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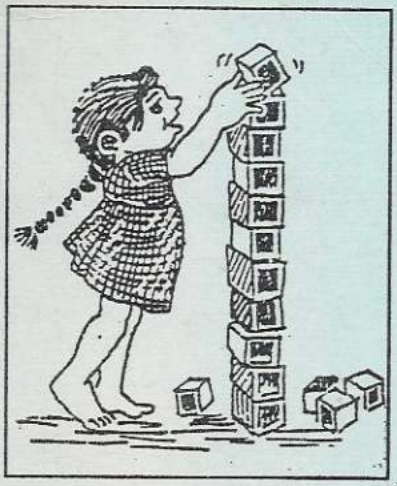
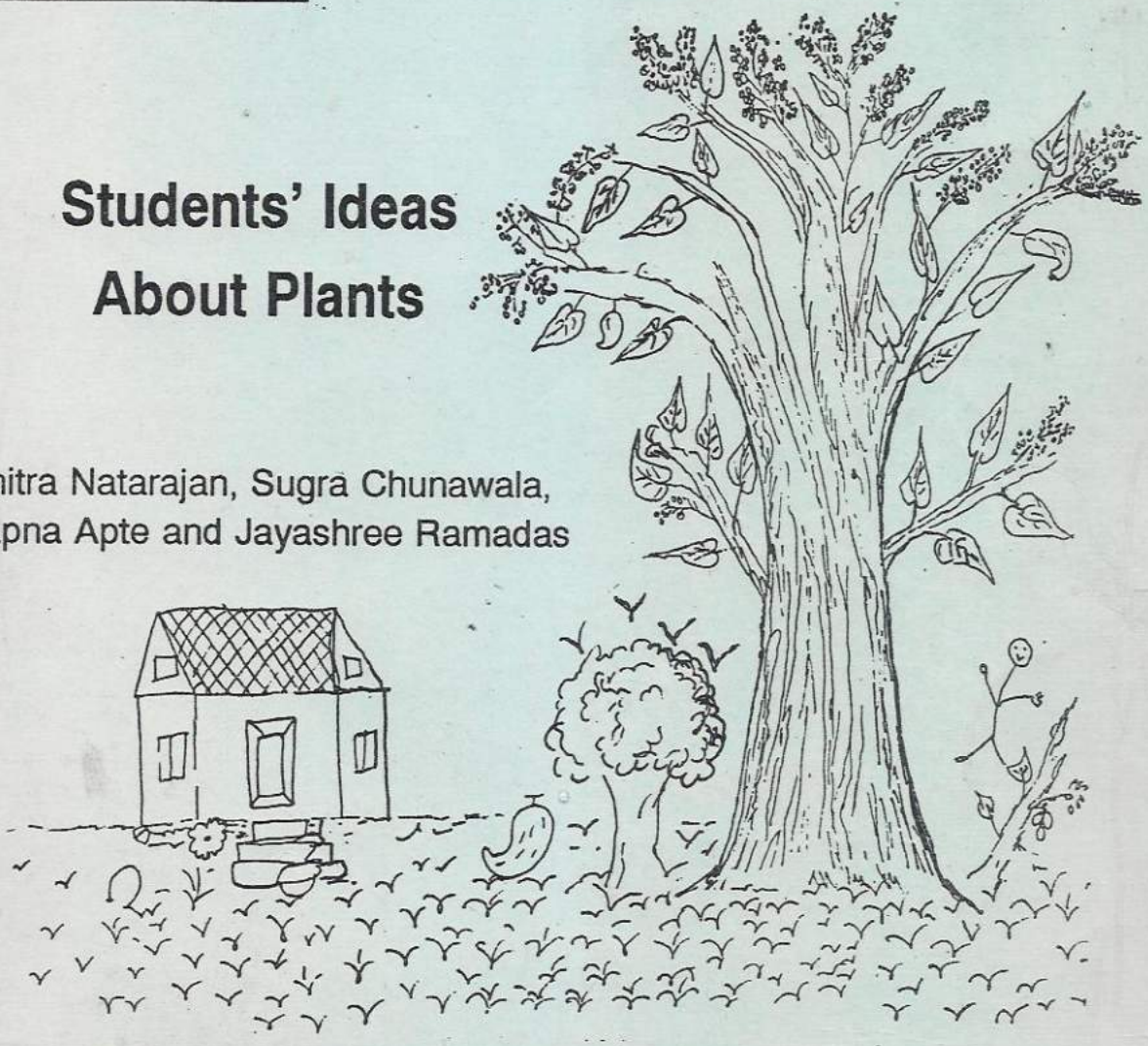


Diagnosing Learning in Primary Science

DLIPS Report - Part 2

Students' Ideas About Plants



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Swapna Apte, Sugra Chunawala, Chitra Natarajan, Jayashree Ramadas

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Chapter 1

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* [10]. Research all over the world has gone into explicating alternative conceptions in different groups of students, and drawing their implications for learning [25].

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

Culture, cognition and the study of plants

Cognition in natural and social settings has been the subject of many recent research studies. Implicit in these studies is the view, developed by Lave [18], Brown and others [7], that cognition is 'situated' — it is a dialectic between persons acting and the setting of that activity; that knowledge is closely intertwined with the activity, the context, and the culture within which it is developed. This view of cognition is particularly relevant in situations where a wide gap exists between the culture of the school and the culture of the home. The study of botany for tribal school students in India is a case in point.

2.1 The tribal context

Tribals typically regard humans as merely part of a community of beings, that include other living creatures as well as elements of the landscape such as streams and rocks. Forest tribals in India, who are attached to particular localities, supplement their meagre earnings as tenant farmers/ labourers, with the sale of fuelwood, catechu (*katha*) extracted from acacia trees, and other minor forest produce like herbs and honey. They attribute sacred qualities to individual trees, ponds, or mountain peaks, or to all members of a particular plant or animal species. The ficus family of trees is one such example [13].

After the first Indian Forest Act of 1865, much of the forests traditionally used by tribals became legally state-owned. The forests being part of *reserve forests* or

protected forests, the state can prevent forest produce from being used as resources by local tribes who are consequently threatened with punitive action. Prior to such state intervention, many tribes legally derived their valuable protein from hunting wild game. State laws on forests have increased the alienation of the tribals living in forests from the people outside that culture [13].

Ashramshalas are an attempt by the government to educate the tribals and integrate them with the mainstream. This endeavour in formal education of tribals, though laudable, has some inherent limitations from a cognitive perspective.

2.2 Formal and informal education

Scribner and Cole [27] see a juxtaposition of formal and informal education as a source of problem in bringing about cognitive change. Their thesis is, "that school represents a specialised set of educational experiences which are discontinuous from those encountered in everyday life and that it requires and promotes ways of learning and thinking which often run counter to those nurtured in practical daily activities." They stress that all culture groups demonstrate the 'cognitive capacity' to remember, generalize, form concepts, operate with abstractions, and reason logically [8]. However, they quote differences in the way these capacities are brought to bear in various problem solving situations, which they refer to as 'cognitive skills'.

According to Harris, culture is simply [16] "the ways people do things and the reason they do them". Lave [19] disputes the idea that culture is a body of knowledge that can be transmitted and acquired. She asserts that knowing, thinking and understanding are generated in practice, in situations whose specific characteristics are part of practice.

Informal education in traditional societies is contextualised and person-oriented — each task is taught by a particular person, and the position of the person, say a family or group elder, imparting the skill is as important as the task to be learned. On the other hand, formal school education demands that children relate only to the subject matter, which is not only decontextualised, but often taught by a different teacher each year. This problem is compounded, in education of tribal children, by the schools representing a culture that has historically oppressed and maligned the indigenous people. Besides, the organization of knowledge in subjects like formal mathematics, grammar and the sciences often conflicts with the traditional ways of understanding and interpreting the world [16].

In this context, the suggestion of anthropologists and psychologists that textbooks

should reflect the child's actual living environment may be a partial remedy. Informal learners, who are more used to 'observational learning' with a marked lack of explanations for how and why they perform a task, may be limited by their inarticulated practical constructs just as often as school learners, who know the words but not the referents, because they have never encountered a practical situation related to their knowledge. These arguments lead to a strong plea for making a connection between everyday life of students and the decontextualised learning in the classroom.

Brown and co-workers [7] [6] lament that cognitive theorists have concentrated primarily on conceptual representation and assumed it to be cognitively prior to knowing the relation of this representation to objects in the world. They propose the theory of 'situated cognition', wherein activity and perception are "importantly and epistemologically prior — at a nonconceptual level — to the conceptualization". Its implication for a classroom would translate as a need for a teacher to know and use students' relations to the objects in their world while teaching important concepts.

2.3 Knowledge of plants in indigenous cultures

Students from indigenous cultures can name and identify a variety of plants. This is known and has been recorded in many studies, especially in the field of anthropology [28]. In one such work by Stross, reported by Tull [28], Mayan students (in Texas, USA) could identify around 200 plants by age 12, about as many as a below-average adult in that culture. Other studies [9] find that urban students have a poor knowledge of names of plants and they cannot identify as many different varieties as tribal students of the same age.

Anthropological and ethnobotanical studies which have documented adults' names for plants show that people in rural and underdeveloped societies have names for many of the wild plants in their environment [1]. Berlin and co-workers developed a model for analysing the layman's scheme for naming plants and animals. In their model, the category *plant*, at the top of the hierarchy, represents the most abstract, the most inclusive level. This is followed by the *life-form* class, which typically includes categories such as tree, bush, vine. Below this is the *generic* class, like oak, maple, ash. Then comes the *specific* class, including names like Spanish oak, red oak, sugar maple. A name like Southern red oak is an example of a varietal name, characteristic of a *varietal* level below the specific class.

Ethnobotanical studies on small-scale rural societies have also found that the generic level is the most frequently used in naming plants and animals [1] [28]. Generic names occur in every language, and the above referenced studies support the hypothesis that

in underdeveloped cultures the salience of the generic level of naming may be a cross-language, universal principle.

One of the many reasons for the discrepancy between the knowledge of tribal and urban students may be sought in the fact that in tribal cultures, there is a direct dependence on plants for survival, shelter, food and medicine. Hunn [17] points out that "biological taxonomies only lexicalize a small portion of the total number of available plant and animal taxa, and what is lexicalised are the plants and animals that have some special importance to people".

In rural and indigenous cultures, even children under 12 years of age participate in agriculture and collection of forest produce. Urban students on the other hand, merely use plant products in their daily lives. In schools, both tribal and urban students go though a common curriculum, in which the study of plants is an important component from grades 1 through 6. The present study attempts to probe the ideas about plants that students develop under these conditions.

2.4 Propositonal knowledge and personal beliefs

It has been recognized for over a decade now that students' understandings involve more than propositional knowledge, and include non-semantic aspects, like, emotions, values, beliefs, interpretive frameworks and personal experiences [14]. All these are also deeply embedded in the physical, social and cultural settings of the students. The school, and evaluations therein, are only concerned with the formal propositional (semantic) knowledge. According to Bloom [3] the technique of context maps, drawn up by students, could provide a convenient way to explore students' ideas: propositional knowledge, as well as the non-semantic aspects.

'Forest' is a word familiar to all students. It conjures up a host of ideas in children and adults, often influenced by stories. It is not a topic of study in the science curriculum. Individual plants and animals, and their adaptation to the environment are introduced in the new Maharashtra State textbooks of grade 5. Different forests are described for the first time in the new Maharashtra Board geography textbooks for grade 7 in the context of the physical geography of the country. While urban students have never been into one, tribal students live on the outskirts of forests. Thus, tribal and urban students from grade 5 and 6, would naturally hold different personal beliefs about the forest. These could, in turn, influence their ideas about plants, animals, and their relation to the forest, and possibly provide a clue to their interpretive frameworks.

The present study was motivated by the observation that tribal students are seen to be at a disadvantage in formal school in terms of performance. Their life-style, and the knowledge of plants and forests on which it has depended over the years, remains unrecognised and under-valued. This attitude is evident in both teachers and in textbooks. By documenting students' ideas, we hope to see if a connection is possible between the situated knowledge of students, and the requirements of the curriculum.

Chapter 3

Sample, methods and tasks

3.1 Sample

The details of the sample are given in Section 1.2.1. A brief historical idea of the lifestyles of the forest-dwelling tribals is given on Section 2.1.

About 200 students from grades 5 and 6 in the age range 10–15 years participated in this study. The number of students varied with the activity. For each activity, about half of the sample was drawn from the urban school, and the rest from the two schools for tribal students. Here, the two groups are referred to as Urban and Tribal respectively.

