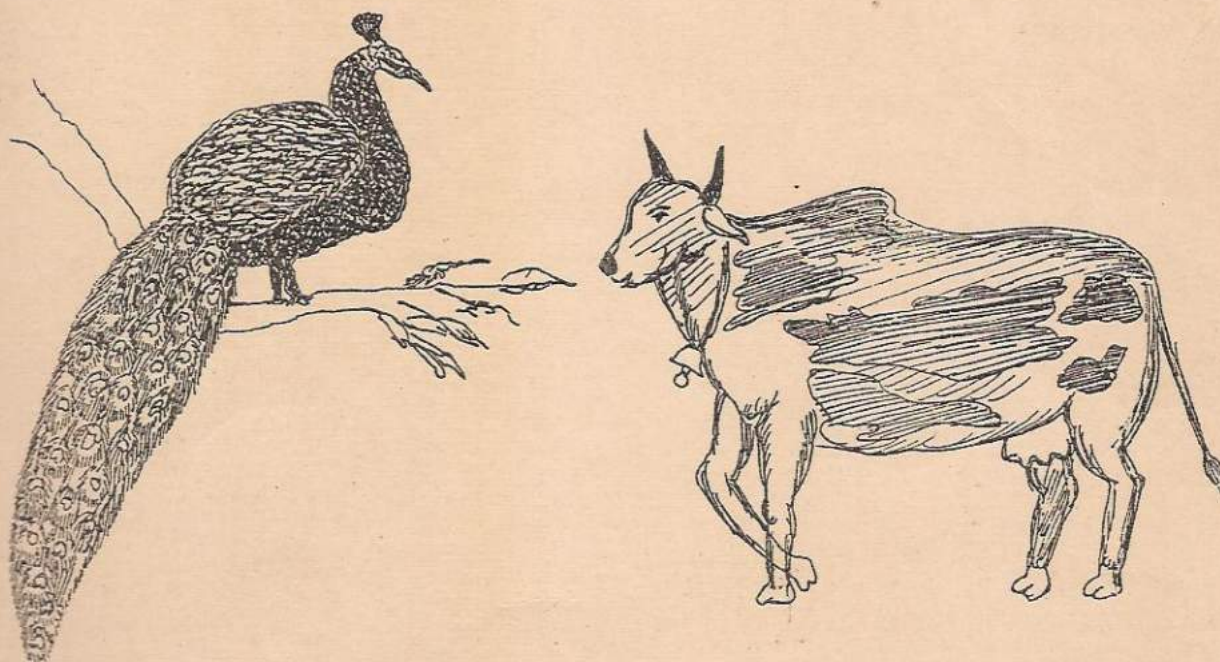**Diagnosing Learning in Primary Science**

DLIPS Report - Part 1

Students' Ideas Related To Living And Non-Living

Sugra Chunawala, Swapna Apte,
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About the DLIPS project

1.1 Students' spontaneous conceptions

A student entering the science classroom has a number of previous experiences, ideas, beliefs and expectations about the natural world. The content taught in the classroom is interpreted by the student in the light of this prior knowledge. As a result of new experiences, mental representation of knowledge undergoes gradual restructuring. Yet, even after formal instruction, students' spontaneous conceptions often remain at variance with accepted scientific ideas. Considering the wide prevalence and the persistence of such conceptions, they have been labelled *alternative conceptions* [5]. Research all over the world has gone into explicating alternative conceptions in different groups of students, and drawing their implications for learning [13].

It is fairly well recognised now that alternative conceptions cannot be easily replaced by correct scientific ideas. One way of looking at this resistance is to imagine that students' conceptions form an interconnected system of beliefs: about the nature of science, of school, of learning, and of the world around. Any one of these beliefs cannot simply be treated as a scientifically inaccurate idea that is easily corrected. That idea has to be understood in terms of a more general world view held by the student, and it has to be also tackled from that perspective.

Knowledge is constructed through interaction with the physical as well as the social environment. Alternative conceptions therefore need to be seen in terms of the context of learning, including the socio-cultural and linguistic background of students, and its relation to the classroom climate. This is what the DLIPS Project set about to do.

1.2   Diagnosing Learning in Primary Science

At the Homi Bhabha Centre for Science Education (HBCSE), research into students' learning has been going on in a consistent way over the last several years. The project 'Diagnosing Learning in Primary Science (DLIPS)' was taken up during 1993-96. The first two years were devoted to data collection, and the third to analysis and writing.

The aim of DLIPS was to diagnose the alternative conceptions of students in a few topics of the curriculum related with their natural environment, to examine these ideas in the light of some socio-cultural and linguistic factors, and to develop the pedagogical implications of these findings.

Prior research on alternative conceptions has been largely done in the developed countries. Consequently, little is known of cross-cultural variations in general, and about conceptions of Indian students in particular. Students in India grow up in a variety of economic and socio-cultural backgrounds. Although in school they follow a common curriculum, research and other observational evidence suggests that the experience of schooling may actually differ for students from differing home backgrounds. Similarly, girls and boys may experience school in different ways, as a consequence of the differing attitudes and expectations of the society, and of the teachers who are part of the society. It is possible that these factors shape their alternative conceptions.

Other influences on students' world views might arise from their life-styles and their environmental experiences. Finally, the curriculum and textbooks would have their own role to play in shaping students' ideas. Our documentation of alternative conceptions was motivated by these rather complex considerations. Thus we looked in our data for gender differences in alternative conceptions as well as for culturally and linguistically interpretable ways of thinking.

The study was done with middle school students from generally deprived socio-economic backgrounds. Our experience has been that these students, particularly in the school situation, are not used to expressing their own ideas freely. Therefore, instead of using paper-and-pencil tests and clinical interviews that are the usual stock-in-trade of such research, innovative methods were developed for eliciting students' conceptions. These involved regular interaction with students in their classroom over two years, rather than occasional visits for data collection. Through the medium of classroom discussions along with a variety of written tasks, games and activities, students were encouraged to express their ideas related to a given topic. The data analysis was largely qualitative, with testing for statistical significance where appropriate. The results are described in a series of three technical reports:

1. Students' ideas related to living and non-living (DLIPS Part 1)

2. Students' ideas about plants (DLIPS Part 2)

3. The role of experiments in school science (DLIPS Part 3)

1.2.1 Sample

The data was collected over two academic years during which the researchers interacted with students from three residential schools, one in Mumbai city (*Urban*) and two tribal schools in rural areas (*Tribal*) in the Konkan region of Maharashtra State. The urban school is run by a charitable organisation and has a mix of (a) day scholars from poor and lower middle-class families, (b) students belonging to an orphanage, and (c) students institutionalised for vagrancy or delinquency. The school allowed us three class periods per week for interaction with the students. Each class was visited about once per week.

The tribal residential schools or *Ashramshalas* are run by the Tribal Welfare Department of Maharashtra State, in response to the problem of educating children of migrant tribes living in remote hilly areas. Most of the students belong to the larger tribes in the region, such as *Katkari*, *Mahadev Koli* and *Thakur*. Their parents generally make a living by marginal farming, agricultural labour, hunting, food gathering, selling firewood, charcoal and catechu. The Tribal Department allowed us to spend one working day (about six hours) per month with each class.

Both urban and tribal students belonged to grades 5 and 6, and ranged in age from 10 to 15 years. About a hundred students each in the tribal and urban groups participated in the study. The ratio of girls to boys was about 1:2 in the urban school and 1:4 or less in the tribal schools, reflecting a severe gender bias in schooling opportunities. The gender ratio decreased further in the higher grades. The medium of instruction was Marathi, the language of Maharashtra State. The tribal students' mother-tongue was a dialect of Marathi.

1.3   Overview of results

The study was done in the context of a science curriculum which is sometimes excessively formal in its approach particularly when seen against students' spontaneous conceptions. The treatment of "living things", "plants" and "experiments" clearly illustrated the shortcomings of this approach. In all of the topics investigated, we

found a mismatch between textbook science and students' conceptions. Nevertheless, the conceptions held by students did show some internal coherence and also consistency within groups of students. Analysis of these ideas led to insights into the nature of learning difficulties in school science.

1.3.1 Living and non-living

Students had their own spontaneous criteria for distinguishing between living and non-living, though these criteria varied with the task context. There was a tendency to mistake non-living for living ('animism') and vice versa ('inanimism'). Natural but non-living objects and phenomena (like the sun, earth and water) were likely to be judged living by students, while human artifacts were less likely to be thus mistaken.

Tribal students displayed better ability to make scientifically correct judgements of life, than did urban students: contrary to the common notion that tribal people are animistic. Gender differences were noticed in the types of non-living objects cited by students, and in their judgements of life and non-life. Girls were found to be more person-oriented, anthropomorphic and animistic.

Students often believed that seeds, eggs and bulbs were non-living, showing up two unexpected alternative conceptions: that a living thing can become temporarily non-living, and that the transition back to living might imply a vital force! What was even more striking was that all the six teachers involved in the project also believed that seeds are non-living. Ambiguous examples from the environment were found useful in clarifying the criteria for life for students and teachers.

Socio-cultural variations in students' ideas about living things might also be related with their attitudes. Tribal students were found to be more positive about plants than animals while urban students preferred animals. The preference for trees amongst the tribals is consistent with the fact that in tribal cultures, there is a direct dependence on plants for survival, shelter, food and medicine. Overall, the tribal students' attitudes reflected their environment and lifestyles, while the attitudes of the urban students seemed shaped by their knowledge through books or stories.

Confirming some common stereotypes, girls expressed dislike towards animals of the lower classificatory order — insects, worms and lizards — more than boys did. "Relation to humans" was the most important factor in determining preference, followed by *appearance* and then *image*. Taking cognizance of students' preferences in designing learning activities would, we believe, improve the quality of instruction in biology.

1.3.2 Plants and forests

Students' ideas about plants were seen to be influenced by physical and social settings and by textbooks. Mere presence of plants in the environment did not result in students being aware of them. Everyday use of, and interactions with, plants and plant products had a greater influence on students' ideas about plants.

For example, despite having a large variety of vegetable plants around the *Ashramshalas*, tribal students chose to describe fruit trees, flowering trees, garden plants, and other trees and plants of local social, medicinal and religious significance. On the other hand, urban students who had many of the above trees around their school, preferred to describe only a few typical fruit trees and common garden plants. Overall, the variety of plants described by tribal students was much larger.

There was a wide gap between students' spontaneous ideas about plants — which were varied and rich in ecological content — and the knowledge in the textbooks. Tribal students incorporated in their drawings of plants and forests, many features that reflected their understanding of ecology, like leaves floating to the ground, a sapling near the tree, or humus, twigs and logs on the ground, food webs, and other interdependences in the forest ecosystem. Tribal students' keen observations were further evidenced in the many instances they gave of seasonal features, like references to time of flowering, shedding and sprouting of leaves, etc.

In contrast to textbooks, students gave few detailed structural descriptions, focusing rather on gross shapes. Tribal students drew realistic pictures of a large variety of fruit, flowering and other forest trees, often correct in placement of leaves, fruits and flowers. They frequently expressed their feelings towards plants, unlike textbooks, which tend to underplay feelings. Tribal students tended to relate their feelings about forests and individual trees to their uses. The uses which they gave compared well with those cited in advanced botany textbooks.

Textbooks however depict very few whole plants or trees, nor do they incorporate affective or ecological features in the pictures they do give. Classroom intervention is necessary here. The study of botany can become meaningful to students only if ecological features, seasonal variations and affective factors are woven into classroom teaching through appropriate activities and interactions that highlight the relevance of this knowledge in everyday living.

1.3.3   Experiments

This study was concerned with some conceptual problems arising while teaching science through experiments. In it, an analysis of the role of experiments in science and in pedagogy was combined with empirical data on textbooks and on students' perceptions of experiments.

The empirical study showed that students used the idea of experiments in a variety of contexts, thus over-generalising it. On the other hand, in the case of specific experiments related to science, students sometimes felt that only scientists or teachers could do experiments. They did not connect an experiment to a question or hypothesis.

Given an experiment and a set of questions, students had difficulty relating one to the other. Students freely drew unwarranted conclusions from experiments. Sometimes, they had difficulty in distinguishing their own beliefs about the phenomenon, from the evidence presented by the experiment.

The hypothetico-deductive view that is presented by science textbooks has many difficulties associated with it, some endemic to experimentation in science, others arising from cognitive limitations and pedagogical needs. Textbooks themselves were found to be guilty of obscuring the connection between experiments and questions by calling for very high levels of inference, often leading to untenable conclusions.

