasoning and knowledge about everyday material world, it use, properties (the properties of materials related to their uses), and states, material kind, categorization of new and unfamiliar materials, to invoke talk about materials their properties, states etc

3. Criteria and reasoning for classification: What are the natural criteria or reasoning children use to classify materials? Also to elicit children’s thinking and talk about the concept “matter”. a) Description b) Reasoning c) Ideas and terminology they invoke to explain, how children reason about a material that belongs to more than one category while they classify. Assigning a category to an unfamiliar substance - how children reason about a material of a new and unknown kind and how they identify it?

Task Description: Open Ended Classification

The materials that are in different states, form, made up of different substance, with different functions and properties are selected for classifying.

Administrating the Task

Number of children participated in each classification: 3
Total Time for the task: 90 minutes (45 minutes for classifying and 45 minutes for Piagetian Clinical interview)
The materials to be classified were arranged on a table and children sat around the materials to classify.
Directions given: “Classify the given materials and sort them into different groups. Take out one material at a time, discuss with your friends the criteria for classification and assign a group to each material based on the discussion, and a category which all members of the group agree to”

Once children began the sorting of materials and assignment of groups they were provided with small pieces of cloths to keep the classified materials. Children were left alone while doing the task without asking questions or providing any clues and care was taken not to influence their thinking and criteria.

Table 3.1: List of materials used for classification

<table>
<thead>
<tr>
<th>Material</th>
<th>Classification</th>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron Balls</td>
<td>Plastic (diff shape/function)</td>
<td>Charcoal</td>
<td>Ghee</td>
</tr>
<tr>
<td>Iron Cube</td>
<td>Rubber</td>
<td>Soap</td>
<td>Butter</td>
</tr>
<tr>
<td>Iron Cylinder</td>
<td>Wax</td>
<td>Sandal</td>
<td>Gel candy</td>
</tr>
<tr>
<td>Iron Mesh</td>
<td>Carbon rod</td>
<td>Moth Balls</td>
<td>Peanut Butter</td>
</tr>
<tr>
<td>Iron Nails</td>
<td>Ebonite rod and cube</td>
<td>Brick</td>
<td>Cheese</td>
</tr>
<tr>
<td>Iron Spring</td>
<td>Card board</td>
<td>Sand</td>
<td>Hair gel</td>
</tr>
<tr>
<td>Iron filings and turnings</td>
<td>Ceramic and clay</td>
<td>Stone (diff types)</td>
<td>Fabric Paint</td>
</tr>
<tr>
<td>Weight Grams</td>
<td>Cotton/cloth</td>
<td>Sugar</td>
<td>Agar Agar</td>
</tr>
<tr>
<td>Iron Wire</td>
<td>Seeds</td>
<td>Flour</td>
<td>Water</td>
</tr>
<tr>
<td>Iron rod</td>
<td>Marble (Sphere and Bar)</td>
<td>Turmeric Powder</td>
<td>Shampoo</td>
</tr>
<tr>
<td>Iron sheet</td>
<td>Papers (diff type)</td>
<td>Custard Powder</td>
<td>Honey</td>
</tr>
<tr>
<td>Brass (diff shape/function)</td>
<td>Pebbles</td>
<td>Salt Crystals</td>
<td>Coconut Oil</td>
</tr>
<tr>
<td>Copper (diff shape/function)</td>
<td>Sponge</td>
<td>Baking Powder</td>
<td>Ink</td>
</tr>
<tr>
<td>Lead (diff shape)</td>
<td>Tablets</td>
<td>Sugar Cubes</td>
<td>Water</td>
</tr>
<tr>
<td>Glass (diff shape/function)</td>
<td>Tablets</td>
<td>Salt Powder</td>
<td>Brown Syrup</td>
</tr>
<tr>
<td>Steel (diff shape/function)</td>
<td>Iron/copper Filings</td>
<td>Iron/Copper turnings</td>
<td>Pink syrup</td>
</tr>
<tr>
<td>Wood (diff shape/function)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermo Cole (diff shape)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
to be decided for classifying the materials. As they started to form the group they
were asked how they were deciding which went together. Children were asked to
write a name and criteria for classification of each the group formed on a piece
of paper and keep it near the group.

**Mode of data collection:** The task was video and audio recorded. Notes
were taken down. Children’s conversation during classification task was noted
down for the purpose of framing questions for Piagetian Clinical Interview
conducted at the end of the task. The way in which children grouped the
materials were also recorded.

The method of classification, how they act on each material and the remarks
made by the children would be noted down while they classify. The important
aspects that were observed during the tasks:

- Criteria used to classify the materials and characteristics discussed
- Classification of materials made of different substances
- Description of the given objects and substances
- Differentiation of object and substance
- Differentiating properties of materials in the set, discrimination between
  properties that are specific to an object and those which are common
to the set
- New encounters with the object or substance
- Comparisons made
- Ability to recognize a particular substance in various materials
- Action performed, how they test materials
- Peer Group interaction.