The textbooks used by the students of different grades and schools were as follows:

Tribal, Grade 6: Old NCERT books - different books for chemistry, physics and biology, [2]

Urban, Grade 6: Old Maharashtra State textbooks for general science, [21] [22]

Both, Grade 5: New Maharashtra State textbooks for general science. [11] [12]

The *Ashramshalas* were in the process of changing over from NCERT textbooks to the Maharashtra State textbooks in the first year of our study. Hence, the old and new Maharashtra State textbooks were analysed for categories of plants which could be compared with those given by urban and tribal students.

3.2 Tasks

Games that required the students to form teams and compete, served to open up interaction channels with the students. This was especially useful in the case of the tribal students, who are normally more reticent. In one such game, played outside the classroom during early interactions, students were required to form teams and identify living things found on land, water, or in the air. The tribal students responded by giving more than 150 plant names. This activity gave the basic impetus to probe the students' knowledge of plants in greater depth, for which several tasks were subsequently designed. A brief description of each task is given below. The tasks are further discussed in the following two chapters dealing with the results.

3.2.1 Task 1 - Classification of plants and animals

A classification task was devised, on lines similar to the 'equivalence classes' in the seminal work of Bruner et. al. [24]. The purpose here, unlike their developmental study, was merely to get a preliminary idea of broad classes used by the students in classifying familiar plants and animals. Carried out on 8 tribal students, each was first given 50 cards, each card with the name of a plant or animal written on it in Marathi. The student was asked to make piles of these cards, placing in the same pile those cards which the student felt should 'go together'. After the piles were made, the student had to give reasons for inclusion of each card in the particular pile. Where necessary, they were asked to clarify the common characteristic of cards in a particular pile. The task was repeated with 56 cards containing names of plants. Names of animals and plants used in this task and samples of cards are given in the Appendix B

3.2.2 Task 2 - Herbarium collection

In the 'herbarium' task, 58 urban students of grade 6 and 99 tribal students of grade 5 and 6 participated. Each student was asked to select one plant from the environs of their school or home, and bring a twig containing a few leaves and a flower, fruit or seed, if it had any. Each student was encouraged to bring a plant different from that of her/his classmates. The students then filled out a questionnaire meant to elicit their ideas related to the plant of their choice and its role in their daily lives. They were asked for information about the plant selected by them: its name, the surroundings where it was found, if the plant was a vine, the support of the plant, their 'thoughts and feelings' about the plant and any stories about it that they may

be aware of. They were also asked to give the colour of the flowers when fresh, and human uses of the plant and its parts.

3.2.3 Task 3 - Drawing and writing about a plant

The participants for the drawing and writing task consisted of 104 urban students from grade 6 and 108 tribal students from grades 5 and 6. Every student drew a plant, its branch, a leaf, flower, fruit and seed, and then wrote about each of these. Of the students responding to the writing task, 22 tribal students of grade 6 were selected for a quantitative analysis of their writings.

3.2.4 Task 4 - Context maps

'Context-maps', a technique due to Bloom [3], was used as a tool to study the propositional knowledge as well as personally meaningful understandings of students about the forest, and plants in the context of a forest.

The context maps constructed by students, involved presenting on paper, through drawings, examples or descriptions, all ideas that occured to them ("whatever comes to your mind") connected with the stimulus word, 'forest' written initially on a blank page. Students were then asked to connect those ideas or descriptions which were related to each other and to label them appropriately. Students were free to organise their ideas in any way they liked.

The context maps task was conducted in the classrooms. While all 40 maps by the tribal students from grade 6 were analyzed, for ease of analysis, the number of context maps selected from the urban school (grade 6) were limited to 40.

3.2.5 Task 5 - Writing about the forest

The context map drawing task was followed by a 'writing' task, where the students wrote an essay describing an Indian forest to a foreigner. This task too was conducted in the classroom. Again, as in the context maps task above, writings of 20 urban students and 25 tribal students, all of grade 6, were selected for analysis.

3.3 Interaction with students

At this point, our differing interaction modes with the two groups, urban and tribal, needs to be considered. With the tribal students, we spent about five hours at a stretch once each month, during which time we carried out many activities. This was consistent with the regular teaching sessions in the tribal residential schools, which were noticed to be more leisurely. All the tribal students participated enthusiastically in the activities, whether out of class or in the classroom. In particular, in all drawing and writing tasks, they took pains to draw as best as they could and often wrote more than the required page.

We interacted with every group of urban students over thirty five minutes each week. During this time, at most one activity could be completed. Most of the activities in this study needed more than one session with the urban students. Such activities were appropriately split, for example into the drawing and writing tasks. This, however, was also the pattern of regular classes in this school. Our interactions with the urban students, coming at the end of their school day, were often less welcome for many students and had to be carried out in a less leisurely manner than in the tribal schools. Only about half of the class of 60 urban students willingly cooperated in the activities, as evidenced from their efforts in the herbarium activity and the drawing and writing tasks. The result was a reduction in the urban sample size for some of the tasks. In the selection of response sheets for quantitative analysis, since the number of urban students was larger, urban students who had written too little were dropped from the analysis. Yet the different circumstances of task administration in the two samples might have led to some bias against urban students which should be kept in mind while looking at the comparative analysis.

Chapter 4

Results: Students' ideas about plants

4.1 Categorising the plants

The anthropological and ethnobotanical views of folk taxonomies of plants [1] are supported by the results of the classification task. The 8 tribal students of grades 5 and 6 used 'plants' (*vanaspati*) to denote the whole class of plants. They called them tree, bush, vine, cactus, grass, etc., which are life-form class names. They also used classes like, flowering trees, fruit trees, vegetable plants, etc., in the classification task. For instance, they justified the grouping of plants in one pile "because they are all 'fruit trees' (*phal dete, phal denari jhad*)", or 'flowering plants' (*phool jhad*), 'vegetable plants' ("gives vegetables" — *bhaji detey*).

In the herbarium and drawing tasks, when all students were asked to name a plant each, they most frequently used the generic name (tree, eg. *amba, naral, bhendi, biti*; vine, eg. *padwal*). They also referred, in some cases to the specific class (*amba — hapus amba, biti — laal biti, limb — methi limb, kadu limb*), and did not refer to a varietal name eg. *Ratnagiri hapus.*

The scientific classification is similar to this hierarchy at the generic, specific and varietal levels. A comparison between folk taxonomies reported by Berlin [1] and the names used by students in this study is given in Table 4.1. Higher levels in the scientific classification, like family, class, order, and division, do not correspond in any way to the folk names.

Table 4.1: A model for analysing lay person's scheme for naming plants.

Group	Model names	Students' names
Plant	most abstract, inclusive level	plant (vanaspati)
Life-form class	tree, bush, vine	tree, bush, vine, cactus, grass
Generic class	oak, maple, ash (most frequently used)	mango, coconut, *bhendi, biti, chavli*
Specific class	Spanish oak, red oak, sugar maple	*red biti, hapus amba*
Varietal name	Southern red oak	*Ratnagiri hapus amba*

The spontaneous categories of students, more inclusive than the generic level, like flowering trees, fruit trees and vegetable plants, were used to analyze the variety and frequency of plants cited. Some trees like *vad* and *peepul* were variously classified by the students. When they did classify them together, they gave a reason of social or religious significance. Hence, such trees have been classified as 'socially significant trees'.

4.2 Herbarium collection

4.2.1 Number and variety

Students collected a great variety of plants distributed over many categories. The plants chosen by the tribal and urban students differed in two ways: the total number of plants in each category, and the variety, or the number of distinct names, within each category. The number of plants within each category given by the urban and tribal students for the herbarium activity is compared in Table 4.2, which also lists the number of distinct names of plants in each category. Since each student gave one herbarium sample, sum of the plants in all categories together equals the number of students, urban or tribal, participating in the activity.

The salient features of the responses to the herbarium questionnaire are given in Table 4.2, shown in the bar graph in Fig 4.1, and discussed below.

Figure 4.1: Number and variety of plants given by tribal and urban students in the herbarium task

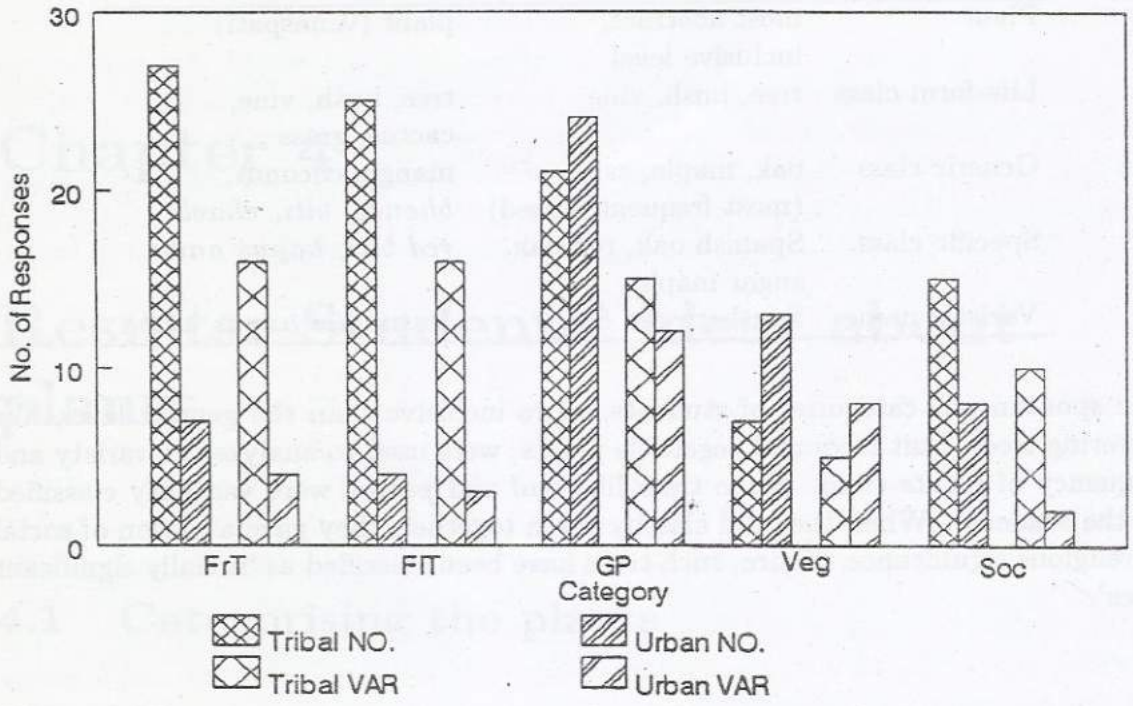


Table 4.2: Number (No.) and variety (Var.) of plants in the herbarium task

Category	Tribal			Urban		
	No.	%	Var.	No.	%	Var.
Fruit trees	27	27	16	7	12	4
Flowering trees	25	25	16	4	7	3
Garden Plants	21	21	15	24	41	12
Veg. Plants	7	7	5	13	22	8
Grass/Water plants	4	4	4	2	3	2
Other socially significant plants	15	15	10	8	14	2
Total	99	99	66	58	99	31

a. Number and Variety of Plants

- **Tribal students gave a greater variety of plants than did urban students. The majority of their choices ($> 70\%$) were evenly distributed over fruit trees, flowering trees and garden plants.**
- **Tribal students gave a significantly greater number of fruit ($z = 2.46$) trees.**

- The flowering trees selected by tribal students were significantly greater in number ($z = 3.34$) as well as variety ($z = 2.51$).
- Forty percent of all plants chosen by urban students were common garden plants, like *jaswand, tulsi*. These were significantly greater in number ($z = 2.63$) and variety ($z = 2.09$) than the garden plants given by tribal students.
- Urban students also chose a larger number of vegetable plants (22%) than did tribal students (7%). Vegetable plants selected by the tribal students were different from the choices of urban students.
- Tribal students chose many socially significant trees, (*vad, peepul, neem, babul*).

The tribal students in this study, who mostly live on the outskirts of forests, are dependent on a wider variety of plants — fruit and flowering trees of the forest, and other trees and plants of local social, medicinal and religious significance. Thus, it is not surprising that they selected a large variety of plants in each of these categories.

However, as it happens, there are also many trees, including flowering, fruiting and other socially significant trees, near the school of the urban students in this study. Flowering trees like *bhendi, gulmohar*, copper pod, *siris, palas, sevri/savar, rui*; fruit trees like mango, fig, coconut palm, tamarind; and other trees like neem, *babul, peepul, vad*; grow in and around the school grounds. Yet the urban students chose only mango, tamarind, *seetafal* among fruit trees, the fruits of which they like to eat! *Jaswand* (17%), and *tulsi* (5%), dominated their choices in the garden variety, these being the plants that they use in their everyday lives — the flowers and leaves are used in perfoming *pooja*.