In the context of Indian schools, the idea of experiments as activities performed by people in authority, perhaps only reflects the actual state of affairs. Similarly, the over-generalisation of the word "experiment" is to some extent also present in textbooks. The models of experimentation held by students and those presented in textbooks were found to differ from scientists' and philosophers' models of experimentation. Each of these however, has aspects that can help us to formulate desirable models of experimentation for science learning.

Four papers based on this work were presented at the Second International Symposium on Cognition and Education at Varanasi in December 1995. The DLIPS project will form an input into the writing of textbooks for primary science, which is   being undertaken in 1996.

Chapter 2

Introduction to students' ideas about living and non-living

The topic of life (living and non-living) forms a major theme in primary school. It is introduced in the Maharashtra state schools in the grade 3 science textbook. Science as a subject is also differentiated from other subjects and presented for the first time in schools at the same time. The topic of living/non-living is repeated at grades 5 and 6, with additional aspects, such as, the criteria for determining life.

Research on students' ideas about life has a long history and the attribution of life to inanimate objects is a matter that has been of interest to anthropologists and developmental psychologists. In 1914, Marett called this attribution *animatism*, while Tylor in 1871 used the term *animism* to refer to the attribution of spirits to objects [7].

Although anthropologists had observed these tendencies in adults, Piaget [14] considered *"animism"* (in the broader sense of attributing life to inanimate objects) to be a developmental indicator, with children passing through four stages: from using any activity to judge life, through using movement, then spontaneous movement, and finally, at age 11+, identifying only plants and animals as living beings. Piaget related these stages to the child's gradual transition from intentional to mechanical causality.

Piaget's ideas have been challenged in several ways. It is now known, for example, that ideas of mechanical causality develop early [1]. Babies at 3 months are capable of perceptual differentiation between biological and non-biological motion, and a primitive concept of *animal* develops even during infancy [8]. Animistic notions have been found among children of all ages, and even adults. Dennis and Russell

who studied animism extensively and longitudinally found that animism decreased as their subjects became older, yet even their oldest subjects continued to attribute life to some inanimate objects.

Brainerd[2] cited a review by Looft and Bartz to conclude that between 50% and 75% of adult subjects may be expected to attribute life to some inanimate objects. University students display animism to almost the same extent as less educated adults. The issue of adult animism has never been properly reconciled with the developmental data. Adult animism is sometimes said to arise from emotional and affective factors rather than cognitive ones (Kathleen Fisher, private communication).

Several studies of animism have involved school and university students who had been taught the biological criteria of life [17] [3] [19]. Tamir and others investigated students studying in grades from 3 to 9, and found that students classify animals as living more often than they do plants, while seeds and eggs are even less often classified as living. Movement and growth are the most common indicators of life. Older students more often used biological attributes such as, nutrition, respiration, growth and death as indicators.

Brumby [3] in her work on the concept of life held by university students studying biology, concluded that the formal characteristics of life, namely, growth, reproduction, external respiration, nutrition, excretion, irritability and locomotion are rote-learned by students. In unfamiliar contexts, students were unable to apply these seven characteristics to the problem set before them. Of the seven, the characteristic of "movement" dominates students' explanations. Brumby found that even after several years of school learning, students' perceptions of life were anthropomorphic.

Carey's [4] developmental studies with students aged 4 − 10 years identified two main sources of animistic responses: semantic problems for very young children, and inadequate biological knowledge for the older ones. Probing into children's justifications for life, she showed that they used multiple criteria, different from the simple ones assumed by Piaget.

Watts and Bentley [19] have tried to argue for a positive value to animistic and anthropomorphic ways of thinking in school, especially with regard to females. According to them, students do use animistic and anthropomorphic approaches to science though in a covert manner. They feel that such approaches could lead to beneficial pedagogic strategies. However, gender and socio- cultural differences in this area have not been extensively studied.

The phenomenon of animism has implications for the representation of biological knowledge about life. Given that judgements of life or non-life may derive from very

complex considerations, it is necessary to go beyond simple responses. One needs to look at patterns of judgements across contexts, and to study students' justifications, rather than simply their judgements. The latter approach is limited by the possibility that justifications may sometimes be post-hoc: one cannot always assume that they reflect directly the actual production process; but we hope that they do provide a close approximation.

Most animism studies look at judgments of non-living objects as living; the opposite tendency, that is, judging living things as non-living, is generally understated. Given that we are looking at knowledge representation and the process of arriving at judgements of life, such discrimination is not justified. The opposite tendency, which we term "inanimism", provides equally interesting insights into ideas about life. It enables us to focus, in a limited way, on students' views of transitions between life and non-life. The present study is done with Indian students who have formally studied the biological criteria of life. It looks at socio-cultural variables that have been identified before but not studied extensively, namely, gender, and belonging to tribal or urban groups.

Chapter 3

Methodology

3.1 Sample

The sample has been described in chapter 1, section 1.2.1. About two hundred students from one urban and two tribal residential schools in grades 5 and 6 participated in the study. These students had been taught the distinction between living and non-living in their science curriculum in grades 3, 4 and 5. In the first science lesson of grade 5, they were exposed to the biological criteria for life, namely, *respiration*, *growth*, *reproduction* and *responsiveness to stimuli*.

3.2 Experimental tasks and sample sizes

Task 1 Examples of living/non-living: Students were asked to give one example each of a living and a non-living object. Urban 109 students (37 Girls + 72 Boys).

Task 2 Questionnaire on living/non-living: Students had to judge 20 items as living or non-living and give reasons for their answers. Pilot questionnaire 111 students (Urban): 37 Girls + 74 Boys; Final questionnaire 302 students: Urban 203 (76 Girls + 127 Boys); Tribal 99 (31 Girls + 68 Boys).

Task 3 Why I am alive?: Students had to write reasons to support the assertion that they were living. Urban 91 (43 Girls + 48 Boys); Tribal 41 (11 Girls + 30 Boys).

Classroom discussion: Ambiguous examples of living/ non-living were discussed in the course of classroom sessions. The sessions lasted about half an hour in the urban school (two fifth grade classes) and one hour in the tribal schools (fifth and sixth grade classes). Each division in the urban school had around 50+ students and less than 20 of them were girls. In one of the tribal schools the two grades were combined, while in the other they were separate (there were about 30 students per grade, one third of them girls).

Task 4 Rice questionnaire : Having found that an embryo or seed was frequently thought to be non-living, a questionnaire was framed on grains of rice at various stages, requiring the students to judge them to be living or non-living, with reasons: Urban 61 (28 Girls + 33 Boys); Tribal 99 (32 Girls + 67 Boys).

Task 5 Rice interviews: Individual interviews on the rice questionnaire Urban 8 (6 Girls + 2 Boys); Tribal 13 (3 Girls + 10 Boys).

Apart from these tasks, other methods which were less data intensive were also used to understand students' ideas about living and non-living. These were:

1. A game wherein students were divided into teams, and had to name the living in air, water and on rocks.

2. A game based on "dumb charades" where a student from one of two teams had to mime a living or a non-living object (suggested to them by the other team) and the team members had to guess the object.

3. An activity of collecting and looking after living things.

4. Activity of observing a living creature, writing about it and drawing it if possible.

5. A slide show about various living beings for both the tribal and urban students

The details of these less data intensive methods are provided in Appendix D.

3.3   Classifying criteria for life

Given our predominant interest in students' justifications for life and non-life, a suitable classification system had to be devised. For Tasks 1 and 2, we found Carey's [4] system, with a few modifications, adequate. The examples derive from our own

data. The starred categories are our additions to Carey's original system. The system needed minor modifications for Task 3 which involved giving reasons for oneself being alive.

I(a) - Use: (Reasons for living/non-living are based on the usefulness/uselessness of the object)

Carey's : A table is alive because you can eat on it.

Ours : Mud is non-living as it can be used to make toys.
A ship is non-living as it is used for transportation.

I(b) - Facts: (Facts are stated as reasons for something being living or non-living)

Carey's : A mountain is not alive because grass grows on it.

Ours : Soil is non-living as it has small particles.
A peacock is living as it is red in colour, and is very beautiful.

I(c) - Existence: (Existence of an object is used to justify it as living/non-living)

Carey's : Trees are alive because I've seen them.

Ours : A cloud is non-living as it is in the sky.

I(d) - Tautology: (An object is justified as living by reiterating that it has life)

Carey's : nil

Ours: An ant is living because it has life.

II(a) - Movement: (Reasons for living/non-living are based on the movement or the lack of it demonstrated by the object)

Carey's : A mountain is alive because it just stays there.

Ours : A butterfly is living as it can move.
An idol is non-living as it cannot go from one place to another.

II(b) - Activity: (Activity of an object is used to justify life)

Carey's : A clock is alive because it goes tick-tock.

Ours : A tiger is living because it growls.

II(c) - Non-living inspite of activity (An object is said to be non-living despite it displaying activity)

Carey's : nil

Ours : A paper kite can fly but still it is not living.

III(a) - Anthropomorphic trait: (An object is judged as living or non-living because of the presence or absence of human-like qualities)

Carey's : A watch isn't alive because it does not have eyes.

Ours : A pencil is non-living as it cannot speak.
Wire is non-living as it cannot eat.

III(b) - Comparison to people/living things: (An object is judged as living or non-living on the basis of comparison to people)

Carey's : A bird is alive because I am.

Ours : An ant is living as it needs air water, same as man needs, lives in the same way as man.

IV(a) - Built by people: (Human intervention justifies living/non-living)

Carey's : A car is not alive because people made it.

Ours : A pencil is non-living as it has a shape given by us.

IV(b) - Autonomous motion: (Any object which demonstrates independent movement is judged living, while those that do not are judged non-living)

Carey's : A bicycle isn't alive because you have to pedal it.

Ours : A goat is living as it can walk.
A pen is non-living as it cannot move by itself.

IV(c) - Any intervention required from some external agent: (If external intervention is required for something then the object must be non-living)

Carey's : nil

Ours : Fire is non-living as it cannot light itself.

V(a) - Biological processes are necessary for life: (Growth, Death, Reproduction, Responsiveness to stimuli, Need for air / water / food)

Carey's : A tree is alive because it grows.

Ours : Vines are living as they can grow.
Mountains are non-living as they do not respond to stimuli.

V(b) - Composition (The composition of objects, biological and chemical, is important if they are to be judged living)

Carey's : A cloud isn't alive because it's just made out of water.

Ours : A bench is non-living as it is made up of wood.

Chapter 4

Results on living/non-living

4.1 Task 1: Examples

Students of grade 5 (age 10–13) studying in the urban school, were asked to write down one example of living and one of non-living. This task was undertaken after the students had been exposed to the lesson on living and non-living in their textbooks and in their classrooms. The task was undertaken first in division A, and it was realised that the examples given by students were either bookish or not related to their environment. Hence in division B, the students were specifically asked to give examples from their environment. Of the total sample almost half were studying in division A and the other half in division B. Sex-wise, there were less girls than boys. This gender difference existed in the classrooms and was greater in division B, which contained institutionalised children.

Table 4.1: Sample of urban students who undertook Task 1

Division	Girls	Boys	Total
A	24	35	59
B	13	38	51
Total	37	73	110

More than one example was given by some of the students. Thus, the number of responses given by students rather than the number of students has been used for the statistical analysis. The 37 girls gave 41 responses for living and 40 responses for non-living, while the 73 boys gave 76 examples of living and 73 for non-living. Table 4.1 presents the sample size for Task 1.

4.2 Examples of living

4.2.1 Categorisation of the examples

The examples for living given by students were classified as animals and plants. The "animal" category was further sub-divided into, mammals, birds, reptiles and insects. Also recorded was the number of times students stated humans as living. Table 4.2 presents students' responses to the task.

Table 4.2: Examples of living mentioned by girls and boys of urban school (5A and 5B)

Categories	Girls r	Girls %	Boys r	Boys %	Total r	Total %
Mammals	17	41	30	39	47	40
Birds	11	27	24	31	35	30
Trees	4	10	6	8	10	9
Insects	4	10	6	8	10	9
Reptiles	3	7	8	11	11	9
Human	2	5	2	3	4	3
Total	41	100	76	100	117	100

r refers to responses

Table 4.2 shows that exemplars of living things selected by students were more likely to be animals (91%) than plants (9%). This is consistent with results from Tamir, Gal-Choppin and Nussinovitz [17] and Carey [4]. Within animals, mammals was the largest category, followed by birds. The mammals tended to be large ones like tigers, lions and wolves, generally encountered only in stories and zoos. The various lower animals that city students are exposed to, such as, rodents, flies and insects, were rarely mentioned. Within mammals, humans were cited least often (3%).