After assigning categories to the entire materials, clinical interview was
conducted with the group around the name and characteristics of the categories
formed, and characteristics of materials in each category etc.

**Sample Questions to Begin the Piagetian Clinical Interview**

_Tell me the name of your groups and characteristics of each group?_

_What are the characteristics common to the materials in each group?_

_Which material represents group 1 the best?_

_Is there only one property that is common to the materials in this group or is
there more than one property?_
What are the differences between group 1 and group 2 materials? Any common property between the groups? Or combination of groups?
What are the materials you wish to include in this group(x) of materials? Do you think any particular materials with some other properties are absent here? If I tell you to add five materials to this group of materials which are the one you will add and why?
Now can you think of any other ways of classifying these materials?

**Task 2: Matter, Substance, Solid Liquid and Gas**

**Aim**

To explore children’s knowledge of the term matter, substance, solid, liquid and gas:-meaning, definition, examples and properties

**Table 3.2: Tasks conducted with children**

<table>
<thead>
<tr>
<th>Task Description</th>
<th>Administering the task</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Define Substance</td>
<td>Worksheet Based Tasks</td>
</tr>
<tr>
<td>2 List example and properties for Substance</td>
<td>Initially children were directed to write five examples, after the completion of which encouraged to write maximum known to them</td>
</tr>
<tr>
<td>3 Define Solid</td>
<td></td>
</tr>
<tr>
<td>4 List examples and properties for solid</td>
<td></td>
</tr>
<tr>
<td>5 Define Liquid</td>
<td></td>
</tr>
<tr>
<td>6 List examples and properties for liquid</td>
<td></td>
</tr>
<tr>
<td>7 Define Gas</td>
<td></td>
</tr>
<tr>
<td>8 List examples and properties of gas</td>
<td></td>
</tr>
<tr>
<td>9 Sort the given names of materials in to Solid, Not solid, Like Solid, I don’t Know</td>
<td>The names are read and children were directed to put name the under the appropriate category</td>
</tr>
<tr>
<td>10 Pick the best solid from the group of given solids</td>
<td>Activity and Interview</td>
</tr>
</tbody>
</table>
Sample Questions of Piagetian Clinical Interview

Piagetian Clinical Interview I

Matter, Substance and Object: Definition, meaning, characteristics and Examples
Have you heard the word matter?
What is matter?
Can you tell the meaning?
What are the examples for matter? What are the properties of matter?

Substance (Padartham)
Can you tell me what a “substance” is?
When I say the word substance what comes to your mind? Where did you hear this word?
Tell me some examples for substance
What are the substances present in this room? Outside the room?
What are the characteristics of a substance?

Object
Can you tell me what an object is?
What are examples for object? What are the objects in this room?
What are the characteristics of object?
Is gold a substance or an object?
Is there any difference between a substance and an object?
Picking substance and object from the group of given items: Empty bottle, wooden piece, Cloth piece, Stone, Cotton, Sugar, Salt, Pen, iron powder, steel tumbler
Can you pick the one which you consider as example for substance? Can you pick the one which you consider as example for object?

Questions based on the worksheet.
Reading out the examples from the work sheets. Asking for each others agreement for the answers on the worksheet. (Do you agree with X’s example of substance? Do you think anything else can be included in his/her list —— also in your list of examples?)
Providing new examples and asking whether it can also be included in the list.
Is air a substance? Does air occupy space? Does it weigh? How will you find out whether air have weight or not?
Can you tell me the name of something that is not a substance?

Piagetian Clinical Interview II

Solid, liquid and Gas: Definition, meaning, characteristics and Examples

Solid
What is a solid?
Examples? Examples in this room? Outside the room?
Are the following solids? Hair, thread, thin wire, flour, Iron filings, Charcoal, Salt crystals, Cotton, Cloth, Silk, Chalk Piece, Paper, Candle, Feather
Which is the best example for a solid? Why do you consider the above as the best? What are the properties/characteristics of the best solid?
Why solids are hard? Why some solids are hard some not hard?
Can you break a solid?
Why it is easier to break the chalk piece than an iron piece?
Why is it easy to dissolve sugar in water?
I want to hammer a nail inside a solid material? To which solid material can I hammer in a nail easily? Why?

Liquids
What is a liquid?
Examples for Liquid
Properties of liquid
Why do liquids flow?
What is inside a drop of liquid? If I look to a drop of liquid using a microscope what will I see?

Gas
Definition, Properties and Example
What is the shape of gas?
Does it have weight?
How will you find out whether air has weight or not?

Solid Liquid and Gas
What is the difference between solid liquid and gas?
Pick the best solid from the group of given solid/ classify the given solids
Endnotes

1 Children till 8th standard are not familiar with the word. Hence it is difficult to proceed further beyond asking the meaning and familiarity of the word during the interview.