Complementarily, although a large variety of vegetable (and garden) plants are found around the *Ashramshalas*, from their greater occurrence in the urban choices, one might guess that they play a more prominent role in the lives of urban students. The different names for the *bhendi* tree may also indicate the differing perceptions of tribal and urban students of the vegetable *bhendi*. The name for this tree is '*bhendi*' among the tribals and '*gul-bhendi*' among the urban students. For the latter group, the prefix *gul* may serve to differentiate the tree from a commonly used vegetable (*ladies finger* or *okra*) of the same name. For tribal students, having the same name for the tree as well as the vegetable may reflect the lesser relevance of the vegetable *bhendi*. It appears likely that, in the herbarium collection task, more than the availability of a variety of plants in the environment, the perceived dependence on the plant, and its everyday relevance, influenced students' choices.

b. Human Uses

- Although both urban and tribal students mentioned uses of flowers and fruits, urban students gave fewer instances of uses. For example, in the case of the mango tree, urban students mentioned "fruit is used for making mango juice and pickles". On the other hand, tribal students wrote, "the fruits are eaten and pickled, flowers are used as medicine and food, leaves serve as decoration on doors and on religious occasions". The most common use cited by urban students for flowers was, making garlands for God.

- Tribal students often expressed positive feelings about the plants they had chosen, in addition to their uses, in response to the question "What thoughts come to mind when you see this plant ?" Some responded with, "we like this plant because it gives us fruits". A tribal fifth grader wrote about the *takla* plant: "The use of this plant is .. when a wound in our body bleeds, ..after squeezing the juice out of the leaves of the *takla* plant .. drip the juice on the blood .. and the bleeding stops .. and the wound heals in two days ... and *takla* is also used for burning (as fuel-wood). Hence when we see this plant, we feel we want (have a desire for) it."

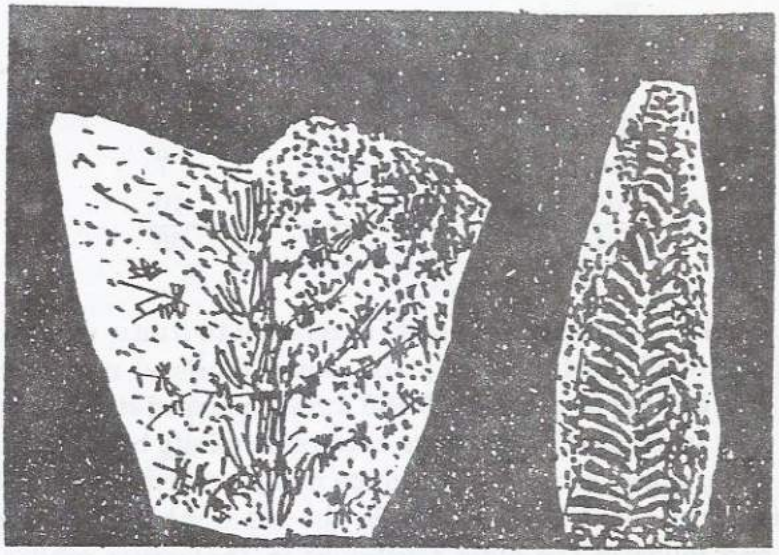
It appeared that students' feelings were often linked to the uses of plants, as food, medicine or fuel. At other times they described the flowers as beautiful and 'gladdening'.

Curiously, a few urban students stated that leaves were used for burning and making coal. This mistaken concept may have arisen from a reference in lesson 23 of the old Maharashtra Board textbook for grade 5 [22], where there are two adjacent pictures; one showing a leaf and another showing a fossil of a leaf on a chunk of coal (*dagdi kolsa* or bituminous coal) Fig 4.2. Besides, the text mentions that plants yield coal.

c. Other details of structure

Both urban and tribal students' responses had a few structural descriptions, for instance, *chini gulab* leaves stand erect (*'saral ubhi'*). In contrast to textbooks that abound in structural descriptions and underplay feelings, there were higher instances of uses and feelings from students, especially from tribal students.

Figure 4.2: Picture from grade 5 textbook showing 'leaf' and 'fossil' on *dagdi kolsa*



4.2.2 Students' herbarium samples and textbook examples: a comparison

It would be interesting to ask what influences students' choice of plants in the herbarium activity: access and availability in the surroundings, familiarity and everyday use, or mention in the textbooks. A comparison of the herbarium samples brought by students with the trees and plants in their surroundings has been made in Section 4.2.1. It appears that everyday use of plants and plant products, as well as their perceptions of use and 'feelings' about the plants, influenced the variety and number of herbarium samples. In the urban students' case, all 'useful' plants may not be found in their surroundings, while in the case of tribal students, the mere presence of a variety of plants in the forest has traditionally led to their use in the everyday life of their community.

One might expect that four years of formal schooling with similar textbooks would have a certain homogenising influence on urban and tribal students. We tried to understand the possible influence of textbooks by comparing the variety of herbarium samples brought by tribal and urban students with those given in the new textbooks for grades 3 and 4 (grades 1 and 2 do not use textbooks). The exercise was repeated for the drawing and writing task, and is reported in Section 4.5.

Table 4.3: Plants in new Maharashtra State textbooks of grades 3 and 4.

Category	Variety
Fruit trees	16
Flowering trees	3
Garden plants	10
Veg. Plants	15
Grass/water plants	4
Socially significant trees	7
Food grains (crops)	10
Total	65

The science textbooks refer to several plants in relation to fruits, vegetables and crops. Table 4.3 gives the number of distinct plant names (variety) mentioned under each category in the new textbooks of grades 3 and 4. The ideas of structure and taxonomy are introduced only in grade 6. Textbooks categorise plants by their life form names, like tree, bush, vine, grass, etc., and introduce many generic names. New textbooks give a larger variety of plant names than do the old textbooks. Although in many cases students had followed the older textbooks in the earlier grades, comparisons here are done with the new textbooks.

Fig 4.3 shows the number of varieties of plants common to the three components — herbarium samples of urban and tribal students and textbooks — in each of 5 main categories, namely fruit trees, flower trees, garden plants, vegetable plants and socially significant trees. Crop plants, like rice, wheat, *jowar* and *bajra* did not appear in students' responses, hence are not included in the figure.

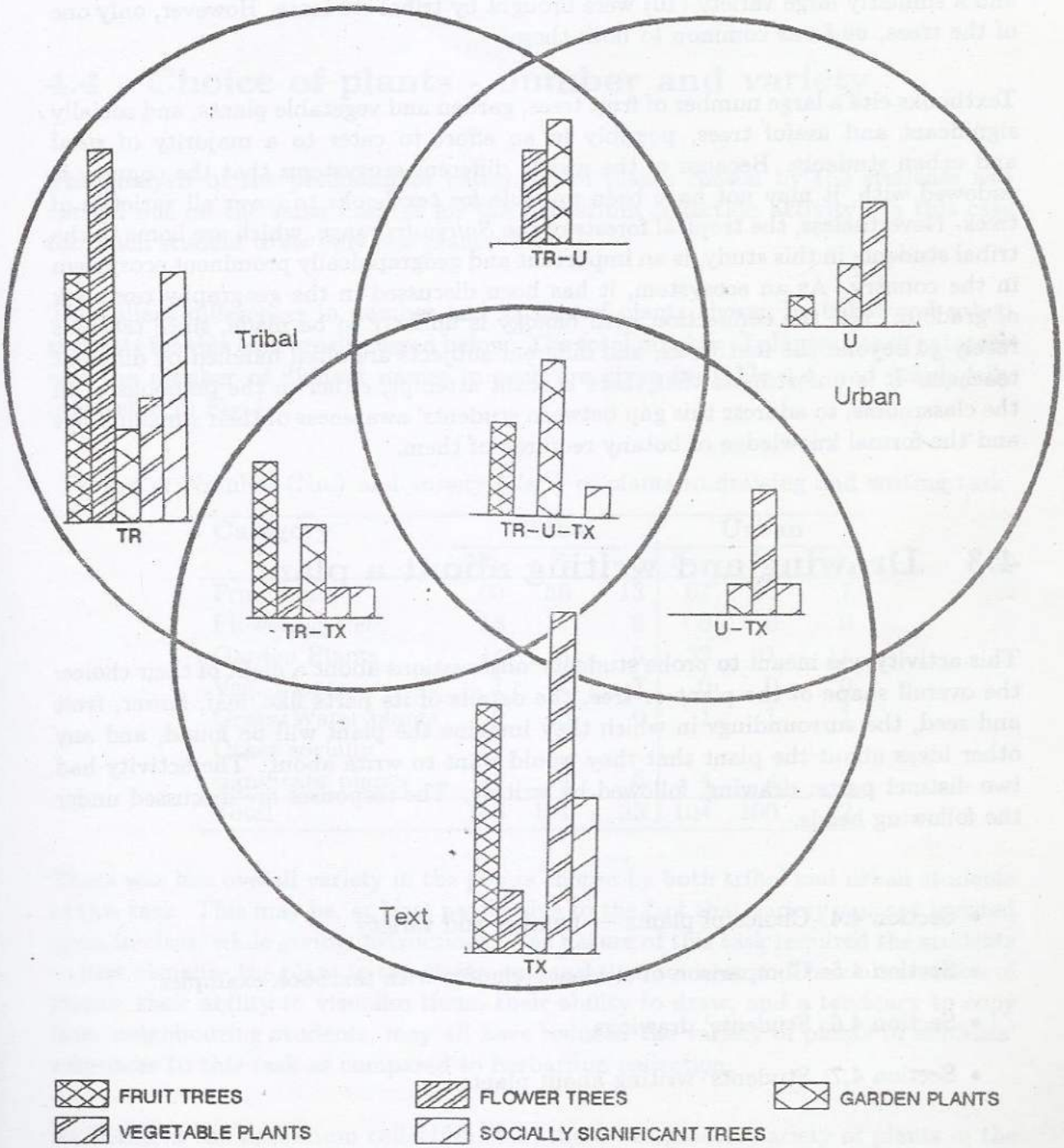
Tribal students brought herbarium samples of many plants that did not appear in the textbooks, largely in the categories of fruit, flowering and socially significant trees. About two thirds of the plant samples brought by the tribal students, and about half those brought by urban students, were different from those given in the text.

Only 3 flowering trees were mentioned in the two textbooks, in contrast to 13 different flowering tree samples brought by tribal students.

Half the plants brought by urban students, including half the garden plants brought by them, were different from those given in the textbooks.

Not one of the 10 crop plants that are mentioned in the new Maharashtra State textbooks (grades 3 and 4) were brought either by the tribal or urban students. These were definitely not available to the urban students. The tribals also would have had to go farther to bring a crop sample, while a large variety of trees and

Figure 4.3: Variety of plants in herbarium task and textbooks — a comparative diagram



plants were available near at hand. At least for the herbarium task, nonavailability may account for the absence of crop plants among students' samples.

A large variety of plants of the socially significant category (7) appear in the textbooks and a similarly large variety (10) were brought by tribal students. However, only one of the trees, *vad* was common to both these.

Textbooks cite a large number of fruit trees, garden and vegetable plants, and socially significant and useful trees, possibly in an effort to cater to a majority of rural and urban students. Because of the widely different ecosystems that the country is endowed with, it may not have been possible for textbooks to cover all varieties of trees. Nevertheless, the tropical forests of the *Sahyadri* range, which are home to the tribal students in this study, is an important and geographically prominent ecosystem in the country. As an ecosystem, it has been discussed in the geography textbook of grade 6. Yet, the connection with biology is unlikely to be made, since teachers rarely go beyond the textbooks, and different subjects are often handled by different teachers. It is unfortunate that there is scant attempt, either in the texbooks or in the classrooms, to address this gap between students' awareness of their surroundings and the formal knowledge of botany required of them.

4.3 Drawing and writing about a plant

This activity was meant to probe students' observations about a plant of their choice: the overall shape of the plant or tree, the details of its parts like, leaf, flower, fruit and seed, the surroundings in which they imagine the plant will be found, and any other ideas about the plant that they would want to write about. The activity had two distinct parts: drawing, followed by writing. The responses are discussed under the following heads.