4.2.2 Comparison with Susan Carey's data

An interesting contrast to these results is found in the study conducted by Carey [4]. Carey had asked students to give examples of some things that are alive, as well as, some things that are not alive. She calls the first "living" and the second "not alive". Her sample was younger than ours and the sample size was small. It consisted of ten students each at the age of 4, 7 and 10, totally 30. The students were studying in an elementary school in an upper middle class suburb of Boston and a nursery

school for the MIT community. She too found that animals are more often reported by students in examples of living as compared to plants. But a striking contrast with the present work, was that in her sample, "people" was the largest response of the students (16 responses from 27 of the 30 students who gave examples of living). In our study however, "people" was the least mentioned category for living. Perhaps the Indian students tended to see this as a textbook-based task, and hence looked for ideal exemplars, rather than appealing to their experience. This cross-cultural difference may also have to do with differing concepts of "self" in the two cultures.

4.2.3 Differences between groups: (Gender and Division)

We found no statistically significant gender differences in the number and kinds of examples of living given by students. Table 4.3 presents the z test values for the differences in the responses between girls and boys.

Table 4.3: Differences between girls and boys in the number and kind of examples given

examples of living	girls r=41	boys r=76	z values
% of trees	10	10	0.35
% of mammals	41	39	0.21
% of birds	27	31	-0.46
% of insects	7	8	0.36
% of reptiles	5	11	0.74
% of humans	8	3	0.79
Total %	100	100	

r refers to responses

In administering the task in the urban school, division A was simply asked to give examples of living and non-living, while division B was asked to restrict their examples to the immediate environment. Some differences were therefore expected in their responses. Table 4.4 presents this data.

Table 4.4 indicates that in the examples for living given by the students of the B division, birds were mentioned most often (36% of all responses) while mammals were mentioned most often in the A division (56% of all responses). Birds, trees, insects and reptiles were stated more often by 5B students, but the difference was not statistically significant. Thus, restricting examples to the immediate surroundings served to reduce significantly the number of mammals stated by students. However, factors other than instructions given could be responsible for the difference in response in the two groups. The two groups of students also differed in terms of their

Table 4.4: Examples of living from students in two divisions of urban school

Categories	5A		5B		z values
	r	%	r	%	
Mammals	33	56	14	24	3.74 *
Trees	3	5	7	12	-1.36
Birds	14	24	21	36	-1.43
Reptiles	5	8	6	10	-0.38
Insects	3	5	7	12	-1.36
Humans/people	1	2	3	5	0.88
Total	59	100	58	99	—

* significant at the 0.01 level
r refers to number of responses

home backgrounds (the institutionalised children in 5B were generally considered less privileged).

4.3   Examples of non-living

Carey reports that the children in her study found it difficult to give examples of things that are not alive. Even at age 10, some children failed to provide examples of appropriate inanimate objects, and those which were provided included, 'dead animals' 'monsters' 'fairies' 'pictures' 'people on TV' 'dinosaurs', etc. In our study, students were able to give examples for non-living quite easily. However, while comparing with Carey's data it is necessary to keep in mind that the children in our study were older though coming from less privileged backgrounds and had more exposure to giving examples in class.

4.3.1   Classification of the examples

The non-living objects stated by the students appeared to be mainly of two kinds: objects of personal use, and objects of general use. Besides these, there were naturally found objects and also human artifacts. The "general-use" category had three sub-categories: "related to the school", "related to the home" and "related to both". Examples in these categories are given in Table 4.5:

Table 4.5: Classification of examples of non-living

1) **Articles of personal use**
   shirt, bangle, ribbon, button, shoe, etc.
2) **Articles of general use**
   i.*Related to school* : compass-box, school bag, blackboard, chalk, etc.
   ii.*Related to home* : house, bowl, plate, knife, pot, etc.
   iii.*Both* : table, chair, window, door, wall, fan, roof, tube-light, etc.
3) **Other human artifacts**
   aluminium, iron, metal sheet, wire, idols, ship, chain, etc.
4) **Naturally occurring articles**
   rock, soil, mountain, wing, wood, stone, thorns, etc.

4.3.2 Gender differences

Although there was no significant difference in the total number of examples of non-living given by girls and boys, there were significant gender differences in the types of examples (Table 4.6).

Table 4.6: Gender differences in examples of non-living (Urban Sample) N = 109: 37G + 72B

Categories	% Responses			
	Girls $r=123$	Boys $r=224$	Total $r=347$	z values
Personal Use	23	4	11	2.70 *
General Use	48	63	58	-1.54
Naturally occurring	15	14	14	0.14
Other human artifacts	15	19	18	-0.14

* significant at the 0.01 level

r refers to responses

In the responses of girls there were many more articles of personal use (23%) than in the responses of boys (4%). Although the responses of boys contained more objects of general use (63%) than the examples given by girls (48%), this difference was not statistically significant. Natural objects and human artifacts were given in equal numbers by girls and boys.

The finding that girls suggest more articles of personal use is in keeping with a large body of research that suggests that women are more person-oriented. Sex-differences in the object-person domain were demonstrated by Goodenough in 1957 [9]. She presented abstract mosaics to children and asked them to make up a story about

the pattern. Girls more often than boys talked about people, while boys more often talked about cars, trains, balls and other objects in their lives.

4.3.3 Differences in the two divisions

The examples for non-living stated by the students of 5A and 5B were compared. There were no significant differences between 5A and 5B students in the examples given. The results are presented in Table 4.7.

Table 4.7: Examples for non-living stated by students in 5A and 5B of urban school.

Categories	5A		5B		z
	r	%	r	%	values
Personal Use	9	15	3	6	1.597
General Use	34	56	31	60	- 0.430
Naturally occurring	8	13	8	15	- 0.305
Other human artifacts	10	16	10	19	- 0.418
Total	61	100	52	100	

r refers to responses

4.4 Criteria for life (Task 1)

Table 4.8 summarises the criteria for life used by students on Task 1. The last row reproduces data reported by Carey [4]. It is important to remember in any comparison that Carey's sample was younger and culturally quite different from our own. Statistical comparison between the two is not attempted since Carey's samples were very small.

In Task 1, movement (II) was the most frequent justification for life. Similar findings have been reported by Tamir, Gal-Choppin, Nussinovitz [17] and Carey [4]. The next most frequently stated reasons, however, differed from those found in other studies. These were reasons based on biological knowledge (V), including concepts of growth, reproduction and death.

Table 4.8: Criteria for life in Task 1.

Categories	Girls	Boys	Total	Susan Carey's Results	Girls-Boys t-test
n	37	72	109	30	—
r	123	224	347	—	—
	(%)	(%)	(%)	(%)	
I	12	11	11	18	0.33
II	27	33	31	33	- 0.61
III	18	11	14	25	1.28
IV	16	17	17	11	-0.01
V	27	27	28	13	0.12

n = No. of students
r = No. of responses
Categories (I - V) (See section 3.3)
Figures in bold represent the two most frequent categories stated

4.5 Task 2: Questionnaire on living/non-living

4.5.1 Pilot questionnaire

A pilot questionnaire containing twenty items was prepared to probe students' ideas about life. This questionnaire was prepared taking into account the knowledge of students, by using many of the examples cited by students themselves in Task 1. Especially selected were those items which were ambiguous. Other items, were taken from common daily life. Care was taken to read out the questionnaire, explain the task, and check through questions that the students had understood what was expected of them. The questionnaire was administered only in the urban school.

The items of the questionnaire could be categorised as follows:

Living	(tree, germs)	2
Non-living	(soil, cloud, water, river, sea, wind, air, mountain, sun, moon, earth, cycle, watch, candle, aeroplane)	16
Ambiguous	(vegetables plucked from a tree, a garland of flowers)	2

The items were also classified as naturally occurring or human-made.

Natural	(soil, cloud, water, river, sea, wind, air, mountain, sun, moon, earth, germs, tree, vegetables plucked from a tree)	14
Human-made	(aeroplane, watch, cycle, candle, garland of flowers)	5
Natural (may require human intervention)	(fire),	1

4.5.2 Sample for pilot questionnaire

This questionnaire was administered to 111 students in the Mumbai school in grade 5. Table 4.9 presents the breakup of the students.

Table 4.9: Sample of urban students who undertook Task 2

Division	Girls	Boys	Total
A	24	36	60
B	13	38	51
Total	37	74	111

4.5.3 Results of pilot questionnaire

The students were asked to classify each of the twenty items as living/non-living. Table 4.10 presents the responses of the students to the questionnaire as also a column titled "scientifically incorrect" response. This column contains our judgement of the adequateness of the response. (The questionnaire is given in Appendix A).

From the above Table, we see that students did have animistic notions as reported by other researchers: non-living and natural objects like the sun, moon, earth were stated by students to be living. However, students also demonstrated what we call "inanimism". This refers to the tendency to think that living and natural objects are non-living, example., trees, germs. This second trend has not been widely reported by other researchers, though Carey has reported instances of children judging some inanimate objects as alive. Inanimism and animism are both indicative of students' confusion in discriminating between living and non-living. Yet animism is more widely reported. This may be because animism is linked with 'primitive cultures', while inanimism is viewed as a pedestrian lack of the requisite biological knowledge. The pilot questionnaire convinced us that there was a need for many more items of living in the questionnaire to probe "inanimism". The other two examples of inanimism that are present in our data are actually very difficult, and do require

Table 4.10: Urban students' responses to items in the pilot questionnaire

Item	living %	non-living %	scientifically incorrect %
1. Natural and nonliving			
a) Soil	2	95	2
b) Cloud	8	89	8
c) Water	4	95	4
d) River	4	95	4
e) Sea	4	95	4
f) Wind	2	96	2
g) Mountain	1	97	1
h) Sun	29	65	29
i) Moon	27	66	27
j) Earth	36	55	36
k) Air	4	93	4
2. Natural and living			
a) Germs	80	11	11
b) Trees	75	17	17
3. Natural and Ambiguous			
or human intervention needed			
a) Garland of flowers	14	69	69
b) Vegetables in a basket	14	84	84
c) Fire	8	87	8
4. Human artifact			
a) Aeroplane	2	96	2
b) Candle	2	96	2
c) Cycle	2	97	2
d) Watch	2	96	2

sophisticated knowledge of biology ('vegetables in a basket' and 'garland of flowers'). In fact here there is no clear right answer in these cases.

The other striking finding from the table is that human artifacts, such as, aeroplane, watch, cycle, candle, which are non-living, are not mistaken by students. However, fire which can be perceived as both a human artifact or a natural event was often mistakenly judged by the students as living. Natural objects, for example clouds, were more prone to be erroneously judged alive by students rather than human made artifacts. Students thus find it easier to categorise as non-living those objects that are explicitly made by humans. Human intervention appears to be a covertly used criterion for non-life.

4.5.4 Final questionnaire on living/non-living

On the basis of the pilot test, a new questionnaire was prepared with twenty items. It was realized that the pilot questionnaire contained very few items which were living, despite which it evoked inanimistic responses from the children. This time it was decided to increase the items of living in the questionnaire. This was actually a difficult task as we had to identify those things which have life and yet are not obviously moving or making some noise. This was done by adding (to the tree and germs of the first questionnaire), items such as, various seeds (potato, onion, mango seed, a lentil-seed, that is, a whole moong seed), embryo (egg), moss and fungus. Overall, the items were selected for their potential for eliciting students' alternative conceptions, both animistic and inanimistic. In order not to present students with a forced choice between living and non-living, the final questionnaire also contained a third category: "not sure".

Of the 20 items, 11 were non-living, while 9 were living. Only one item was man-made, (aeroplane) while the remaining 19, are all found in nature. There was one difference in the items used in the tribal and urban settings. The last item of the questionnaire used with tribal students was 'rain' while for urban students, this item was 'sea'. This change was made because it was realised that most tribal students had heard about the sea but never seen it.

An important change in answering this questionnaire was made, that is, students were asked to write 'don't know' if they were unsure of the answer of any item. This would prevent students from attributing life or lack of it to objects in case they were unsure. The questionnaire is presented in Appendix B.

4.5.5 Sample for final questionnaire

This questionnaire was administered to tribal students as well as the urban students. Both the tribal and urban were studying in grades 5 and 6. The following table depicts the sample break-up.