- Section 4.4: Choice of plants — number and variety
- Section 4.5: Comparison of students' choices with textbook examples
- Section 4.6: Students' drawings
- Section 4.7: Students' writing about plants

Participants in this task numbered 104 urban students of grade 6, and 108 tribal students of grades 5 and 6. The students were asked to first draw the overall shape

of the plant and its features, and then to fill out its surroundings. They also drew, on a separate sheet, a branch, a leaf, flower, fruit and seed, of the same plant, in detail. Unlike in the herbarium task, students were not required to choose different plants. Different students could draw the same plant.

4.4 Choice of plants - number and variety

The analysis of the predominant categories of plants chosen by the students was carried out on the same lines as for the herbarium collection activity. In this case too, each student drew only one plant.

The salient differences in number and variety of plants chosen by tribal and urban students for this task are discussed below. The total number of plants in each category and the number of distinct names in each are given in Table 4.4, and graphically illustrated in Fig 4.4.

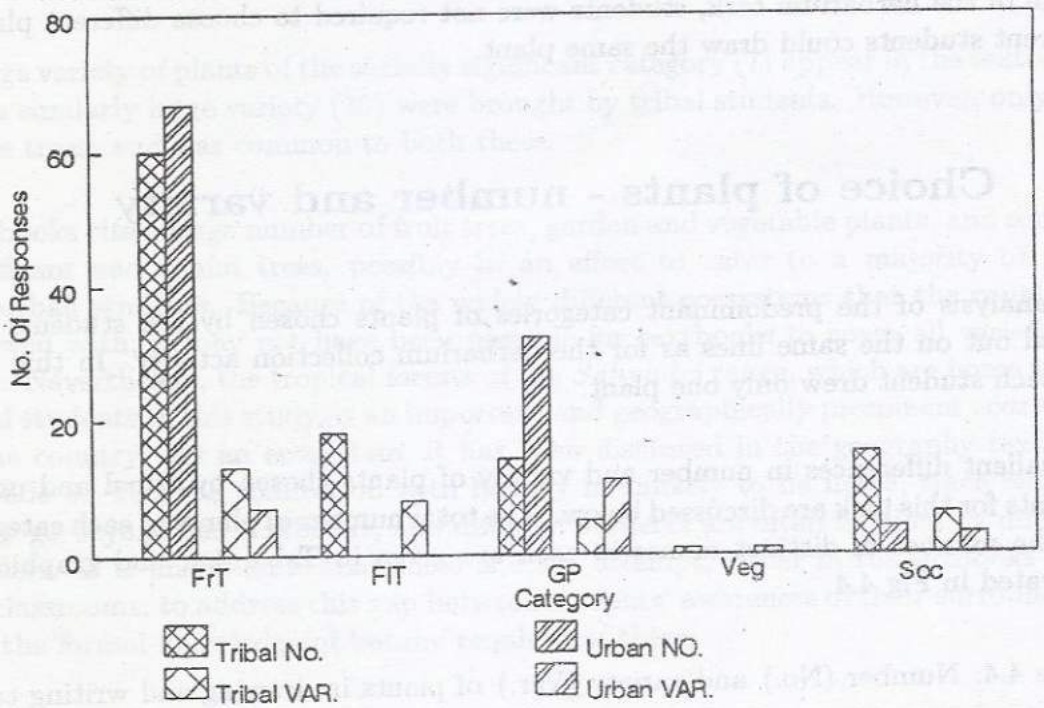
Table 4.4: Number (No.) and variety (Var.) of plants in drawing and writing task

Category	Tribal			Urban		
	No.	%	Var.	No.	%	Var.
Fruit trees	60	56	13	67	64	7
Flowering trees	18	17	8	0	0	0
Garden Plants	14	13	5	32	31	11
Veg. Plants	1	1	1	0	0	0
Grass/Water plants	0	0	0	1	1	1
Other socially significant plants	15	14	6	4	4	3
Total	108	101	33	104	100	22

There was less overall variety in the plants chosen by both tribal and urban students in this task. This may be, at least partly, due to the fact that variety was not insisted upon in class, while giving instructions. The nature of this task required the students to first visualise the plant in the classroom, and then to draw it. Their observation of plants, their ability to visualise them, their ability to draw, and a tendency to copy from neighbouring students, may all have reduced the variety of plants in students' responses to this task as compared to herbarium collection.

As found in the herbarium collection task, there was greater variety of plants in the drawings of tribal students than in urban students' drawings. Urban students largely drew fruit trees or garden plants.

Figure 4.4: Number and variety of plants in the drawing and writing task



Fruit trees were drawn by 60% of all students. Fruit trees drawn by tribal students were marginally less in number ($z = 1.8$), and yet greater in variety than those drawn by urban students ($T = 13, U = 7$). Besides mango, coconut, cashew, jackfruit and fig, all native to the forest region where the tribals live, their choice also included typical cultivated varieties like apple and grapes. The fruit trees drawn by urban students were mostly the three stereotypical ones; coconut palm, tamarind and mango. The coconut palm is often perceived to be easy to draw and is part of all typical 'rural scenes' in books. The sour fruit of the tamarind is inexpensively available with roadside vendors in urban areas and is a favourite with children. The mango is a summer treat. No tribal student drew a tamarind tree.

Flowering trees were drawn by 18 tribal students, and included 8 different varieties, while urban students drew none.

Garden plants figured less in tribal students' drawings, both in number ($z = 3.8$) and variety ($T = 5, U = 11$), than in urban students' drawings. The latter drew all the garden plants the tribal students did and as many more. In fact, the incidence of garden plants drawn by tribal students may have been overestimated, since they included plants like *jaswand* and *ghaneri*, which are used as garden or fence plants in urban and rural areas, but are also found growing in the wild.

Chavli was the lone vegetable plant drawn by a tribal student, while the urban students drew none.

Fifteen tribal students drew 6 different socially significant trees, while only 4 urban students chose to draw 3 different trees of this category (*banyan, peepul, nilgiri*). The other trees (e.g. *sag, reeti*) drawn by the tribal students are not common in the environment of urban students.

The drawings are discussed in greater detail in the following sections, first in terms of students' choices in comparison to textbook examples, followed by a section on the details given by the students in their drawings and writings.

4.5 Comparison of students' choices with textbook examples

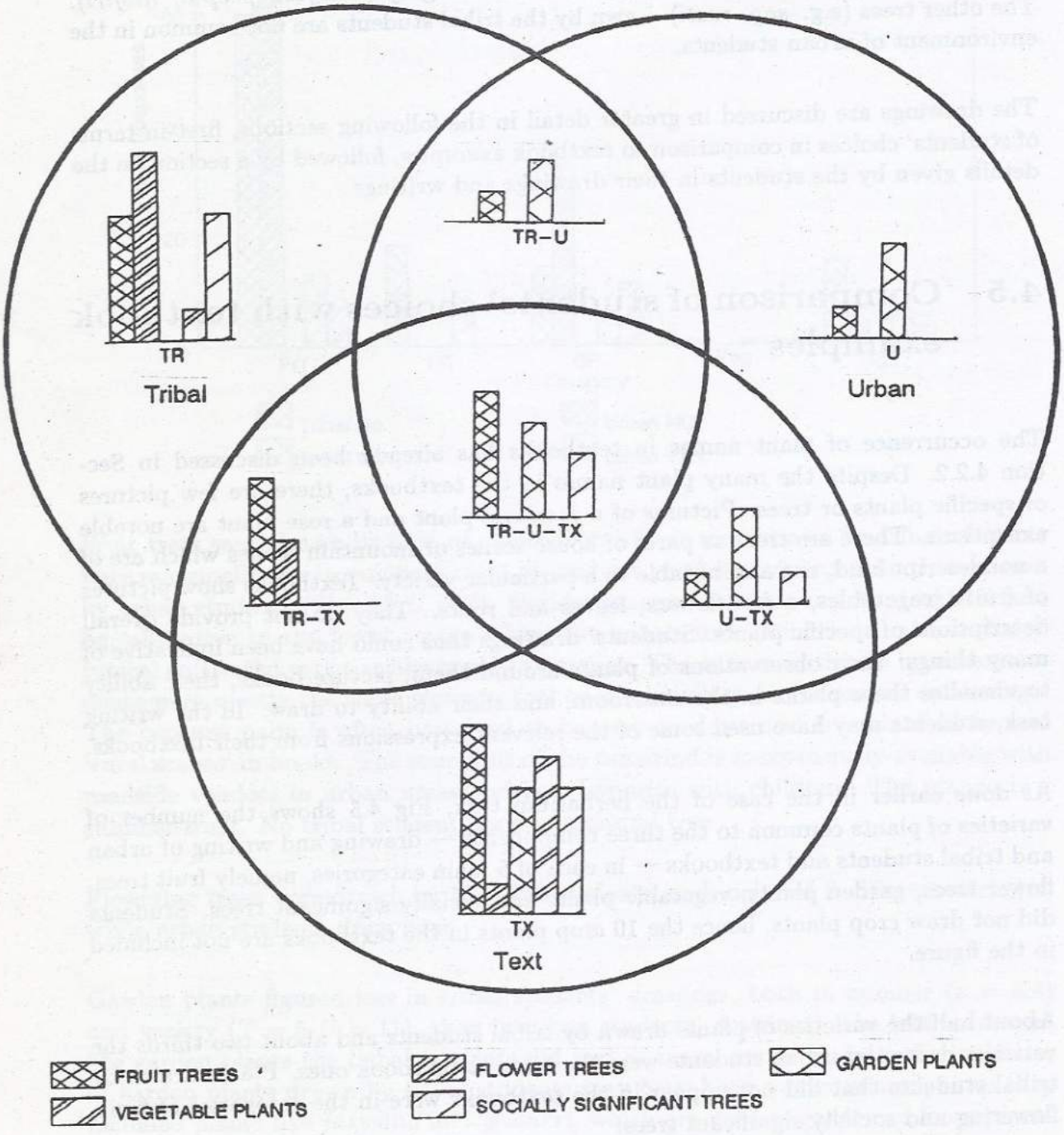
The occurrence of plant names in textbooks has already been discussed in Section 4.2.2. Despite the many plant names in the textbooks, there are few pictures of specific plants or trees. Pictures of a *jaswand* plant and a rose plant are notable exceptions. There are trees as parts of house scenes or mountain scenes which are of a nondescript kind, not attributable to a particular variety. Textbooks show pictures of fruits, vegetables, a few flowers, leaves and roots. They do not provide overall descriptions of specific plants. Students' drawings thus could have been indicative of many things: their observations of plants around them, picture books, their ability to visualise these plants in the classroom, and their ability to draw. In the writing task, students may have used some of the relevant expressions from their textbooks.

As done earlier in the case of the herbarium task, Fig 4.5 shows the number of varieties of plants common to the three components — drawing and writing of urban and tribal students and textbooks — in each of 5 main categories, namely fruit trees, flower trees, garden plants, vegetable plants and socially significant trees. Students did not draw crop plants, hence the 10 crop plants in the textbooks are not included in the figure.

About half the varieties of plants drawn by tribal students and about two thirds the varieties drawn by urban students were the same as textbook ones. Plants drawn by tribal students that did not appear in the textbooks were in the categories of fruit, flowering and socially significant trees.

Five of the fruit trees drawn by the 60 tribal students were different from those

Figure 4.5: Variety of plants in tribal and urban students' drawings and in textbooks — a comparative diagram



mentioned in textbooks. Two of the fruit trees drawn by urban students, *badam* and *phanas*, did not find mention in the textbooks.

Flowering trees, drawn only by tribal students, were mostly different from the 3 given in the two textbooks.

In the remaining categories, namely, vegetable ($z = 4.5$) and garden ($z = 2.2$) plants, and socially significant trees ($z = 2.4$), tribal students' drawings had significantly less variety than did the textbooks. Yet, the fact was that they could draw so may varieties from memory, without having any drawings in their textbooks.

Most of the socially significant trees drawn by the tribal students were also different from textbook ones.

Urban students drew all the garden plant varieties drawn by tribal students, some mentioned in the textbooks and not drawn by tribal students, and more. In urban areas, potted plants around the house, courtyard or even on balconies afford students an opportunity for close observation of plants. 'Money plant', *jaswand*, *gulab*, *chini gulab* are all examples of commonly grown terrace garden plants which were drawn by urban students.

Clearly, in this task, as in the herbarium task, textbooks have had marginal influence. Besides, particularly in this task, textbooks have been of little help in terms of pictures of plants, either familiar or unfamiliar ones. This aspect is discussed further in the following section.

4.6 Students' drawings

It has been said [15] that, "No drawing is an automatic print-out of some perceptual world ... What is seen or intended must be translated into the action of drawing, and we need to understand fully the nature of translation and the nature of action". These comments have been made while studying emotional and cognitive developmental features in the drawings of young children. In this context, Jacqueline Goodnow [15] holds the view that it is often of value simply to point out a relationship — for example to notice that a drawing has a certain feature, or that two drawings are like one another in this way and unlike one another in that. The observer then has a new way of seeing or a new set of questions. It is also possible to predict when certain kinds of drawings are likely to occur, or whether we can elicit certain kinds of drawings by setting up certain conditions.

The following analysis focuses not on cognitive development, but on 11-15 year old students' observations and knowledge about plants.

In particular, we look for evidence for realism, and attention to details of structure. Although an analysis of the drawing for the concept of space may yield interesting results about how the students cope with multiple relationships and consider more distant reference points [26], this does not fall within the purview of the present study.

The anaysis starts from the premise that the drawings of plants by the students are their translation of what they see and 'think' about the plant, and hence provide important clues to their understanding of the plants. Certain features of the drawings have been pointed out that indicate possible lacunae in the teaching of botany in classrooms. The nature of these features, or 'patterns' in them, may help us understand what needs to be addressed if the school botany is to form a useful scientific basis for the students to understand their environment. The salient features of the drawings of urban and tribal students are described below.

4.6.1 Accuracy of drawings

Overall, tribal students were more accurate in their drawings of trees, while urban students were more accurate in drawing garden plants. The variety of large trees drawn by tribal students was also larger. About a third of the urban students drew garden plants. Among large trees, urban students drew only the coconut palm correctly.

Inaccurate trees by urban students

An urban sixth grader drew prominent adventitious roots on the peepul tree, shown in Fig 4.6. The banyan, the peepul and the fig all belong to the same generic class, viz. Ficus, and have adventitious roots. Of these, only in the banyan tree are they very prominent, and hang separate from the trunk. The student in this case may have overemphasised the roots, or made an observational error. The round fruits were attached to the branch by a stalk, rather than growing directly on the branch. The leaves were oblong instead of the well-known heart-shaped ones. The drawing had stereotypical flowers, also at the end of stalks.

Another urban sixth grader drew a *peru* tree, with flowers growing on stalks from the main trunk, whereas the round — rather than pear-shaped — fruits were shown growing at twig terminals. It is apparent from Fig 4.7 that the student did not make

any connection between the flower, the fruit, and the seed. Besides, the flowers were oversized, and the fruits were smaller than the flower, contrary to what is observed.

Another example was placement of the fruits (Fig 4.8) on a *tamarind* tree, which is cited in the discussion on exaggerated features.

Accurate garden plants and coconut palm by urban students

Urban students did not draw accurate pictures of big trees other than the coconut palm. They were more accurate in their drawings of garden plants.

About forty percent of urban students drew coconut palms. They drew the characteristic overall features of a coconut palm: ribbed trunk, location and shape of leaves and fruits. Besides, these trees were shown, curving artistically, in very picturesque surroundings, by a stream or river, with a boat in the stream. A typical drawing is given in Fig 4.9.

Many urban students drew leaves of common garden plants, like the *jaswand* in Fig 4.10, rose in Fig 4.11, or *chini gulab* in a pot in Fig 4.12, accurately and in great detail — relative size, position, serrated leaf margins, and thorns at the nodes. Some features, like the *jaswand* flowers in Fig 4.10, were exaggerated. This plant has been drawn in textbooks, and the one in the new Maharashtra State textbook for grade 6 is a small-sized plant with rather large flowers. It had 5 leaves, 2 large flowers, and several buds. The roots of the *chini gulab* drawn by an urban student could be seen in great detail (Fig 4.12), but there was no indication of the presence of soil in the pot.

Accuracy of tribal students' drawings

Drawings of big trees by tribal students had the correct overall shape. Shape of leaves, leaf arrangement on branches, and position and shape of fruits were shown different for different kinds of trees, and were mostly correct.

Tribal students also drew roots of some large trees above the ground, while, in the same picture, small plants and saplings of large trees did not have roots above ground. Hence showing roots above ground seemed to be, for tribal students, an attempt at faithfully depicting a familiar scene. This was in contrast to some of the urban drawings where roots of potted plants were shown in detail, with no indication of soil — this appeared to be more in the spirit of making a scientifically correct drawing.

Figure 4.6: *Peepul* Tree by an urban student.

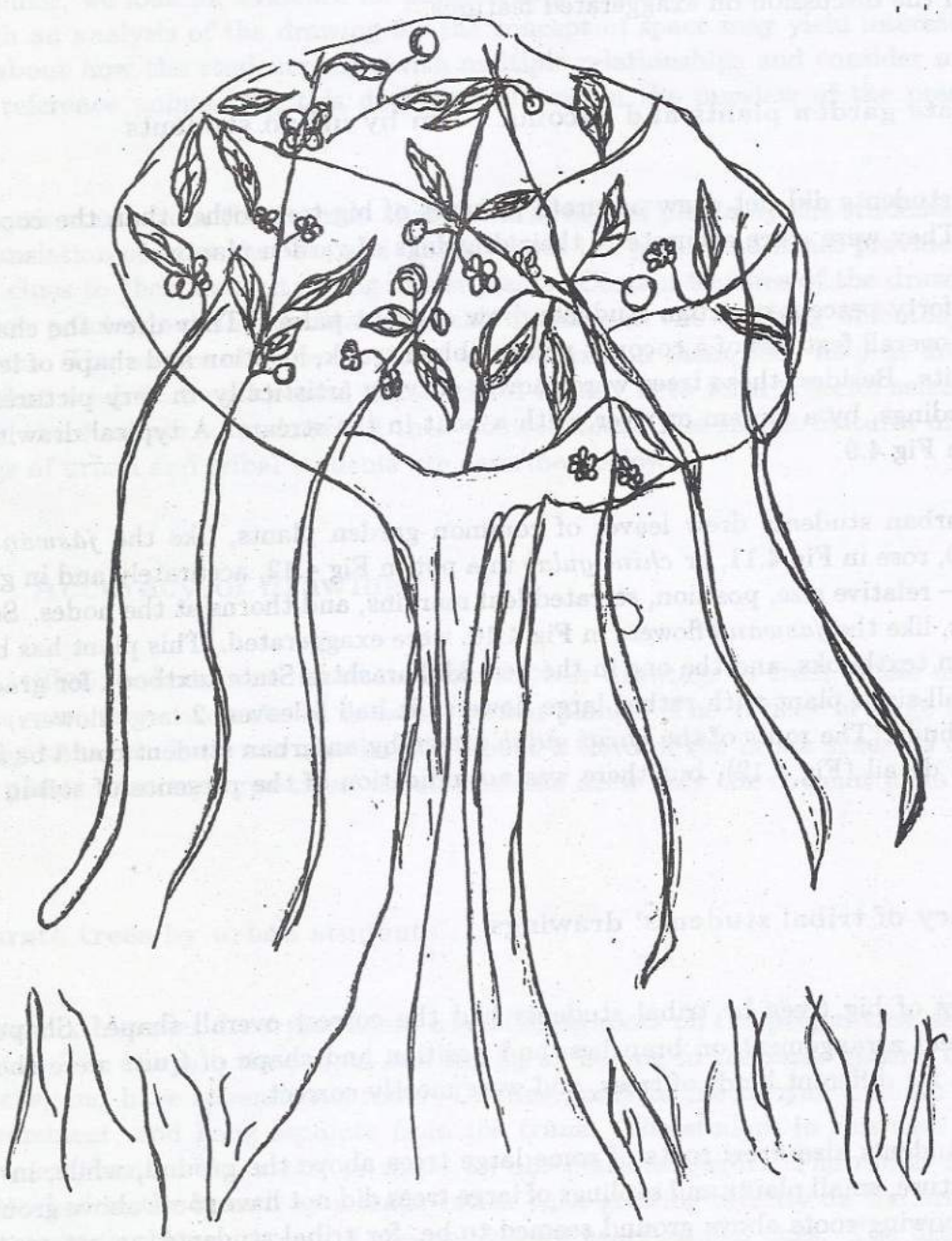


Figure 4.7: *Peru* Tree by an urban student.

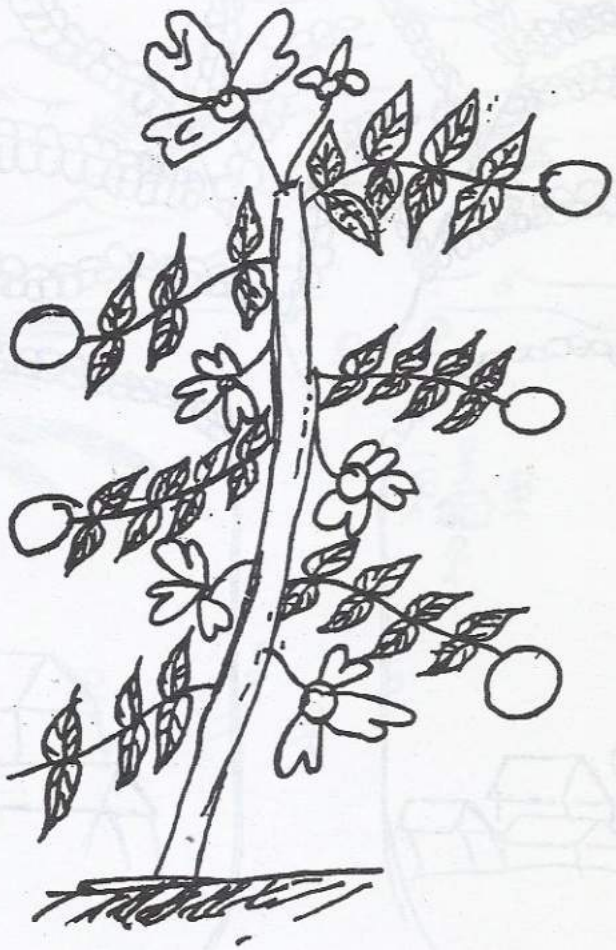


Figure 4.8: Tamarind tree by an urban student.

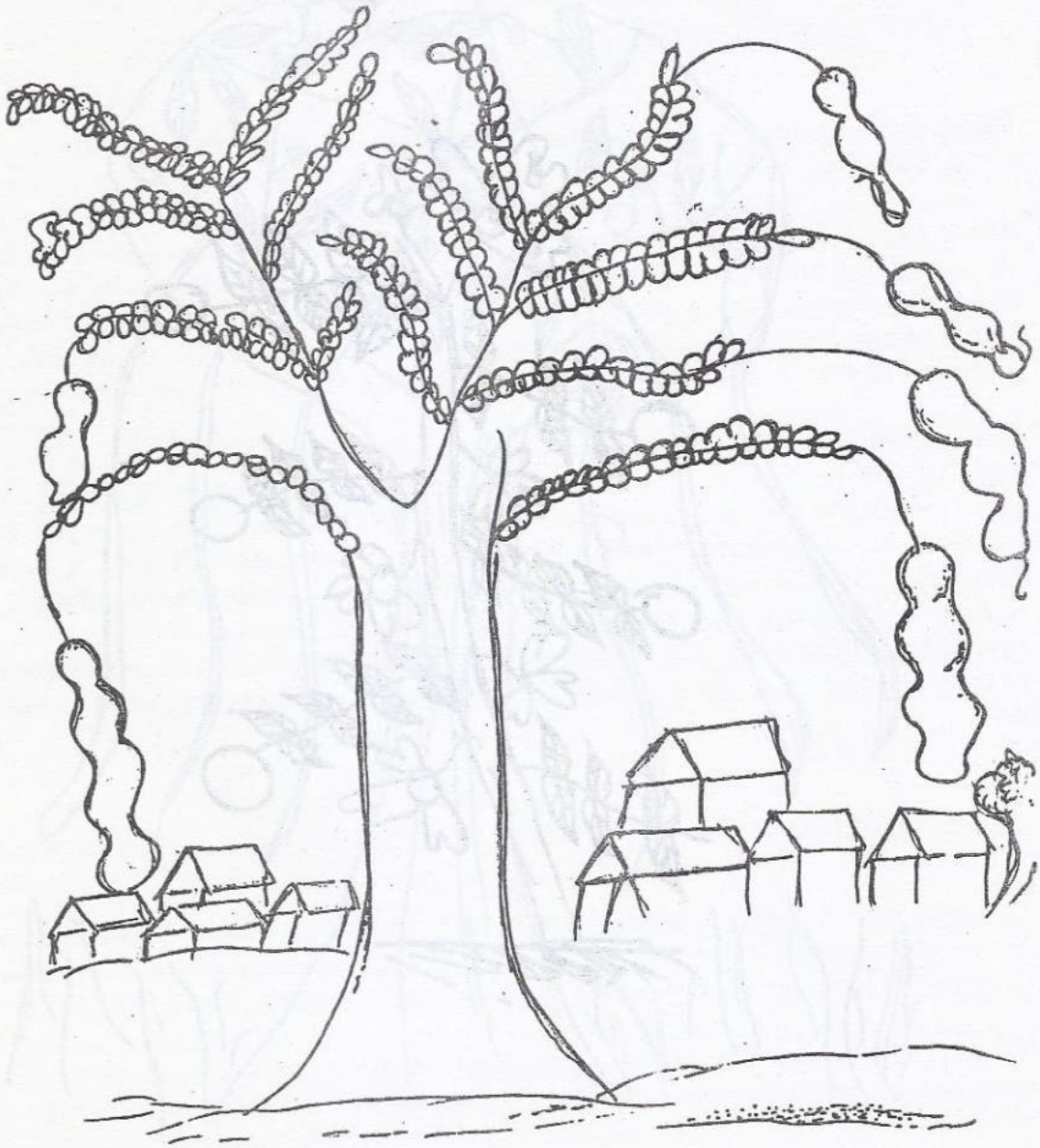


Figure 4.9: Coconut palm by an urban student, showing scenic surroundings.