Table 4.11: Sample for final questionnaire

	Girls	Boys	Total
Tribal	31	68	99
Urban	76	127	203
Total	107	195	312

4.5.6 Judgements of life (Task 2)

The responses of the students to the various items in the questionnaire along with differences by gender and rural settings are presented in Table 4.12.

The Table shows that while animistic responses were common for sun, earth, moon, clouds, water, rain, sea and split lentils, inanimistic responses were common for eggs, seeds, fungus, moss, potatoes, onions and whole lentils.

4.5.7 Tribal-Urban differences in responses

Comparisons between tribal and urban students as also between girls and boys are shown in Table 4.12 (% of inaccurate ideas is tabulated here). Interestingly, tribal students were more accurate than urban students in determining life in living things while boys were more accurate than girls in judging the absence of life in non-living things (earth, river, water, moon and sun).

Along with other items, the earth was termed living more often by urban students than the tribal students! This is surprising considering the common notion that tribal people are more attached to the earth and consider it is all life-giving. A significant point to note is that tribal students were less inanimistic, that is, living objects were recognised as such by them. An explanation for this could be the fact that tribal students placed in rural areas, have a greater contact with their environment and this improves their biological knowledge. The only inaccuracy shown more often by tribal students as compared to urban students was over the item rain/sea. However,

Table 4.12: Inaccurate judgements of life, (Task 2): gender and tribal/urban differences

Item	Girls 107 %	Boys 195 %	Urban 203 %	Tribal 99 %	Total 302 %	G-B z values	T-U z values	
Living:								
Less errors								
<= 10%								
Tree	0	1	1	0	0	-1.403	1.432	
Germs	9	10	10	8	10	-0.285	0.581	
More errors								
> 10%								
Mango seed	17	19	22	10	18	-0.436	2.865	*
Whole lentils	36	39	48	18	38	-0.517	5.752	*
Onion	39	30	43	91	57	1.567	-10.641	*
Potato	39	35	47	15	36	0.687	6.381	*
Moss	54	56	56	55	55	-0.334	0.164	
Fungus	66	69	75	55	67	-0.531	3.418	*
Egg	68	70	74	61	70	-0.359	2.246	*
Non-living								
Less errors								
<= 10%								
Aeroplane	7	3	3	6	4	1.453	-1.123	
Mountain	6	6	5	7	6	—	-0.670	
Soil	13	6	7	11	8	1.908	-1.105	
River	14	6	10	7	9	2.127	* 0.904	
More errors								
> 10%								
Rain/Sea	21	15	14	25	17	1.278	-2.206	*
Cloud	23	14	20	12	17	1.888	1.858	
Water	26	11	15	19	16	3.128	* -0.856	
Moon	32	18	26	18	23	2.650	* 1.620	
Split lentils	34	40	37	40	38	-1.040	-0.502	
Earth	42	19	31	19	27	4.154	* 2.350	*
Sun	43	21	30	26	28	3.925	* 0.733	

* = Significant at 0.05 level

G-B — Girls-Boys;   T-U — Tribal-Urban

this item was different for the two groups ("rain" for tribal students and "sea" for urban students).

4.5.8 Criteria for life

Students were asked to give one reason why they considered each item on the questionnaire, living or non-living. These reasons were categorised according to the classification mentioned in section 3.3 and the results are presented in Table 4.13.

Table 4.13: Criteria for life in Task 2.

Categories	Girls	Boys	Tribal	Urban	Total	G-B t-test		T-U t-test	
n	107	195	99	203	312	—		—	
r	1817	3204	1673	3348	5021	—		—	
	(%)	(%)	(%)	(%)	(%)				
I	**29**	19	**26**	**21**	23	3.09	*	8.21	*
II	17	13	14	15	15	3.60	*	-0.96	
III	10	10	4	13	10	1.57		-5.61	*
IV	2	1	1	1	0	1.66		-1.22	
V	**40**	**56**	**53**	**49**	**50**	-3.92	*	0.31	*

n = No. of students

r = No. of responses

Categories (I - V) (See section 3.3)

Figures in bold represent the two most frequent categories stated

*= Significant at the 0.05 level

G-B — Girls–Boys;   T-U — Tribal–Urban

Table 4.13 shows that in Task 2, the most prevalent criteria for judging life were the biological ones (V), followed by the criterion (I) which is a combination of "use", "fact", "existence" and "tautology". The prevalence of the "tautology" justification was curious, as also its greater appearance among tribal students. This may well be a consequence of the Marathi language, in which the word for living is *Sa-jeev*, or "with-life", and that for non-living is *Nir-jeev*, or "without-life". However, such a terminology also makes it plausible that the notion of having *jeev*, or "life", might be interpreted in an explicitly vitalistic way. This possibility was explored in Tasks 4 and 5.

Table 4.13 also points to some clear differences between the tribal/urban groups and a gender difference in Task 2. The Urban students gave more anthropomorphic (III) justifications than tribal students, who gave more use-oriented (I) justifications. Girls gave more responses based on use (I) and movement (II) compared with the boys, who

gave more biological (V) reasons for life. These findings were statistically significant despite the fact that the gender ratios were unequal in the tribal and urban samples.

The results indicate that the reasons or criteria utilised by the students to the largest extent was knowledge of biological aspects, such as growth and reproduction. Thus, something was living if it grew and reproduced and non-living if it failed to do so. This reason was followed by the criterion of movement. These results are somewhat different from the earlier data where movement was the most important indicator of life.

4.6   Task 3: Writing reasons to support one's being alive

The first two tasks demonstrated that students use multiple criteria for judging life, and that biological and movement criteria are predominant in their justifications. Task 3 was meant to explore the extent of this tendency towards multiple criteria, in a context that would encourage responses based on personal experience, rather than on the textbook. Asking students to justify why they themselves were alive might elicit a large variety of responses and provide insight into the basis of their justifications.

This task is apparently simple: students were asked to state whether they themselves are living or non-living. The answer was a categorical yes! They then had to write down as many reasons as they could think to support their answer. The catch lay in the terminology, write as many as you can. This forced students to write more than the answers typically given in the text-book. This task was undertaken in Mumbai (n=91, g=43, b=48) in grade 5 in both the divisions, and in the tribal region (n=41, g=11, b=30) in grade 6. This was a completely open-ended task. The responses of the students were classified in terms of the earlier mentioned categories and are presented in Table 4.14.

Although the number of responses was large (an average of 7 reasons were given by each student), the variety of criteria used was not significantly larger than the previous tasks - probably a result of the restricted task context. This particular task elicited a large proportion of anthropomorphic responses, especially from tribal students (each student gave approximately nine reasons).

The responses given most often by the tribal students were biological (36%), followed by anthropomorphism (33%) and movement (20%) while the urban students' largest responses were biological knowledge of growth /reproduction (55%), followed by movement (19%) and anthropomorphism (17%).

Table 4.14: Criteria for life in Task 3.

Categories	Girls	Boys	Tribal	Urban	Total	G-B t-test	T-U t-test
n	54	78	41	91	132	—	—
r	333	492	349	476	825	—	—
	(%)	(%)	(%)	(%)	(%)		
I	10	9	9	9	9	0.60	1.91
II	16	22	20	**19**	20	-2.84 *	3.23 *
III	21	26	33	17	24	-1.11	3.23 *
IV	0	1	2	0	1	—	—
V	**54**	**42**	**36**	**55**	**47**	3.34 *	-0.20 *

n = No. of students

r = No. of responses

Categories (I - V) (See section 3.3)

Figures in bold represent the two most frequent categories stated

* = Significant at the 0.05 level

G–B — Girls–Boys;   T–U — Tribal–Urban

Girls gave more biological responses (54%), followed by anthropomorphism (21%) and movement (16%); while boys also followed the same order of reasons.

Examples of the kind of responses given in this task are, 'I am alive because': I have blood circulating in my body (Facts); I have life (Tautology); I can move from one place to another (Movement); I can study (Activity); I can speak, eat (Anthropomorphism which in this case means human specific); I can move at my own will (Autonomous motion which in this case is nothing but voluntary movement); I can breathe / I can grow in height, weight (Growth, Death, Reproduction); I am made up of blood, bones, muscles, acids (Composition).

4.7   Classroom discussion

After completion of Tasks 1-3, discussions were held with students, with the aim of checking the consistency of their responses, and their ability to defend their view against counter-suggestions. Due to scheduling constraints, the time for discussion was about half an hour each for the urban groups and about one hour for the tribal groups. The major examples taken up during the discussion were, "aeroplane", "sun", "firefly" and "seed".

In the dynamics of this group situation, minority opinions were often suppressed. Thus, animistic ideas like those found in the written responses remained largely unexpressed, whereas students were more ready to defend their inanimistic ideas (eg. relating to seeds and bulbs).

Students were presented with seemingly paradoxical statements, like, "an aeroplane 'breathes' air and 'drinks' fuel"; "some people never reproduce"; "the sun moves without anyone pushing it"; "life on earth is possible only because of the sun"; "have you ever seen a firefly take food and water, or grow ?". They were able to counter these suggestions with arguments like, "aeroplanes never reproduce while most people do"; "fire too moves like the sun but it is non-living"; "light-bulbs give light and energy like the sun, and even help eggs to hatch, but we do not call them living".

In the case of the firefly, students often gave responses of the *activity* type - "it glows therefore it is living", while some students insisted that they had seen fireflies drink water. In this example, it appeared as if students had pre-judged their answer, perhaps on the basis of category membership, and were using biological criteria as post-hoc justifications.

The greatest confusion occurred in relation to seeds: whole, de-husked or cooked, and bulbs like onions and potatoes which are often seen sprouting inside the house in the monsoon season. In all these cases, the predominant idea involved a transformation, from living to non-living, and then back to living! Students maintained that seeds and bulbs "become alive" because they get *kas* ("essence", "nourishment") from the soil. Remarkably, all the teachers in these classes expressed similar ideas. The case of the seed was therefore thought to merit further study (see Tasks 4 and 5).

4.7.1   Tribal setting 1

The discussion in grade 5 of one of the *Ashramshalas* began with the example of 'aeroplane'. Students unanimously said that an aeroplane was non-living, but when asked to give reasons for their answer, there was silence. Some time elapsed before a student said "because it does not speak" (anthropomorphic reason). On being probed further as to whether all things that do not speak were non-living, students answered in the negative, but stated that the aeroplane was non-living as it did not eat or drink. They were contradicted by suggesting that perhaps fuel and water was food/water for aeroplanes. The students did not respond to this suggestion for a while, after which one student said that an aeroplane did not grow in size, nor did it reproduce, so it was non-living.

Germs were discussed next. There was a mixed response as to whether these were living. While some students thought germs were non-living, other students said that they were similar to pests like ants, cockroaches, etc. One girl added that they could be found in water and air and could enter a human body through these media. She added that germs were living as they could reproduce, resulting in many more germs.

The students were next questioned about the moon. They were absolutely sure that the moon was non-living, hence they were asked, how it showed movement if it was non-living. This was answered by a boy who felt that it was not the moon which moved but the earth's rotation which made it seem so. The students were next questioned about the earth. They said that it was non-living, but were not able to give any reasons for their answer. After some time one boy hesitatingly replied that the earth was non-living as it did not grow in size.

When asked their opinion about split lentils (*moong dal*) the boys said that it was living as it grew. The girls were better informed and contradicted the boys saying that whole lentils (*moong seed*) grew on planting but the *dal* did not. Hence split lentils were non-living while whole lentils were living. The discussion was continued with fungus which also generated a mixed response, and was ambiguous for the students. When asked if students had seen fungus, there was no response for a while, after which students said that it was white, black, or green in colour and was found on wet grain, *chapatti*, wood etc. When asked again whether it was living or non-living, students said that fungus was living as it grew in 'size'.

4.7.2 Tribal setting 2

Students were asked to state which of the examples in the questionnaire they had found ambiguous and their answers were, earth and sun. The students were then asked to form groups and to debate whether the sun is living or not, by using the various reasons they already knew. The grade 5 students had to argue for the sun as a non-living, and the grade 6 for it to be living. A grade 5 student started the argument saying that sun was non-living as it did not require food. This was supported by another grade 5 student who added that the sun was non-living, as it did not grow or reproduce. A grade 6 student countered by saying that the sun was living as it had movement. This argument was demolished by the grade 5 student who gave examples of many non-living things showing movement, such as, aeroplanes and fire.