Figure 4.10: *Jaswand* plants drawn by two urban students.

Figure 4.11: Rose plant by an urban student.

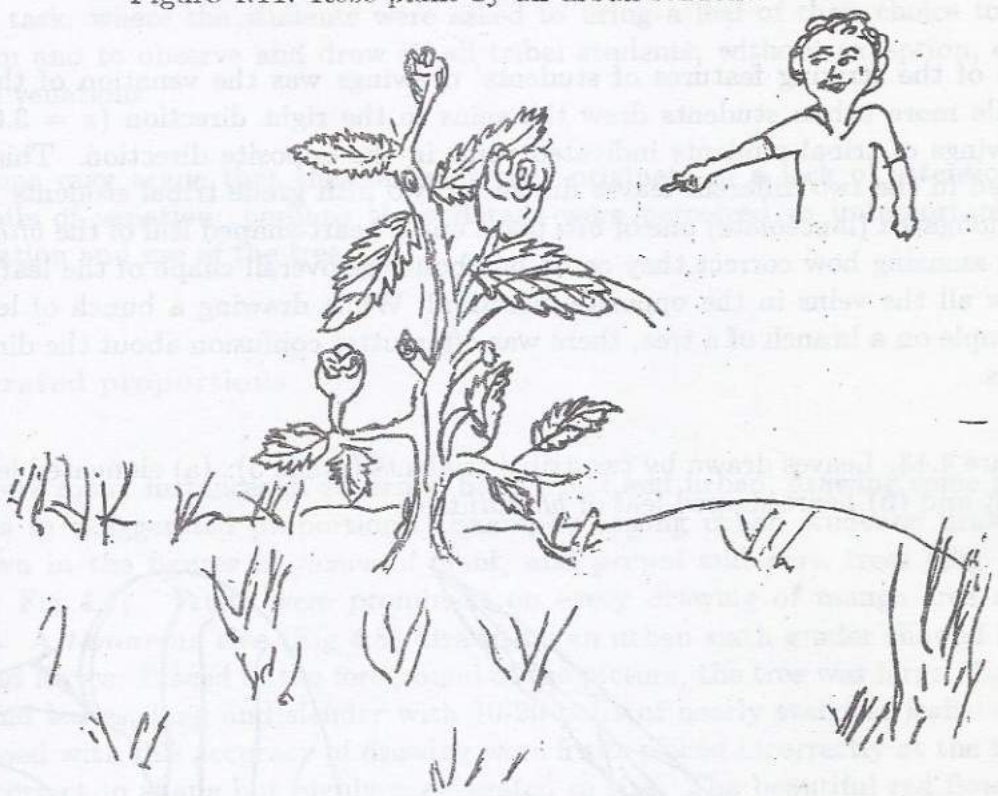
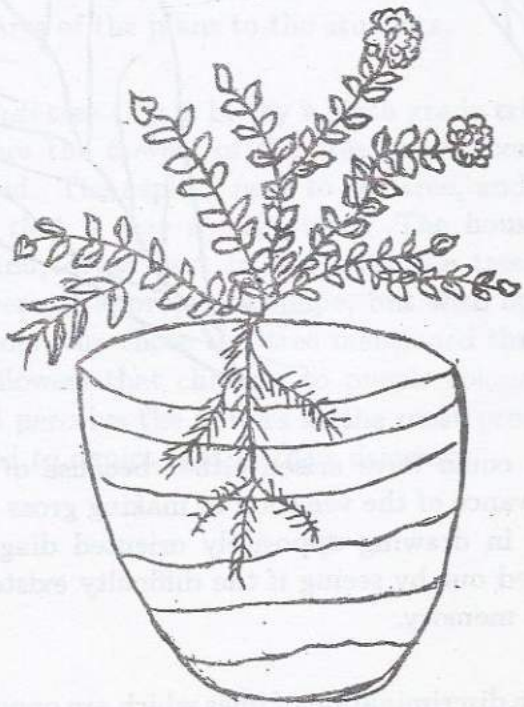


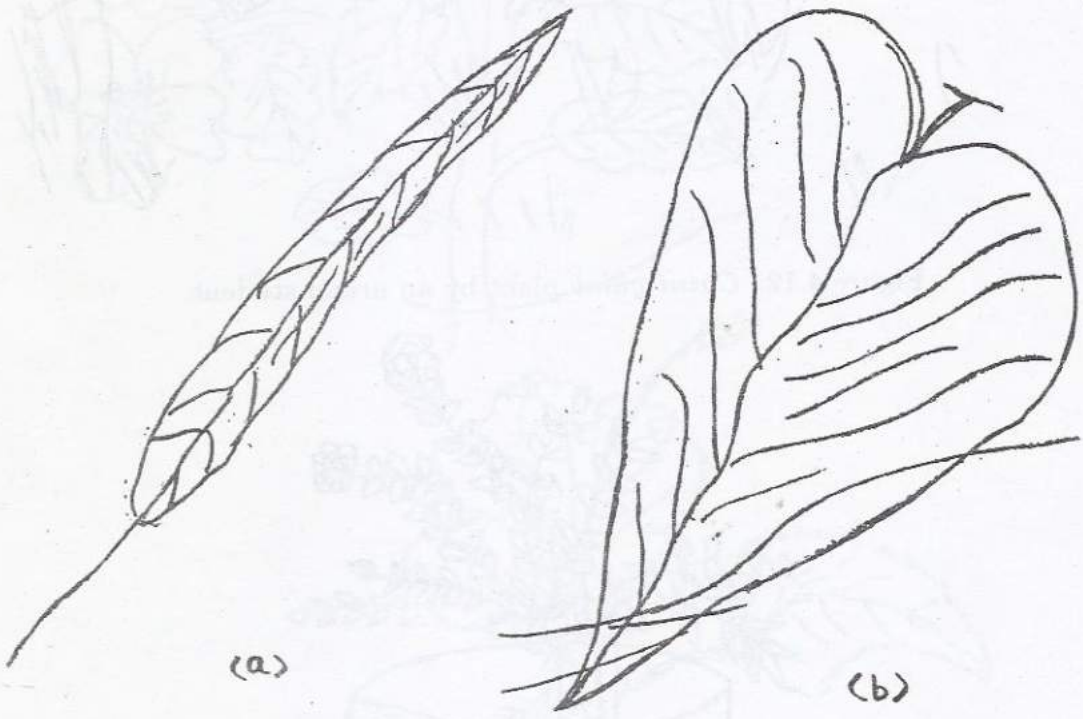
Figure 4.12: *Chini gulab* plant by an urban student.



Venation of leaves

One of the striking features of students' drawings was the venation of the leaves. While more urban students drew the veins in the right direction ($z = 3.0$), many drawings of tribal students indicated veins in the opposite direction. This is illustrated in the two different leaves drawn by two fifth grade tribal students Fig 4.13: an elongated (lanceolate) one of *biti* plant and a heart-shaped leaf of the *bhendi* tree. It is amazing how correct they could be about the overall shape of the leaf, and yet draw all the veins in the opposite direction! While drawing a bunch of leaves, for example on a branch of a tree, there was often utter confusion about the direction of veins.

Figure 4.13: Leaves drawn by two tribal students (grade 5): (a) elongated leaf of *biti* plant and (b) heart-shaped leaf of *bhendi* tree.



The confused venation could have arisen either because of lack of observation of details, perceived irrelevance of the venation in making gross identification of plants, or perhaps a difficulty in drawing oppositely oriented diagonal lines. The latter possibility could be ruled out by seeing if the difficulty existed in copying a leaf, or only in drawing it from memory.

Olson [23] noted that the discrimination of lines which are oppositely oriented obliques is the most difficult of a series of perceptual cues for orientation. This, however,

turned out to be not the case for the tribal students in this study. In a later independent task, where the students were asked to bring a leaf of their choice to the classroom and to observe and draw it, all tribal students, without exception, drew accurate venations.

Hence, one may argue that the confusion may originate in a lack of attention to the details of venation; perhaps these details were perceived as unimportant for identification and use of the tree.

Exaggerated proportions

There were many instances of students, both tribal and urban, drawing some parts of plants in exaggerated proportions. Examples among urban students' drawings are shown in the figures of *jaswand* plant, and *peepul* and *peru* trees (Fig 4.10, Fig 4.6, Fig 4.7). Fruits were prominent on every drawing of mango tree as in Fig 4.15. A *tamarind* tree (Fig 4.8), drawn by an urban sixth grader showed large fruits and leaves. Placed in the foreground of the picture, the tree was large, 'having compound leaves, long and slender with 10-20 pairs of nearly stalkless leaflets' [5]. Juxtaposed with this accuracy of drawing were fruits placed incorrectly at the tip of leaves, correct in shape but highly exaggerated in size. The beautiful red flower of the *jaswand* plant and the sour fruit of the *tamarind* tree happen to be favourites, especially with children. The size of these features may be an indication of the relative importance of these parts of the plant to the students.

The drawing of a *bhendi* tree (Fig 4.14) by a sixth grade tribal student was another striking example, where the flowers of the tree were incorrect in shape and were shown very large indeed. The sapling next to the tree, and the root structure near the ground indicated that it was a large tree. The house, that appeared to be either in the foreground, or at best in line with the tree, was also drawn much smaller. The leaves were of appropriate shape, but with opposite venation. In the herbarium task, students who chose this tree mentioned that they liked the tree for the attractive yellow flowers that changed to purple colour when about to wither. Thus the students did perceive the flowers as the most prominent part of this tree, and possibly attempted to depict that in their drawings.

Figure 4.14: *Bhendi* tree by a tribal student (grade 5).

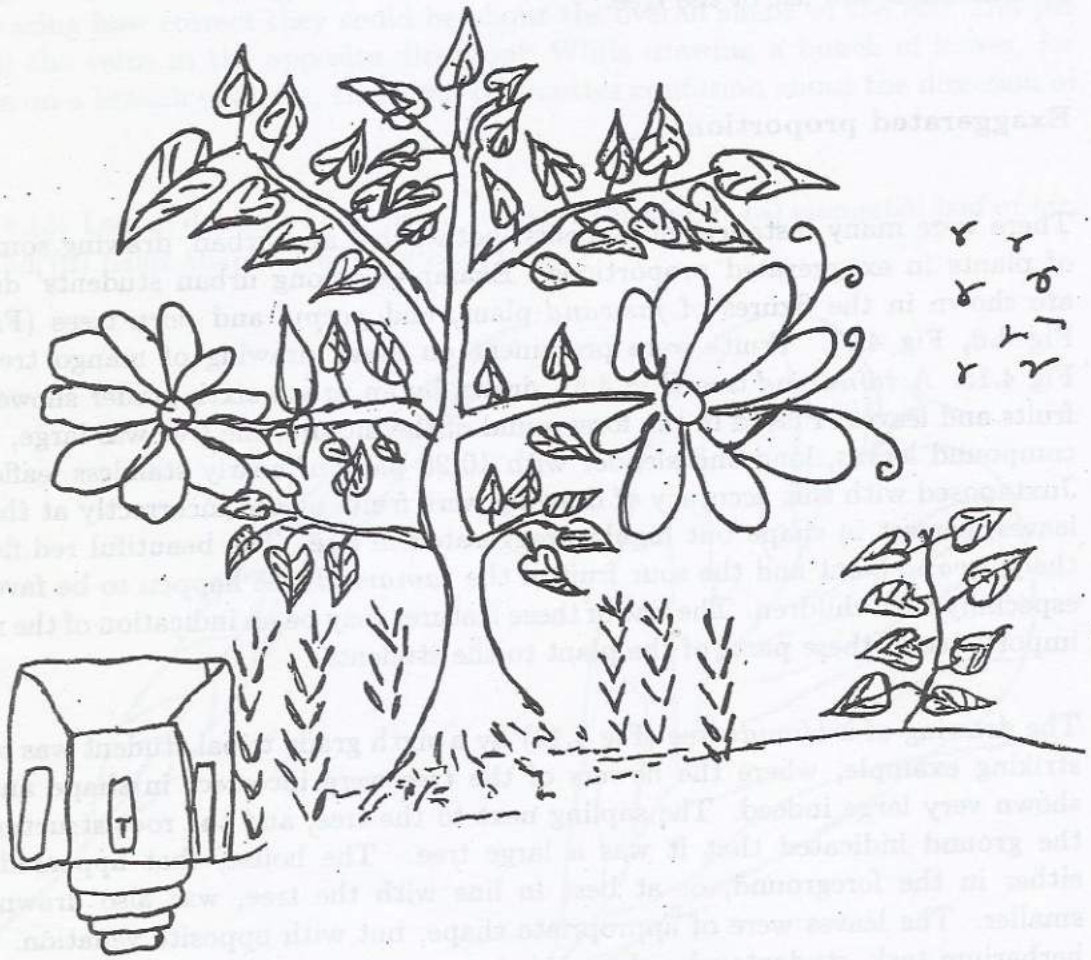
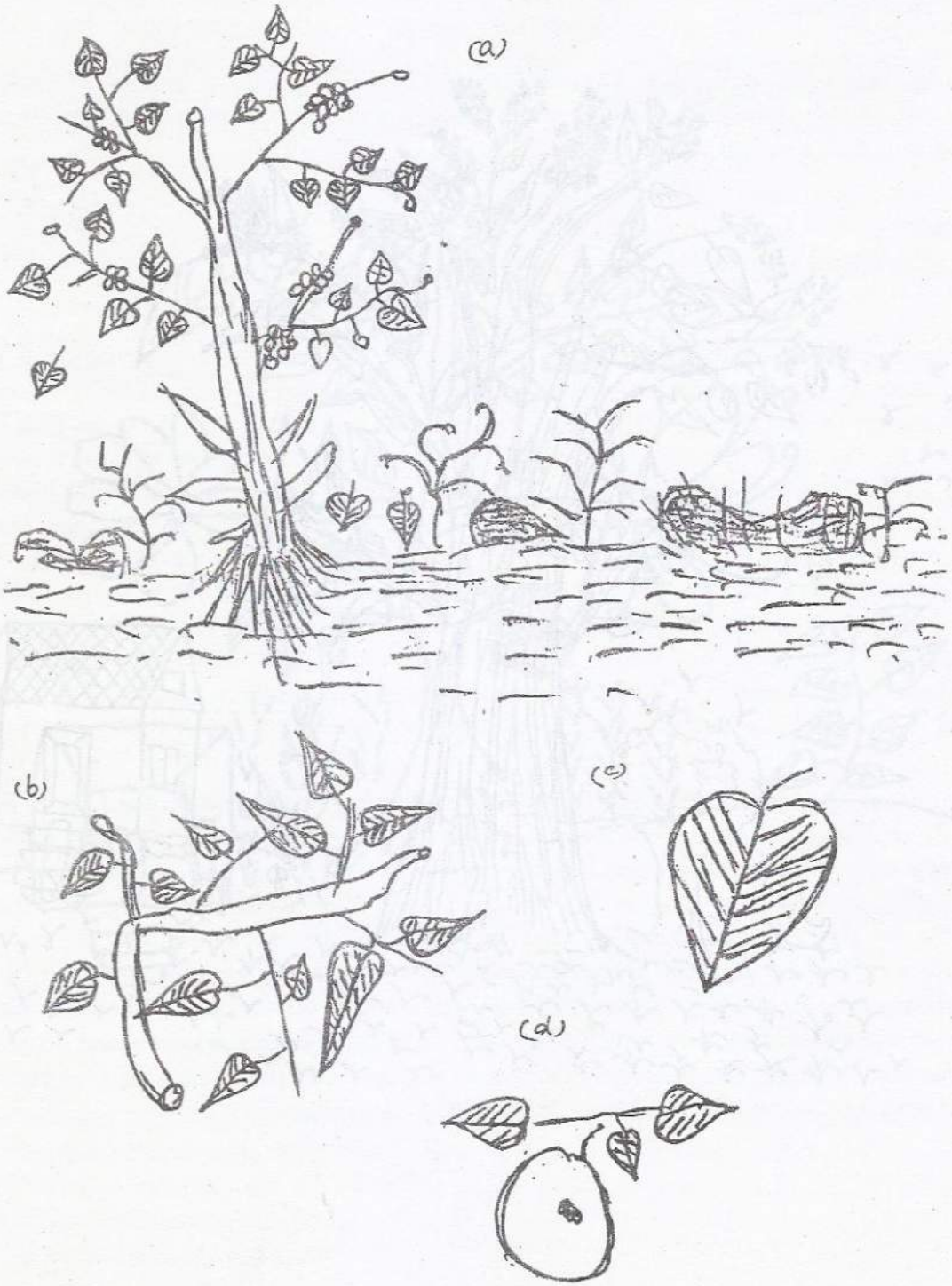


Figure 4.15: Mango tree by a tribal student (grade 5).

Figure 4.16: Fig tree by a tribal student (grade 5).



4.6.2 Ecological features and realism

These aspects were largely seen in tribal students' drawings, although urban students' drawings of coconut trees in scenic surroundings would also fall in this category. Many tribal students drew large trees with saplings of the same variety growing nearby. Examples are the *bhendi* tree in Fig 4.14 and the mango tree in Fig 4.15.

The mango tree drawn by a fifth grade tribal student (Fig 4.15), despite apparent inaccuracies, had features that indicated ecological understanding. It showed a realistic shape of the tree, inflorescence and fruit. The mango fruit was shown as a prominent part of the tree, as well as of the whole scene. One mango was on the ground, and a child was running to get it. Some of the errors here were that the lone fruit was attached directly to the branch of the tree, rather than growing at twig terminals, and both flowers and the mature fruit were shown simultaneously on the tree. In the writing task however, this student referred to the seasonality of fruiting and flowering. This eagerness to depict incompatible features (symbolically?) on the same tree, is intriguing.

In the drawing of a fig tree in Fig 4.16, roots were shown above ground, saplings around the tree, and logs of wood strewn around. The fruits were attached in clusters to the main branches. The leaf shape was distinct and correct. The drawing clearly indicated that it was the season for shedding of leaves. A few leaves were floating to the ground from the large tree, while the saplings were already bare. But the fruit, indicated separately, though of the correct shape, was incorrectly positioned on the branch, and a lone seed was drawn inside the fruit.

4.6.3 Textbooks and students' drawings

The new Maharashtra Board science textbook for grade 6 [12] describes many parts of plants in great detail, including apex, veins, margins and stalk of leaf, and style, stamen, stigma and pollen in flowers. Detailed descriptions of the parts of a stem, leaf, and flower, are given, but the book says little about how all these are connected to each other. There are very few pictures of the whole plant or tree.

A variety of shapes of leaves are pictured in the textbooks of Maharashtra State Board. Students drew the leaf shape and leaf margins more accurately than other parts. Yet, many students did not draw the veins of leaves correctly.

All the factual knowledge about parts of a plant is usually taught within the classroom, with neither field trips nor collection of plants for demonstration in the class-

room. The facts are then rote learned in the confines of students' homes. Given these circumstances, one is left to explain how the students got it so right.

Tribal people have had intimate links with the trees in their environs, since they have used these trees as sources of food, fuelwood, medicines, colour dyes for clothing, and other social needs. They have also needed to know the animal habitats and their dependences on trees, since tribal people hunted small animals for food. They have thus evolved ways to distinguish between the different trees in their daily lives, using the visual criteria of shape, size and distribution of leaves, besides smell, texture and other non-visual criteria. These are often used implicitly rather than in an explicit manner in identifying trees. The tribal students probably 'know' these by 'situated learning'. This was evident from the discussions with them during the game on identifying living things in their surroundings. Tribal students also expressed this knowledge in their drawings. Besides their drawing abilities, they may have been limited to whatever they had 'learned' despite their being 'situated' in the formal school, which does not connect with their knowledge most of the time.

Urban students relate to plants in their daily life through watering their garden plants, picking flowers of garden plants like *jaswand, rose* or *chini gulab*, and throwing stones to drop *tamarind* and *mango* fruits from road-side trees. Most students also know and use many parts of the coconut tree. The distinct shape of the coconut palm is most familiar to the urban students of Mumbai.

In this, the drawing task, it seemed to be the use of a plant and plant products in everyday life, and interactions with the plant, which decided the plant chosen and the accuracy of drawing. Since textbooks had very few drawings of whole plants, they did not help students in responding to this task. That may also explain why the details that the textbooks give were not given by the students, unless they were details of familiar plants, like garden plants for urban students. There is apparently a wide gap between students' spontaneous ideas about plants — which were varied and rich in ecological content — and the knowledge in the textbooks.

4.7 Students' writing about plants

The students were asked to describe the plant they had drawn, in which they had to include its overall shape, its surroundings, its trunk, branches, leaves, flowers, fruits and seeds. It was specified that they should describe characteristics like colour, smell, texture (feeling to touch), periods of flowering and fruiting, and whether the plant shed its leaves. They were also asked to write about the uses of the plant and its role in the environment. This task sought information in a more formal way than did

the earlier herbarium and drawing tasks, and was hence closer to a typical classroom task.

Urban students, who gave too few items to be analyzed in any detail, mostly gave gross structure and functional features, and little else. In general, most tribal students wrote much more about the plant they had chosen to draw than did an average urban student. Tribal students of grade 6 had neater handwritings and expressed themselves better than did the grade 5 students. For all these reasons, analysis focused only on the writings of 22 sixth grade tribal students.

4.7.1 Rationale for the analysis

The description of plants given by the students was analyzed in the light of some aspects that are commonly found in the textbooks, and some other aspects that were called for in the task.

Textbooks give many plants as examples while discussing variety in leaves, root, stem, the general structure of plants or functions of plants and their parts. They abound in definitions, classifications and statements of cause and effect. Textbooks also describe processes like germination of seeds and give procedures for growing plants. However, textbooks of grades 3 through 6 do not have descriptions of a single plant on the lines requested of the students. There are a few nonvisual descriptions. But texts are devoid of affective statements or imagery and metaphor, especially in grades higher than the fourth. Time references, like, fall of leaves or flowering seasons are absent in textbooks.

The writing task on the other hand, explicitly asked for nonvisual aspects, feelings and time references. Taking all these aspects together, a preliminary scheme was evolved to analyze the content of students' writing about plants. The analysis involved counting instances in the students' description of plants which came closest to one of the aspects given below. The examples cited are from the writings of students.

- Gross structure, GS
  — 'the tree has green leaves', 'small yellow flowers', 'sour fruits'.
- Gross function, GFA, GF
  — the uses to humans, of the tree and its parts, e.g. anthropocentric uses (GFA) such as, 'trunk is used to make houses and furniture', 'flowers serve as decorations in the house', etc.;

— functions of the plant in the ecosystem (GF), such as, 'sheep and goats eat the leaves'; 'birds build their nest on it'.

- Affective, A

  — '.... feel very happy to see the tree in bloom'; '... gorgeous-looking blossoms' (*khulavoon disnare mohor*).

- Classificatory, C

  — 'the plant belongs to ....'; 'this is a fruit tree'.

- Details, D

  — parts other than subparts (leaf, fruit), like cotyledons.

- Time reference, T

  — '... leaves fall in December'; '... gets new leaves in the monsoons'; '... it blossoms in the month of February'.

- Non-visual, NV

  — strong; smooth; splashing sound, sour.

- Imagery, Analogy, Metaphor, I

  — '... like an umbrella'; '... like crescent moon'; '... is like chicken egg'.

- Process, etc. Pc

  — '... after a few days of planting the seed, it germinates, giving out a small shoot ...'; '... the plant then gets new leaves and grows new stems'.

- Procedure, Pd

  — '... the seed must be planted and watered'; '... when it grows to a certain height, it must be transplanted in a new place'; '... must add manure to ensure flowers and fruits'.

- Textual type definitions, Td

  — '... this is called germination'.

- Cause-effect, C/E

  — '.. it gets new shoots because of the rain'; 'on giving water, it germinates'.