The groups were asked if they knew about any thing which was alive but did not reproduce. There was no answer from the class. The example of old people was given to students. The grade 5 boy suggested that old people had finished their growth and

hence did not reproduce, whereas in the case of sun it was not growing. At this point, one of the researchers supported "the sun is living" hypothesis, and asked students how they could say that the sun was non-living when we see around us all kinds of life arising from the sun's energy (students stated that without the sun there would be no living things on earth). To support this point, a grade 6 girl said that the sun is living, as it gives out light and energy. One grade 5 boy said that the sun even if it gives out energy is not to be called living, just as we do not call a light-bulb living, though it too gives out energy and light. Another boy added to this, by saying that energy is responsible for the living that we see in nature, and not the sun. He gave an example to support his point: he said that an egg can hatch with energy from a light bulb, yet we do not say that the bulb is also living.

The students at this juncture were told to list the different characteristics of living. They came up with : 1) they grew in size 2) they reproduce 3) they breathe 4) they move about and 5) they ate food. It was pointed out to the students that they had missed out the characteristic of responsiveness to stimuli, which is present in their textbooks. Students were told that it was not necessary that all the characteristics would be applicable to all things in determining life.

4.7.3 Urban setting

In the urban school we attended a classroom teaching session on the topic of life and in subsequent sessions initiated discussions. A lecture session of one teacher is reported. Some researchers also participated in the discussion. This teacher began the session in a routine manner. She asked the students to name some living in air. After writing these on the board, she selected one of those stated which happened to be 'glow-worm' and asked, why is it living? She wrote down the answers on the board:

-it glows: (without asking, if something glows, does that mean it is living ?) -it requires air -it requires food and water

The teacher accepted all these answers. Then she asked whether a blackboard was living, and took down reasons for it not being so, which were the opposites of those listed above. At this point, one of the researchers asked the students, how they knew that a glow-worm, breathed, or ate or drank and whether they had seen this. Some students did say yes, they had, though it seems doubtful. Some students said they had seen it eating leaves, and seemed confident about it. When asked whether they had seen it drinking water one student said, that there is water in the leaves. Others supported this. Then they were asked, how does one know that a blackboard does not take in air by which it is surrounded, or the water with which it is wiped. The

answer given to this question was a tautology. 'We know this because it is non-living'. It seemed as if the students first decide whether something is living, and then apply the formal criteria to it.

Since seeds were a problem for urban students, the discussion was led in that direction. Students were asked whether rice seeds (with covering) and polished rice are living. There was a heated controversy over this. According to one vocal girl, (V1) grains of rice are living because they grow in size when cooked. Five or six other students agreed with her, but the majority seemed to think that grains of rice were not living. Another vocal girl (V2) reiterated that rice was food so it definitely could not be living. This conception was also noticed in other students: some feel that we cannot eat a non-living others that we cannot eat a living. (The terms "living" and "non-living" are used in a noun form in this and subsequent discussions, to give a flavour for a similar usage prevalent in *Marathi*.)

When asked about seeds of rice taken from the plant, the majority said that the seeds were living when on the plant, non-living when taken off it, and living again when planted in the soil. (This is an interesting idea of transformation from living to non-living and back again). When asked if non-living can become living in this way, V2 said yes, it could as it got the *"kas"* from the soil and therefore became alive. (The word *"kas"* has several meanings, it could mean essence, or nourishment and suggested that there could be a vitalism in the thinking of students). V1 disagreed vehemently and said that the seed was living throughout, as it had potential for growth when placed in suitable environs.

Other girls, including V2, stated that seeds are non-living when kept in a corner of the house, as they do not grow in the house. These students were convinced that the seed can move from a stage of living to non-living and back to living. V1 pointed out that onions and potatoes can sprout even inside the house. However, V2 and the others maintained that onions and potatoes, also mango seeds, were non-living.

4.8   Task 4: Rice questionnaire

Rice is the staple grain of the Konkan region, where this study was conducted. Rural students are intimately familiar with the process of rice cultivation, and even urban students are likely to have some knowledge of it. This questionnaire asked students to judge the living or non-living nature of grains of rice at several different stages: (1) on the plant, (2) ripe and removed from the plant (seed), (3) seed planted in the soil, (4) rice husk, (5) polished rice, and (6) cooked rice. Although the "not sure" option was present in this questionnaire too, students rarely used it. (The questionnaire is given
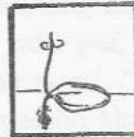
in Appendix C). Totally 130 students filled the rice questionnaire. This questionnaire was administered in Mumbai in division B of grade 5, and in the tribal region in grades 5 and 6 of both schools. Table 4.15 shows the breakup of students who undertook this task while the percentages of correct responses to this questionnaire are shown in Table 4.16.

Table 4.15: Sample of students for rice questionnaire

Division	Girls	Boys	Total
Tribal	30	66	96
Urban	28	32	60
Total	58	98	156

Overall, tribal students gave more scientifically correct answers than did the urban students. It was clear from many of the responses that students were implying a transformation of the seed from living to non-living and back again to living. Gender differences were significant on two of the items, with boys giving a higher proportion of correct answers.

Table 4.16: Adequate responses to rice questionnaire (Task 4)

Items	Girls n=60 r=337 %	Boys n=100 r=552 %	Tribal n=99 r=584 %	Urban n=61 r=305 %	Total n=160 r=889 %	G-B z values		T-U z values	
Living:									
Rice seed on stem	86	99	92	100	95	-2.619	*	-2.919	*
Rice seed not on stem	51	59	46	78	56	-0.929		-4.119	*
Planted rice seed	88	95	94	89	92	-1.382		0.986	
Non-living:									
Husk of rice	92	92	97	80	92			2.848	*
Polished rice	53	77	85	30	69	-2.926	*	7.358	*
Cooked rice	88	91	96	76	90	-0.555		3.118	*

* significant at the .05 level

G–B — Girls–Boys; T–U — Tribal–Urban

4.8.1 Reasons for life

The criteria given by students in determining life were analyzed in a slightly different manner for this task. One way of analysis was ascertaining whether students used one criterion or changing criteria of life for the six conditions of rice. The criteria used for this analysis were slightly different from those used earlier. For example, categories II and IV were absent in the students' responses. Examples of the kind of responses in the categories which did occur are illustrated below:

I a Use

- Use related to Living:
  As a seed is living, we are able to sow and reap the benefits.

- Use related to Non-living:
  Polished rice is nonliving as we use it as food.

I d Tautology

- Seed is living as it is living.

III a Anthropomorphic traits

- Anthropomorphism / anthropocentrism
  A cooked grain of rice is non-living as it cannot walk.

V a Need for food, growth, reproduction

- Potential for growth
  If the seed is sown and given water it grows into a plant.
- Current growth
  A seed is living because it is still growing.
- Needs air, water
  A seed is living as it needs fertilizers, water to grow.
- Cooking kills it
  A grain of rice is non-living as cooking has killed it.
- Absorbs water, minerals
  A grain of rice is living as it absorbs water, while we cook it.
- Death
  A grain of rice is non-living as it is dead.

V b Composition

- Moisture/Drying
  A grain of polished rice is non-living as it is dry.

VI Others

- Kind of change
  As a seed of rice is plucked from the plant it becomes non-living.
- Vitalism
  A grain of rice is non-living as it has lost all its strength and energy.
- Vitamins
  A seed of rice planted in the soil is living as it is filled with vitamins.

Table 4.17 depicts the number of criteria utilised by the students for the six questions presented to them, while Table 4.18 shows the types of criteria.

Table 4.17: Number of criteria used for determining life in the rice questionnaire

Number of criteria	% students
Single criterion	17
2 criteria	35
3 criteria	30
4 criteria	12
5 criteria	05
6 criteria	02
Total	101

Students gave many reasons for life, although the number of distinct criteria were fewer. They used between one and six criteria for judging life in these six situations, the mean number of criteria per student being 2.6.

Out of a total of 889 responses, 71% used the biological criteria which largely included "potential for growth" and "intake of food/ water/ air" while 15% were tautological, i.e. using the idea of "jeev". There were no major differences between tribal and urban students. Support for person-orientedness of girls might come from gender differences in the reasons for life, since girls gave more anthropomorphic reasons than did boys. This was indicated earlier in Task 1, although here the difference turned out to be statistically significant.

Thus, while the majority of students considered that potential for growth was a sufficient indication of life, many also thought that the appropriate conditions for growth had to be present, before the seed could be called living. The environment of the seed could put life into it (for example, soil and water) or take life away (de-husking and cooking).

Table 4.18: Criteria for life in Task 4.

Categories	Girls	Boys	Tribal	Urban	Total	G-B t-test	T-U t-test
n	60	100	99	61	160	–	–
r	337	552	584	305	889	–	–
	(%)	(%)	(%)	(%)	(%)		
I	24	16	19	19	19	2.09 *	-0.88
II	0	0	0	0	0	–	–
III	8	1	5	1	4	2.14 *	-2.21 *
IV	0	0	0	0	0	–	–
V	63	76	71	71	71	-1.98 *	-1.74
Others	4	5	6	9	6		

n = No. of students;
r = No. of responses;
Categories (I - V) (See section 3.3);
Figures in bold represent the two most frequent categories stated
* = Significant at the 0.05 level
G–B — Girls–Boys;   T–U — Tribal–Urban

Vitalistic ideas occurred in both biological and tautological types of responses, though they were more obvious in the first. Students used the word *"kas"* which refers to the richness of the soil, for something that is added to the non-living seed. They also said that the seed loses its strength when it is cooked, or loses vitamins when it is removed from the stem, thus becoming non-living. Again, the Marathi word for vitamins is *"jeevan-satva"* which can be roughly translated as "the essence of life".

4.9   Task 5: Rice interviews

Twenty one students were interviewed for about 5-10 minutes each on their responses to the rice questionnaire. Students who had given one or more interesting response to the questionnaire were selected. Since a student could give many interesting responses in the interview, the responses mentioned in the next paragraph do not add up to twenty one. The aim of the interviews was to gauge the nature of the vitalistic notions that apparently lay behind the tautological responses (4 students), and to verify the existence of transformation ideas, that is, life to non-life to life again (12 students). Other students with interesting ideas were also interviewed, such as, those who gave importance to water (6 students) and those who relied on anthropocentric criteria of life, like stressing usefulness to humans (4 students).

In the interviews, 9 students used vitalistic notions to justify life. They used terms like power *"shakti"*, flame of life *"praanjyoti"*, miracles *"ki-maya"*, self-confidence *"aatmavishwas"* and soul *"aatman"* to justify life. Interestingly there were more vitalistic responses from the tribal students (7 students). The transformation from living to non-living and back again was mentioned by 7 students. The reasons for the first transformation were: separation from living, e.g. a leaf breaks from a tree (2 students), and lack of water or drying up (12 students). Availability of water, miracles, the flame of life and power, were given as causes of the next transformation (3 students). Four students could not say why the second transformation took place.

Other ideas which came up during the interviews were, something is living because it is useful to humans (anthropocentrism); something can be both living and non-living at the same time, such as, an egg which is living inside and non-living outside; there are things which are either a little alive or more alive. Thus, there is a continuum of life. The last response came from a student who said that life is a result of power possessed by the object. Excerpts from a few interviews are given below:

(q= questionnaire item. Iq= interview question, s= student, r= researcher)

Female student-1 (urban) :

All the items in the rice questionnaire were answered as living by the student (except the husk of rice). The interview ran as follows.

q1) (rice seed on stem) The rice seed on stem is living or non-living?
s) living : because it grows after sowing.

(In the questionnaire she had said that a rice seed on a stem is living because it has *jeev* or life. She was reminded of this answer and asked if she still felt that the answer was acceptable).

s) Yes.

Iq) What is *jeev*?
s) It is that due to which humans live, work, do activity and movement.

Iq) What is this it?
s) *Praanjyoti* (Life flame).

Iq) What are living (*sajeev*) ?
s) Those which can breathe, move, reproduce and work are living (an answer from the text-book).

Iq) Give one example of a non-living.
s) Bench.

Iq) Why is it non-living?
s) Cannot move, cannot make a new bench.

Iq) What was the bench earlier?
s) Tree, but then it had *Praanjyoti* (life flame), after cutting the tree there is no *Praanjyoti*.
It is like a man, if he dies then he becomes non-living.

Iq) Can you give one example of a non-living which was never living?
s) Stone.

Iq) Is a stone dead?
s) No it never had *Praanjyoti*, it can not die.

Iq) Can a living become non-living?
s) Yes

Iq) Can non-living become living ?
s) No it is not possible.

Iq) Okay, tell me whether the following are living or non-living.
Seed :
Living

Egg :
Living

s) Both are miracles of *punarnirman* (resurrection)

Food:
It is living because it is useful to humans.

(This was asked as in the questionnaire she had said that cooked rice is living because it is full of *jeevan satva*; vitamins, also seeds are living because if they are not we will not get food):

(The student showed vitalistic and anthropomorphic reasoning in justifying life).

Male student-2 (tribal)

The answers in the questionnaire had been:

q1: (rice seed on stem) living : can grow after being sown
q2: (rice seed not on stem) living : same as above
q3: (planted seed) living : grows
q4: (husk of rice) non-living: there are no seeds
q5: (polished rice) living /non-living: it will not grow
q6: (cooked rice) non-living: cannot grow

* In the questionnaire this student had given all apparently biological reasons, but in the interview he showed vitalism and anthropomorphism.

Iq: Define living:
s: Those which have *'jeev'* (life).

Iq: Is this stone living?
S: No.

Iq: Why is it not living?
s: It does not have any *'shakti'* (power).

Iq: Which things are living?
s: Those that do some movements.

Iq: Is that paper flying there living ?
s: No

Iq: But isn't it moving?
s: Not by its own *shakti*, it uses the wind.

Iq: So those things are living that move by their own *shakti*?
s: Yes

Iq: What about the wind, and the river, they move by their own strength, are they living?
s: No.

Iq: Why?
s: Because they do not talk

(This is a case of shifting criteria: when one response is challenged the student comes up with a new one. The last response is anthropomorphic and apparently a last ditch effort by the student to justify his beliefs).

Iq: Of all the reasons you have given: movement/ speaking/ strength/ growing, which do you think is the most important for life?
s: Growing

Iq: Can living become non-living?
s: No

Iq: Can non-living become living?
S: No

Male student-3 (tribal)

Iq: Define living:
s: Those that have jeev, those that move:-*haal-chaal kartaat*

Iq: Is a car living?

s: No it has to be driven.

Iq: Clouds?
s: No, nature moves them

q1:(rice seed on stem) non-living: it is natural *"naisargik"*

(confusion between natural and non-living)

Iq: Tiger:
s: Living

Iq: Cow:
s: Living

Iq: Tree:
s: Living

Iq: Why?
s: It absorbs water, transports it, they grow and we get food

Iq: Germs:
s: Living

Iq: Rat:
s: Living

q2: Non-living:
s: Cannot grow, though we get-rice *bhaat*

q3: Living :
s: Can absorb water

q4: Non-living:
s: Cannot move

q5: Non-living:
s: Cannot move

Iq: But q1 and q3 also did not show movement:
s: These do not have *jeev, shakti,* what is there is too little

q6: Non-living:
s: They become soft, filled with water, we can eat them, and we cannot sow them.

Iq: Why?
s: Because of cooking some vitamins are gone

Iq: Is that their *shakti?*

s: Yes

Iq: Can living change to non-living?
s: Yes, man dies, we burn him, cannot speak or walk.

Iq: Can non-living change to living?
s: No

Iq: Pointed out that this answer contradicted his earlier answer:
s: Does not happen in humans, but happens in plants.

Iq: How does it happen in plants?
s: Water gives strength.

Iq: If man is given water after death?
s: No use the *aatma* (soul) is gone.

Iq: Is *aatma*(soul) the *jeev* (life)?:
s: Yes

Iq: Then trees have *aatma* (soul)?
s: Yes, return of *aatma* is possible in trees.

(The student's ideas included vitalism and concept of water as the source of life and strength. The concept of 'a little life' and power was also mentioned by some other students.)

Chapter 5

Students' likes and dislikes of plants and animals

5.1 Introduction

The motivation to learn depends on one's attitudes towards the subject matter. Learning of biology in the elementary grades, being close to everyday experiences, is particularly likely to be influenced by affective factors, i.e., by students' subjective feeling towards the living world. These feelings may be shaped by story books, mass media, or the attitudes of parents and the society in which they live. The consequences of such feelings in the educational domain are numerous [11]. In studies quoted by Silberstein and Tamir [16], it was found that students preferred studying organisms through direct observations but were not inclined towards causing them any harm. Wandersee [18] found that students in a rural area preferred animals to plants and recommended that this should be taken account of in biology classrooms. Tamir and Silberstein [16] aimed at understanding the factors which affect students' attitudes towards living organisms used as instructional aids in the class and laboratory. Millett and Lock [10] suggest that teachers be sensitive to the range of attitudes in their classroom when dealing with socially controversial issues of a scientific nature, such as the use of animals in science.

Living organisms form a part of the curriculum from the earliest years of school. The fact that students' ideas about living organisms reflect socio-cultural variations has already been discussed in the previous chapters. The present study focuses on the role of a specific affective aspect, namely, likes and dislikes of students towards living things, in understanding these variations. Likes and dislikes of plants and animals could significantly affect students' ideas about the living world, and their

predisposition to learn more about it. Another objective of the study was also to understand the factors which affect students attitudes towards use of animals as part of research and learning. The study was carried out with grade 5 and 6 students, in tribal and urban settings. Gender differences in students' attitudes were also studied.

5.2 Sample and tasks

Both the urban and tribal students belonged to grades 5 and 6, and ranged in age from 10 to 15 years. About a hundred students in the tribal and urban groups participated in the study. The data was collected on the basis of two tasks given to the students.

5.2.1 Task 1: Examples of likes/disliked animals

In this task, students had to give one example each, of the plant and the animal they liked and disliked the most. The task was meant to tap the salient examples of living things liked and disliked by students. It was administered to 95 students in grade 5 of the urban school and 100 students in the grades 5 and 6 in two tribal schools. (Urban: G = 30, B = 65; Tribal: G = 28, B = 72). The total number of students was 195 (G = 58, B = 137).

5.2.2 Task 2: Questionnaire on liked/disliked animals

Task 2 consisted of a questionnaire which contained 18 items representing different sublevels of the animal kingdom. Students had to state which of these they liked, which they disliked, and which they were neutral to, with reasons for the same (Appendix E) The animals in the list were as follows:

- Mammals:-Donkey, Cow, Monkey, Fox, Cat, Dog, Elephant, Tiger, Rabbit.
- Birds:-Vulture, Parakeet, Peacock.
- Reptiles:-Snake, Lizard.
- Worm:- Earthworm.
- Insects:- Butterfly, Housefly, Dragonfly.

These animals were selected on the basis of the examples given by the students in the earlier task. This task was also carried out in both the settings, urban and tribal, in grades 5 and 6. The total sample was of 260 students (Urban 164: G = 67, B = 97; Tribal 96: G = 28 , B = 68).

5.3 Results

5.3.1 Task 1: Examples of liked/disliked animals

Though students were asked to give one example of a liked and disliked plant and animal, many students gave more than one example. The different living organisms stated by students were categorised into animals (mammals, birds, reptiles, insects) and plants. Table 5.1 shows the number of students expressing a liking for the different categories of living things, while Table 5.2 shows the number of students expressing a dislike for the same categories.

Table 5.1: Prominent examples of living liked by students.

Items	Tribals n=255		Urbans n=222		Total n=477		z value	
	r	%	r	%	r	%		
1 Trees	123	49	84	38	208	44	2.435	*
2 Animals	131	51	138	62	269	56	-2.435	*
2a Mammals	103	79	101	73	204	76	1.156	
2b Birds	25	19	25	18	50	19	0.211	
2c Reptiles	2	2	7	5	9	3	-1.350	
2d Insects	0	0	2	1	2	1	-1.181	
2e Worms	1	1	0	0	1	0	1.150	
2e Germs	0	0	0	0	0	0		

* Significant at 0.05 level

r refers to responses

Tables 5.1 and 5.2 show that a large majority of the students mentioned animals rather than plants, both in the "liked" as well as the "disliked" categories. Thus overall, animals held a more prominent place in the students' minds. This was true for both urban and tribal students. However, there was a significant difference between the tribal and urban students in their preferences for plants and animals. Tribal students mentioned trees as "liked" and animals as "disliked" more often than did urban students. On the other hand, urban students mentioned animals as "liked" and trees as "disliked" more often than did tribal students.

Table 5.2: Prominent examples of living disliked by students.

Items	Tribals n=222		Urbans n=189		Total n=411		z value	
	r	%	r	%	r	%		
1 Trees	31	14	60	32	91	22	-4.374	*
2 Animals	191	86	129	68	320	78	4.374	*
2a Mammals	121	63	71	55	192	60	1.428	
2b Birds	17	9	8	6	25	8	1.019	
2c Reptiles	28	15	25	19	53	17	-0.927	
2d Insects	5	3	18	14	23	7	-3.338	*
2e Worms	17	9	7	0	24	8	4.346	*
2e Germs	3	2	0	0	3	1	1.98	*

* Significant at 0.05 level.

r refers to responses

With respect to animals an overwhelming percentage of the liked animals were mammals, followed by birds. Here too, there were differences between tribal and urban students in the kinds of animals mentioned. Urban students tended to give examples like tiger, lion, elephant, rabbit etc.: typical storybook animals, rather than those encountered in everyday life. Tribal students often gave examples of common animals easily found in their daily lives (example: parakeets, dog, cat, pigeons, hen). As compared to urban students, they showed a greater dislike for mammals, particularly for the higher mammals like tiger, lion and fox. Animals of the lower classificatory order were disliked by both the groups of students (tribal and urban). Insects (except butterflies) were disliked by urban students while worms were disliked by tribal students.

5.3.2 Task 2: Questionnaire on liked/disliked animals

Task 1 enabled us to identify some prominent examples of liked and disliked living beings. The results also gave us some idea of the attitudes of students towards particular categories of animals. However, this task was limited by the fact that it elicited only one or two spontaneous preferences per student. In Task 2, which focused only on animals, certain exemplars of the sub-categories were selected in order to more exhaustively analyse students' preferences. These examples were then given to students for systematic rating. Table 5.3 confirms the major result from Task 1, namely, an overall liking for the higher classificatory levels and a dislike towards the lower group of animals with a few exceptions. Animals disliked were, fly, vulture, lizard and snake while animals liked were cow, peacock, rabbit, dog, cat and donkey.

Table 5.3: Students' likes and dislikes of various animals (z test).

Items	Tribals n=96			Urbans n=164			Total n=164			z value
	L %	D %	N %	L %	D %	N %	L %	D %	N %	TL - UL
Cow	100	0	0	99	1	0	99	1	0	1.287
Parakeet	98	0	2	98	1	1	98	0	2	
Butterfly	95	2	3	98	2	1	97	1	2	-1.210
Peacock	96	1	3	97	1	3	96	1	3	-0.416
Rabbit	94	2	4	94	3	3	94	3	3	
Dog	95	2	3	91	7	1	93	5	2	2.039
Cat	92	3	5	78	18	5	85	11	5	3.288 *
Elephant	91	4	5	92	4	4	91	4	5	-0.277
Donkey	86	11	2	76	17	7	84	10	5	2.056
Dragonfly	52	25	23	57	20	22	55	24	23	-0.781
Earthworm	50	39	11	51	35	14	50	37	13	-0.156
Monkey	30	55	15	56	29	15	29	55	22	-4.280 *
Tiger	14	78	8	7	89	4	11	86	6	1.723
Fox	12	73	16	2	85	12	7	79	14	2.864 *
Snake	10	75	7	22	73	5	16	75	9	-2.694 *
Lizard	5	73	22	8	77	15	7	75	18	-0.715
Vulture	5	86	8	9	64	26	7	75	17	-4.266 *
Housefly	4	85	10	3	89	8	3	86	9	0.912

* Significant at 0.01 level.

L — Like;   D — Dislike;   N — Neutral

TL — Liked by Tribal students;   UL — Liked by Urban students

Tribal and urban differences

Between the two groups, significant differences were seen for five of the eighteen animals. The cat was liked by the tribal students more than the urban students, while the opposite was true of animals like, snake, fox, vulture and monkey.

Gender differences

The responses of the students were also analyzed on the basis of gender. Table 5.4 indicates the gender differences in preferences of animals among the total sample. Statistically significant differences were seen for 5 of the 18 animals presented to the students. Boys liked tiger, cat, dog, and dragonfly more than girls. Of all the

Table 5.4: Gender differences in the total sample (z test)

Items	Girls n=95			Boys n=165			z value
	L %	D %	N %	L %	D %	N %	GL - BL
Cow	75	24	1	100	0	0	-1.045
Parakeet	101	0	0	98	1	1	3.321 *
Butterfly	96	3	1	98	1	1	-0.573
Peacock	98	0	2	97	1	2	1.708
Rabbit	97	0	3	95	3	2	2.009
Dog	90	9	2	96	4	1	-8.495 *
Cat	73	23	4	90	6	4	-4.270 *
Elephant	87	8	5	95	2	2	-0.875
Donkey	78	16	5	81	14	5	-1.178
Dragonfly	54	22	24	58	23	19	-5.627 *
Earthworm	40	48	10	58	31	11	-2.081
Monkey	46	40	14	48	39	13	-0.532
Tiger	6	90	4	12	84	4	-2.845 *
Fox	3	82	14	8	81	11	-0.311
Snake	21	73	7	21	76	3	-0.625
Lizard	4	85	11	9	75	16	-2.259
Vulture	1	75	21	13	73	15	-1.823
Housefly	4	89	7	2	90	7	1.747

* Significant at 0.01 level.
L — Like;   D — Dislike;   N — Neutral;
GL —Liked by Girls ;   BL — Liked by Boys

categories girls had liked only three animals more than boys. These were parakeet, peacock and rabbit, of which only the parakeet was liked by significantly more girls. These differences were not considered of great importance.

5.3.3 Reasons for likes and dislikes

A study of the responses alone does not give details of all the differences in attitudes. Hence the reasons given by students for likes/dislikes were also taken into account. The reasons stated by the students were analyzed in three different categories, the categories were formed on the basis of responses found in the task 1. The categories were:

I Relation with Humans (This category concerned how the animal was viewed in relation to humans, example; useful/harmful)

There were four subcategories, examples given by students in each category is presented:

a Harmless/Harmful
Tiger is disliked as it is harmful.
Rabbit is liked as it is harmless.

b Useful/Useless
Cow is liked as it gives us milk.
Dog is liked as it guards our house.
Monkey is disliked as it is useless.

c Playful/Aggressive
Monkey is liked as it is playful.
Tiger is disliked as it is aggressive.

d Tame/Wild
Fox is disliked as it is a wild animal.
Elephant is liked as it is tame.

II Appearance /Qualities (This category stressed various perceptible qualities or appearance of the animal)

a Beautiful/Cute/Ugly
Butterfly is liked as it is beautiful.
Cat is liked as it is cute.
Vulture is disliked as it is ugly.

b Cuddly/Slimy
Rabbit is liked as it is cuddly.
Earthworm is disliked as it is slimy.

c Clean/Dirty
Vulture is disliked as it is very dirty.
Cow is liked as it is clean.

d Sweet voiced/Noisy
Parakeet is liked as it is sweet voiced.
Donkey is disliked as it is very noisy.

III Anthropomorphic attributes (This category was concerned with the image that the animal has in human life, example; clever/dumb)

a Clever/Dumb
Dragonfly is liked as it is clever.
Donkey is disliked as it is dumb.

b Brave/Cowardly
Tiger is liked as it is a brave animal.

c Revered/Despised
Peacock is liked as it is the national bird.
Lizard is a disgusting animal.

d Innocent/Sly
Fox is disliked as it is a sly animal.
Rabbit is liked as it is innocent.

e Entertaining/Boring
Monkey is liked as it entertains us.
Donkey is disliked as it does not amuse us.

IV No reason

Tribal–Urban differences in reasons for likes

Table 5.5 indicates the reasons for liking of animals stated by the total sample of students. Overall the "relation to humans" category was the primary reason for liking or disliking an animal (56%). This reason was followed by the "appearance" category (29%), while the "anthropomorphic attributes" category (8%) was less frequently stated as a reason for liking or disliking an animal. Tribal students gave many more reasons based on the "relation to humans" category as compared to the urbans. Their like or dislike of an animal relied more on the useful/harmful nature of the animal rather than its "appearance". Tribal students' familiarity with the forests, arising

from their living in it and using its products extensively in their everyday lives, could be an important reason for this fact [12]. "Appearance" was equally emphasised by the two groups, while "Anthropomorphic attributes" was more often reported by the urban students .

Table 5.5: Frequency of reasons given by the students for likes / dislikes.

No	Categories	Tribal r=1288		Urbans r=2527		Total r=3815		t-test values	
		r	%	r	%	r	%		
1	**Human Related**								
	Harmful/Harmless	243	30	497	38	740	19	2.90	*
	Useful/Useless	527	65	738	56	1265	33	3.29	*
	Playful/Aggressive	30	4	74	6	104	3	2.00	*
	Tame/Wild	14	2	14	1	28	1	0.59	
	Subtotal	**814**	**63**	**1323**	**52**	**2137**	**56**	**6.577**	*
2	**Appearance**								
	Beautiful/Cute/Ugly	232	59	395	54	627	16	0.28	
	Cuddly/Slimy	16	4	33	5	49	1	0.44	
	Clean/Dirty	120	31	182	25	302	8	-0.91	
	Sweet voiced/Noisy	25	6	116	16	141	4	5.22	*
	Sub total	**393**	**31**	**726**	**29**	**1119**	**29**	**1.271**	
3	**Anthropomorphic attributes**								
	Clever/Dumb	9	11	16	7	25	1	0.20	
	Brave/Cowardly	5	6	6	3	11	0	0.99	
	Revered/Despised	21	27	30	13	51	1	0.47	
	Innocent/Sly	4	5	57	25	61	2	4.64	*
	Entertaining/Boring	40	51	123	53	163	4	3.51	*
	Sub total	**79**	**6**	**232**	**9**	**311**	**8**	**-0.307**	

r = No. Of responses

* Significant at 0.01 level.

Gender differences in reasons for likes

The table 5.6 shows that boys stressed reasons based more often on the "relation to humans" for liking animals.

Table 5.6: Gender differences in the frequency of reasons given by total students for liking / disliking animals

No	Categories	Girls r=338		Boys r=950		t-test values	
		r	%	r	%		
1	**Human Related**						
	Harmless/Harmful	262	37	478	33	-1.27	
	Useful/Useless	400	57	863	60	-4.32	*
	Playful/Aggressive	31	4	73	5	-2.20	*
	Tame/Wild	11	2	17	1	-1.03	
	Sub total	**704**	**48**	**1431**	**55**	**-4.155**	*
2	**Appearance**						
	Beautiful/Cute/Ugly	243	57	384	55	1.45	
	Cuddly/Slimy	22	5	27	4	1.36	
	Clean/Dirty	97	23	204	29	-2.06	*
	Sweet voiced/Noisy	64	15	77	11	1.62	
	Sub total	**426**	**31**	**692**	**28**	**1.941**	
3	**Anthropomorphic attributes**						
	Clever/Dumb	9	7	21	11	-1.45	
	Brave/Cowardly	4	3	7	4	-1.28	
	Revered/Despised	24	19	28	15	-0.02	
	Innocent/Sly	34	27	27	14	0.83	
	Entertaining/Boring	56	44	105	56	-1.52	
	Sub total	**127**	**12**	**188**	**11**	**0.923**	
4	**No Reason**	108	8	139	6	2.280	

r = No. of responses
* Significant at 0.01 level.

5.4 Summary of students' attitudes

A majority of students prefer animals; they also show an inclination towards their study as a part of the curriculum. The attitude of students towards animals is that of affection. They are much more drawn towards those animals that are useful to us or are easy to associate with. Wild animals or those which might cause harm are not liked by the majority, but this does not amount to any wish to cause them harm.

Overall students preferred animals to plants. Tribal children were found to have a preference for trees while urban children preferred animals. Related to earlier findings where [18] rural students showed higher preference for animals than plants, the present study shows that rural students do like animals more than plants but as compared to urban students they have more preference for plants. In a related study

[12], it was seen that the reasons for their preference for trees amongst the tribal students may lie in the fact that in tribal cultures, there is a direct dependence on plants for survival, shelter, food and medicine.

The attitudes of the urban students seem to be shaped by their knowledge acquired through books, whereas the tribal students attitudes reflect their environment and culture. There is a greater chance that tribal students' encounter some of these animals in their life.

Reasons for liking showed that *relation to humans* was an important criterion, followed by *appearance* and *anthropomorphic attributes*. There were very few gender and tribal-urban differences in reasons for liking, with *relation to humans* being more important for tribal students and boys. This study shows that teachers should take cognisance of their students preferences in designing learning activities in biology. These activities should help in developing students' interest in biology in general, and in particular all kinds of plants and animals. Considering that use and harm are important reasons for students' preferences, teachers can utilise these activities to reinforce the ideas of interactions between organisms, especially with reference to human beings. Students' attitudes towards earthworms, for example could certainly be improved through teaching about their ecological importance.

Chapter 6

Conclusions

This study was done in the context of a science curriculum in which students learn about living things by first distinguishing them from non-living things. This rather formal introduction to the notion of life barely touches on the real richness and diversity of life around us, and seems singularly inappropriate to a primary school curriculum. Our interaction with students confirmed that they too have difficulty in grasping the subtleties of such distinctions.

The study has succeeded in unravelling at least a few of the complexities in students' notions of life. Even after being taught the biological criteria of life, students did not apply them uniformly. Judgements of life or non-life, and the criteria used therein, varied with the task context.

Results of the exemplars task suggested that in some cases at least, judgements of life might be derived from knowledge of category membership. Thus, large mammals are more easily judged alive than plants. In fact, in the pilot version of Task 2, 17% students judged a tree to be non-living, while 8% did not answer.

Another instance where students seemed to be using category membership to judge life, was the case of human-made artifacts. They found it easier to categorise as non-living those objects that are known to be made by humans. Interestingly, in Task 2, for the item aeroplane (the only human artifact in this questionnaire) students' explicit justifications were frequently biological. Human intervention thus appeared to be a covertly used criterion for non-life.

A gender difference was noticed in the examples of non-living cited by the students. Girls were more person-oriented: they cited many more objects of personal use than did boys.

With respect to the justifications given by students for judging life, the various tasks elicited different results, with biological criteria increasing steadily in frequency. Successive tasks perhaps sensitised the students to the need to draw on the biological knowledge that was so easily accessible in their textbooks.

In Task 1, (exemplars of living and non-living) students often used "movement" as a criterion for selecting and justifying their examples. There was no significant difference between girls and boys in the justifications provided. The tendency to use the "movement" criterion decreased appreciably in subsequent tasks, being replaced by a trend towards biologically appropriate criteria.

In Task 2, (questionnaire on living/non-living) the largest categories of reasons provided by students were in the biological category and the category combining use/ facts/ existence/ tautology. Girls provided more responses in the latter as well as the activity category and less in the biological category, as compared to boys. Tribal students provided more of the tautological and fewer of the anthropomorphic responses.

Task 3, (giving reasons for oneself being alive) elicited a large proportion of anthropomorphic responses, in addition to biologically appropriate ones. Here, the tribal students were more susceptible to anthropomorphism. The urban students' persistence in using biologically appropriate criteria, in a task context that encouraged anthropomorphism, perhaps reflected their ability to distance themselves from the task context. The ability to decontextualise is known to be an effect of schooling and also related to urbanisation [15], [6].

Task 4, (rice questionnaire), like Task 2, elicited many more biological reasons and the use/ fact/ existence/ tautology (I) reasons. Probably, the task content precluded any reasons based on movement and human intervention. Girls gave more of the category (I) as well as the anthropomorphic responses, while boys gave more biological reasons. Tribal students also gave more anthropomorphic reasons.

The study also highlighted students' preferences of plants and animals. Overall students preferred animals to plants. Tribal students showed a preference for trees while urban students preferred animals. The reasons for liking of animals indicated that *relation to humans* is an important criterion followed by *appearance* and *anthropomorphic attributes*. Tribal-urban and gender differences in reasons for liking suggested that *relation to humans* was more important for tribal students and boys, than for urban students and girls.

Recent researchers [4] have taken the stand that animism should be seen as a manifestation of inadequate biological knowledge. In this context, the phenomenon of 'inanimism' becomes equally worthy of study. 'Animism' and 'inanimism' are both

manifestations of the inability to discriminate between living and non-living. The reason for largely neglecting the second trend could lie in a tendency to romanticise animism and its linkage with so-called primitive cultures, while inanimism is seen as a pedestrian lack of biological knowledge.

Many inanimistic responses occurred in the case of seeds, embryos and bulbs. These cases turned out to be extremely interesting as they showed up two unexpectedly common alternative conceptions: a) that a living thing can become temporarily non-living, and b) that the transition back to living might imply a vital force.

At least part of the reason for the vitalistic ideas might be traced to language. In Marathi, the word for living is *Sa-jeev*, or "with-life", and that for non-living is *Nir-jeev*, or "without-life". Both these are used as nouns. The first is a technical word, introduced via the textbook, while the second is a colloquial word. The possible linguistic source for vitalistic notions might also be found in Marathi words used by the students like, *"kas"*, referring to the richness of soil that is passed on to the seed, and *"jeevan satva"*, the essence of life which is also the word for vitamins.

Another possible source of the vitalistic ideas centres around the role of water as life-giving. This could also be an over-extension of the biological ideas taught in school, namely that living things need food, air and water. Students stated that a non-living can become living by taking in water, and a living becomes non-living when it dries up or loses water. An extreme over-extension of this idea was that cooked rice is · living, as it is bloated with water.

Gender and tribal/urban differences in relation to scientifically adequate estimation of life/non-life for Task 2 and Task 4 indicated that tribal students and boys were more accurate. It is remarkable that tribal students, who are known to be more animistic in their religious practices, had judgements closer to the scientific ones as compared to urban students. Perhaps their more accurate judgements are a result of their closeness to the natural environment. More intensive studies are called for here, both to explore the nature of the tribal students' superior knowledge [12] and the stark paradox of their poor performance in the school context. The study mentioned above (DLIPS - Part 2) found that tribal students cite a much larger variety of trees and small plants, many of which do not occur either in the textbooks or in the urban students' responses. One reason explaining the latter is the curriculum of the schools which is heavily biased in favour of urban mainstream students. Such bias is illustrated in the examples chosen to explicate living: these are, a rose plant in a pot and a bird in a cage, clearly meant for urban rather than rural children.

Having found that girls are more person-oriented, anthropomorphic and animistic, it is important not to facilely dismiss this as scientifically immature thinking. Rather, it should be a reason for making science textbooks more person-oriented than they

are at present. For example, one could use the fact that students find it easier to categorise as non-living objects explicitly made by humans.

This study shows that teachers should take cognisance of their students' preferences in designing learning activities in biology. These activities should help in developing students' interest in biology in general, and in particular all kinds of plants and animals. Considering that use and harm are important reasons for students' preferences, teachers can utilise these activities to reinforce the ideas of interactions between organisms, especially with reference to human beings. Students' attitudes towards earthworms, for example could certainly be improved through teaching about their ecological importance. These ideas also need to be conveyed to teachers, so that science can be presented in the classroom as a human enterprise, related to personal and social concerns.

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Appendix A

Task 2 (Pilot questionnaire)

Name:...................................... Std:...................

Please tick whether the following are living / non-living and state reasons for your answer.

	Living	Non-living	Reason

1. Soil

2. Cloud

3. Water

4. Bicycle

5. River

6. Candle

7. Sea

8. Aeroplane

9. Wind

10. Air

11. Mountain

12. Watch

13. Vegetables in a basket

14. Garland

15. Fire

16. Sun

17. Moon

18. Tree

19. Earth

20. Germs

21. Shellfish

22. Ivory

23. Diamond

24. Pearl

Appendix B

Task 2 (Final questionnaire)

Name: .... Std: ....

Please tick whether the following are living / non-living and state reasons for your answer.

	Living	Non-living	Not sure	Reason

1. Tree

2. Aeroplane

3. Moss

4. Germs

5. River

6. Onion

7. Earth

8. Egg

9. Mountain

10. Potato

11. Split lentils

12. Cloud

13. Sun

14. Whole lentils

15. Mango seed

16. Soil

17. Water

18. Moon

19. Fungus

20. Sea/Rain

Appendix C

Task 4: Rice questionnaire

Name:............................... Std: ....

Birth date:.............................. Age:..................

Please state whether the following are living or non-living with reasons for your answer.

1) Rice seed on the stem.

2) Rice seed.

3) A rice seed on being planted in the soil.

4) Husk of the rice seed.

5) A grain of polished rice.

6) Cooked rice.

Appendix D

Games/activities related to living/non-living

D.1 Game 1: Naming living in air/stones, water and on land/grass

This game was played in the urban school and one of the *Ashramshalas* with grade 5 students. The class was divided into teams, and each team was asked to name the living found in various places. In Mumbai, the options given were, water, grass and rocks, and the students were taken out of class and asked to name only those living objects which were visible then. In the tribal school the game was played in two contexts, once within the class, and later outside the class where students could only name those living that were visible. The table (Table D.1) presents the number of living that the students of the tribal school were able to name as members of teams A,B,C and in the two contexts.

Table D.1: Number of living named by tribal students

| | A | | B | | C | |
	class	outside	class	outside	class	outside
Land	34	77	37	34	61	48
Air	18	10	16	9	14	5
Water	12	2	12	4	11	2
Total	64	89	65	47	86	55

Appendix D. Games/activities related to living/non-living

Table D.2: Number of living named by urban and tribal students

Places	Urban students (outside/class)	Tribal students (observed)	Tribal students (class)
Land/grass	30	159	132
Water	30	8	35
Air/stones	29	24	48
Total	89	191	215

The above table makes it clear that the tribal students have an extraordinary knowledge of the plants in their area. The most number of responses for living were always given by students for living on land and these were more trees herbs and plants rather than animals. This point becomes clearer when it is observed that students observed and pointed out to the researchers the living that they observed outside. In this context the students pointed out various vegetation.

The same game was played with the students in urban school in 5A, with students formed into groups and having to observe the living in three areas, grass, stones and water. However, the students misunderstood and felt that they did not have to actually observe these living, but list as many of them as actually exist in the areas given. One comment of a girl was 'let's look in a book'. especially when many possibilities were exhausted. The living listed were:

Water: Fish, crab, frog, duck, crocodile, snail, moss, 'bhaji' (vegetables), tortoise, crane, snake, shellfish, lotus, prawns, insects, earthworm, spider (walking on surface of puddle), 'tachni' (smaller than but similar in shape to dragonfly), mosquito, ant (walking on puddle) and 'lavhale' (kind of water- grass).

Grass: butterfly, bee, rat, ant, frog, cuckoo, snake, earthworm, frog, dragonfly, fly, chameleon, grass, crab, red ants, orange beetle and garden lizard.

Stones: shells, earthworm, lizard, chameleon, scorpion, crab, spider, snake, frog, man, ant and goat.

Trees: tamarind, plantain, coconut, jamun, cowslip, jackfruit, mango and ashoka.

A tribal-urban comparison makes it clear that the tribal students could actually point out to a great number of living in their environment (195/215) and this number greatly exceeded that provided by the urban students (89). Table ?? provides details of this comparison.

D.2 Game 2: Dumb Charades

This popular game was played in both the urban and tribal school. Students were divided into two groups. Each group had to decide on a living or a non-living to suggest to the other group to act out. Students quickly decided that non-living things would be more difficult to act out and hence began to concentrate on those. These non-living tended to be from the students' environment (school and non-school), example, paper, table, cupboard (school) and playing top, cloud, water and rickshaw, bowl, telephone, mountain. Students' miming of the living beings eg., 'ghorpad' a big lizard, camel, tortoise, bear and chameleon, crocodile, snake, donkey, pig, often showed remarkable acting talent.

D.3 Activity 1

Students in the urban school, grade 5, were asked to bring any specimens of living. Students brought

- Two large crabs

- One small gecko (lizard)

- Four to five dragonflies (small variety, about an inch long, 2 inches wing span)

- Ant (big, black)

- Small fishes, small prawn-like crustaceans

- 'Sontakka' a flowering plant

- Earthworms

Students were asked what food was essential for these to survive. The information given by the students on the diet of each living thing are:

- Crabs: (earthworm, fishes)
- Gecko: (insects)
- 'Sontakka'(a flowering plant) : (Red soil and water)

- Fish: (moss, insects, flour)

- Ant (sugar, jaggery)

- Dragonflies:(flowers, juice of flowers)

- Earthworms: (soil)

Students agreed that all the living things needed air to live, but there was some disagreement in case of the fish and the earthworm's requirement of air. Students' arguments were:

- Fish stay in enclosed glass boxes, they don't get air inside.

- Fish do not require air in fact they die when exposed to air.

- Earthworms go to the bottom of a pile of leaves; there is no air there.

- Earthworms can live deep in the soil and there is no air there.

- Fish need air but they have to come to the surface of the water to breathe.

- There is oxygen in water.

The specimen brought by 5B students (excepting the dragonflies, which were released after the class) had been handed over to the teacher and the laboratory assistant, who had kept them all, including the plant, inside (!) a cupboard in the lab. One of the crabs and the ant had died, but the earthworms inside the crab jar seemed to have been eaten. The plant was wilting. When this was pointed out to the teacher, she expressed mild surprise that the lab assistant had done this, but was reluctant to pursue the matter, or take initiative in assigning the care of the living things to someone. A few jars were provided to students from 5B to helped in cleaning the jars. A few girls overcame their revulsion to procure earthworms for the crabs, and agreed, somewhat reluctantly, to get insects for the gecko and otherwise look after the living things for the next few days.

During our next visit to the laboratory where crabs, lizard, fish, and plant were kept, a few students of 5B volunteered to tend the animals. The plant was watered, the fish received changed water and moss ('shevale'), the crab a few earthworms and the lizard some dragonflies and a cricket. However, after the session, the lizard had still not eaten the insects, and in fact seemed to be avoiding them, so we released it, admitting lack of success in feeding it.

A suggestion was received that perhaps a larger terrarium is needed, where the animals have more room to move around and hunt for food.

It was however realised that besides organising a larger terrarium, it is essential to instil students with some sense of responsibility towards living things before asking them to capture and look after them. Students have developed certain behaviour patterns towards animals, just as they have with other human beings. The way they treat animals, while varying from student to student depending on their experiential and attitudinal backgrounds, is also characteristic of their age. Responsibility towards a task, however, can be taught, and through familiarity and bond formation, they can learn to like, or care for the animal or plant. This is a task that will take both time and effort.

D.4   Activity 2

In the urban and tribal schools, students were asked to observe an animal or a plant for a week and write about it. Thus the task was explained to students during one visit and their responses collected in the next. It was found that instead of giving importance to the observation, most students had written an essay largely taken from textbooks. Incidentally they had also drawn the animal/ plant in question, of which two drawings appear on the cover page of this report.

D.5   Activity 3

In the urban schools teachers had stated that they were unable to show specimens of some of the living things mentioned in the book. The "paisa" insect (a kind of millipede which when touched curls up tightly like a coin) and the touch-me-not plant were specified by the teachers (illustrating the characteristic "responsiveness to stimuli"). These were thus taken to the school in one session and each child was given a chance to observe and interact with them.

D.6   Activity 4

Students of the urban school were brought to HBCSE for a slide show, accompanied by their teachers. The slides shown were: lotus, mushrooms, venus fly trap,

praying mantis, honey bees, snake and mongoose, python squeezing a cheetah, snake swallowing a frog, lizard catching a fly by elongating tongue, penguin, kiwis, ostrich, sambar, swans, seal, ant sewing a leaf, paper wasps, camouflaged caterpillar.

The students were questioned on each slide. Almost the entire class classified the mushroom as an animal and not a plant. But at least some students knew that it was not green because it did not have chlorophyll, and that hence it cannot make its food. They said that it grows on tree trunks. Nobody thought it could be consumed as food by humans.

No student knew anything about animal-eating plants. They even called the venus fly-trap a box. The praying mantis was mistaken for a stick insect or a grasshopper. The students were excited about the snake and the mongoose and told some stories about mongoose eating the snake, or the other way around. But none of the stories were 'magical' as found in the tribal school. Some said the snake sways because the charmer plays a tune and it wants to attack the charmer. The kiwis were totally unfamiliar. Swans were largely confused with ducks. But later when they were told about it being swans, they came up with swan having, 'longer neck', 'sharper beak' (duck has flatter). They pointed out a duck in the picture, which we had not noticed.

In the tribal schools for the slide show almost the entire school students were present in a large room. The slide show received a good response from students. The ostrich they had never seen except in pictures, but could say that its feathers are used for making badminton shuttles.

Appendix E

Questionnaire: Likes and dislikes

Name:................................. Std: ....
School:.............................. Date: ....

Please tick the appropriate for the following animals, and state reasons for your answer.

	Liked	Disliked	No Feelings	Reason

1. Donkey

2. Butterfly

3. Cow

4. Dragonfly

5. Snake

6. Monkey

7. Fox

8. Vulture

9. Cat

Appendix E. Questionnaire: Likes and dislikes

10. Parakeet

11. Dog

12. Housefly

13. Elephant

14. Earthworm

15. Tiger

16. Peacock

17. Lizard

18. Rabbit