- Environmental, En

  — description of the environment, '... there are mountains and forests where this tree grows'; 'this is found by the banks of the river'.

Table 4.5: Aspects of plants: number of instances given by students compared with textbooks.

Aspect	Abbreviation	Students		Text
		Tot.($N = 22$)	Mean	
Gross structure	GS	276	12.6	H
Gross function				
- Anthropocentric	GFA	68	3.1	H
Gross function	GF	11	0.5	L
Affective	A	33	1.5	L
Classificatory	C	6	0.3	H
Details	D	39	1.8	H
Time reference	T	53	2.4	L
Non-visual description	NV	13	0.6	L
Process description	Pc	29	1.3	H
Procedure description	Pd	11	0.5	H
Text-like definition	Td	2	0.1	H
Imagery, Analogy	I	12	0.6	L
Cause-effect connections	C/E	5	0.2	H
Environment details	En	14	0.6	L
Errors	Er	15	0.7	— —
Total		581	26.4	

Note: H — Relatively higher number of instances;
L — Relatively lower number of instances

4.7.2 Aspects of students' writing about plants

Table 4.5 gives the number of instances of each aspect in students' writings about a plant. Mean number of aspects per student is also tabulated.

The predominant feature in the writings of students given in Table 4.5, was description of gross structure, such as colour and size of tree trunk, stem, leaf, flower, and fruit. The students' writings closely modelled the textbooks in four aspects — gross structure and gross anthropocentric functions, details, and process descriptions. There were over 12 gross structural features per students, on the average, and over 3 functional ones. Tribal students gave many uses, most of which were human uses, of the plants and their parts.

Students rarely referred to the subparts of plants — they only gave *cotyledons* — although there are many references in the textbooks to stamens, style, margins of

leaves, etc.

Students described processes more often than procedures, and most cases pertained to germination of seed and plant growth. That germination of seeds should figure in the writings of students is not surprising, since textbooks deal with this in some detail, and even suggest that students try the activity of germinating some common seeds. Some of the teachers claimed to have done this in the classroom, and some students too mentioned that they had done it.

There were a large number of instances where students referred to seasonal variations in plants. Most tribal students wrote about time of flowering, when leaves were shed, and when they sprouted anew. Many of them seemed to have enjoyed writing about the plants, which could be inferred from the feelings expressed in their writing. Some students wrote a few sentences about the surroundings in which the plant was to be found and described them with feelings (*"khulavoon disnare mohor"*, lush green *"hirve gaar"*). Thus the students writings were relatively high on feelings and references to seasons, though the textbooks are low on them.

Students did not make many classificatory or cause-effect statements, nor did they give definitions or procedures in their writings. Textbooks, on the other hand, abound in these.

In this task, students gave a few instances of nonvisual descriptions (a trèe trunk is strong), or imagery (*bhurkat*, umbrella shaped, half-moon, like a chicken egg). These descriptions, in addition to environmental details and gross function find low instances in both students writing and in textbooks.

Chapter 5

Students' ideas about forests: Context maps

The analysis of students' ideas about plants showed that tribal students had rich knowledge of plants as compared with urban students, often surpassing in extent the information present in their textbooks. To probe this knowledge base further, it was natural to extend the study to students' views of plants in the context of a forest, and their ideas about forests in general.

It is important to recall here the differences in life-styles and experiences of the tribal and urban students. Some of these are elaborated in Section 1.2.1. The tribal students live in hamlets on the outskirts of forests in the mountain ranges of Western Maharashtra, called the Western Ghats or the *Sahyadri* ranges. Most of them, though living in residential schools located in villages close to small towns, continue to experience life in the forest during their vacations. The urban students on the other hand, were not expected to have had much first-hand experience of forests, as was confirmed by their responses.

The two tasks that are discussed in this and the following two Chapters are, context maps and writing about forests. These were aimed primarily at the tribal students, with data from the urban sample serving largely as a comparison point.

5.1 Method of analysis

To get the students started on the 'context maps' task, the class first worked collectively through examples of context maps on 'school' (*shaala*) and then 'sky'. Students were explicitly encouraged to include 'feelings'. Yet, they did not suggest 'feeling words' in the context maps of 'school' until prompted to do so through appropriate questions, like, "do you have any feelings about the school, a subject or activity in school ?" In the task on 'sky', students were prompted with words like blue, sun, moon, rain and cloud.

The ideas of the whole class were written on the blackboard and the class was asked to make links (*sambandh, jodi*) between what they perceived as associated ideas. The associated ideas were connected and the links were verbalised. After this introduction the actual task was administered, that is, drawing of context maps of 'forest'.

Students' spontaneous responses were analysed for the number of items given. These were enumerated in broad categories that included 'plants', 'animals', 'description of the surroundings', and 'human and economic use'.

The context map of each student was first analyzed for its propositional content, by noting the frequency of occurrence of various components: environmental features such as trees, shrubs, grass, mammals, birds, parts of plants, and general description of the environment, climatic and seasonal references, non-commercial and commercial uses (like industrial products, forest produce, etc.), and biological concepts. The frequency of occurrence of folk names of individual animals and plants was also tabulated.

The analysis was complemented by a tabulation of the mean and median of the number of items given by students in each group. It was then followed by analysis of the kinds of links they had made between various items in the map. The differences between tribal and urban students regarding their perception of plants in the forest, and about the forest itself, were inferred from this analysis.

Semantic knowledge was represented in the context maps by the frequency with which a student cited certain items (eg. animals, plants), or ideas (eg. human use of forests, ecological issues like food webs and dependencies). Some of the questions addressed by the analysis were: whether the two groups differed in terms of number of environmental features, a bias in favour of plants or animals, numbers of individual plant and animal names cited, and the kinds of uses given — human or other, commercial or non-commercial.

Other important contextual aspects like metaphor, and emotional, sensory and aesthetic aspects were also noted, wherever they were explicit. Sometimes they were inferred from the drawings, writing and links in the context maps.

5.2 Results

Context maps given by two urban and four tribal students are shown in figure 5.1 through figure 5.6, at the end of this Chapter. They represent the maps given by the two groups. The total number of instances for the various components of context maps of tribal students and urban students are shown in Table 5.1. The Table includes several levels of categorization of these components. Both numbers and percentages are given for each component at each level.

5.2.1 Time for completion

The time spent on the task by individual students varied. Most students in the tribal group continued adding items to their context maps for almost an hour, and some had to be told to end the task after an hour. On the other hand, most urban students finished the task in about half an hour, even before the interaction time was up.

5.2.2 Frequency of items

Tribal students cited about twice as many items (971) as the urban ones did (506). This was as expected, considering the tribal students' intimate familiarity with the forest. On the other hand, even though the urban students had never seen a forest, they did give a fairly large number of items. The animals they cited, like lions and elephants, perhaps reflected ideas about forests in story books, television, movies, in folk tales, or ideas they may have gleaned from textual references to plants and animals.

The data from context maps were analysed in terms of the mean, standard deviation and median, in two broad categories, namely, 'all items' and 'items pertaining to environmental features'. The values are given in Table 5.2.

There was a close agreement between the median and mean, indicating that distribution of the number of items between the minimum and maximum values was close to normal.

Table 5.1: Number of instances in the context maps

	Category	Tribal (N=40)				Urban (N=40)			
		subcat.		tot.cat.		subcat.		tot.cat.	
		No.	%	No.	%	No.	%	No.	%
I	Envt.Feat.			**733**	**75**			**472**	**93**
I-1	All Plants			218	22			76	15
a	Trees	145	15			48	19		
b	Shrubs	24	2			3	1		
c	Grass	30	3			23	5		
d	Vines	11	1			2	0		
e	Herbs	15	2			7	2		
I-2	P.Parts			134	14			43	8
I-3	P.Names	112	12			8	2		
I-4	Animals			181	19			244	48
a	Mammals	86	9			129	25		
b	Birds	55	6			52	10		
c	Fish	0	0			10	2		
d	Reptiles	29	3			21	4		
e	Insects	11	1			32	6		
I-5	A.Names	115	12			133	26		
I-6	Seasonal			14	1			4	1
I-7	Gen.Des.			186	19			104	21
II	Uses			**189**	**18**			**24**	**4**
a	Non-comm	57	6			3	1		
b	Recreatn	4	0			15	3		
c	Comm.	128	13			6	1		
III	E.S.A.			**18**	**2**			**0**	**0**
IV	Other			**31**	**3**			**10**	**2**
	Total			**971**	**100**			**506**	**100**

Note:
Envt. Feat. – environmental features; P.Parts – plant parts;
P.Names – plant names; A.Names – animal names;
Seasonal – seasonal and climatic variations; Gen.Des. – general description;
Non-comm – non-commercial uses; Recreatn – recreational uses;
Comm. – commercial uses; E.S.A. – emotional/sensory/aesthetic.

Table 5.2: Statistical data for the context maps

		Mean	Std.Dev.	Median	Min.	Max.	Range
Tribal	Envtl	18.3	8.5	16	1	35	28
$N = 40$	All	24.3	12.7	24	8	52	45
Urban	Envtl	11.8	3.1	12	5	19	15
$N = 40$	All	12.7	2.9	13	7	19	13

Note:
Envtl — subtotal of items under environmental features,
All — total of all items.

5.2.3 Environmental features

Environmental features dominated the list of items in both the groups, but more so in the urban group. These features form 93% of all items given by urban students, as against 75% among the tribal students.

Environmental features included, besides plants and animals, a large number of 'general descriptions': ponds and rivers, mountains and caves, clouds and rain. The proportion of 'general descriptions' was about the same for both the groups (Tribal= 19%, Urban= 21%).

5.2.4 Plants: number and variety

Tribal students gave a large number and variety of plants, commensurate with the results of the drawing and writing on plants. Over one third (36%) of all the items in the tribal students' maps pertained to plants, with a large proportion (two fifths) referring to parts of plants (14%). Large trees formed the largest category of plants cited by students, both tribal and urban ($T = 145$ out of 218, $U = 48$ out of 76). There were 8 instances of herbs in tribal students' maps.

In the context maps of urban students, by contrast, plants formed only about a fifth (23%) of the items, about half of these being parts of plants. Herbs were totally absent in their context maps.

5.2.5 Animals: number and variety

Urban students showed a remarkable preference for animals, which formed about half (48%) of all the items given by them. About half of the animals cited were mammals in the case of urban as well as tribal students (U: 129 out of 244, T: 86 out of 181), the rest being birds, insects, worms and reptiles. After mammals and birds, reptiles formed a significant component of forest fauna for urban students. Tribal students drew or mentioned worms and insects more frequently. Fish did not occur in tribal students' maps, while urban students cited them 10 times.

5.2.6 Naming plants and animals

There were 112 instances of individual names of plants in tribal students' maps, while urban students most often just categorised plants as 'tree' or 'grass'. Tribal students gave about as many names of individual animals (115). The urban group apparently thought of forests more in terms of animals than plants, citing individual names of animals 133 times, in contrast to their low frequency for naming plants (8).

5.2.7 Human use

For both the groups, most of the remaining items pertained to human uses of forest and forest products. For tribal students, uses of forest formed a fifth (189 items, 19%) of the total number of items, while for urban students these constituted only 5% of the items.

These items were further analysed for human uses that were non- commercial, recreational and commercial. The former included use of branches and twigs for thatching roofs of huts; leaves, roots and bark used as medicines, and food derived from the flora and fauna. Commercial uses of forest produce were: paper and furniture manufacturing, *temburni* made into *bidis*, collection and sale of lac and honey, hunting animals for sale of skins and meat. Sightseeing and picnicking were recreational uses.

There is a notable difference between the tribal and urban students in the number and ratio of items given under the 'non-commercial' and 'recreational' uses of forest. The most frequently cited use in urban students' maps was, 'hunting for recreation'.

Considering that tribal people have traditionally depended solely on the forest for their survival, it seemed natural that tribal students should consider the forest pre-

dominantly useful for everyday life, which they did, and less as a source of recreation (only 4 items). Besides their personal livelihood, they also considered the forest an economic resource of the country. Their ideas of commercial uses of the forest and its importance as a national resource might possibly derive from the fact that tribals have, for many years, been working as labourers for government or industry contractors in mining and tapping forest produce [13].

5.2.8 Emotional, sensory and aesthetic features

Tribal students gave several instances (18) that could be classified as their emotional, sensory, or aesthetic responses to the forest: "beautiful butterflies"; "peacock dancing happily"; "fearsome leopard". Urban students, on the other hand, gave no such emotional responses in the context maps.

Figure 5.1: Context map of an urban student (U1).

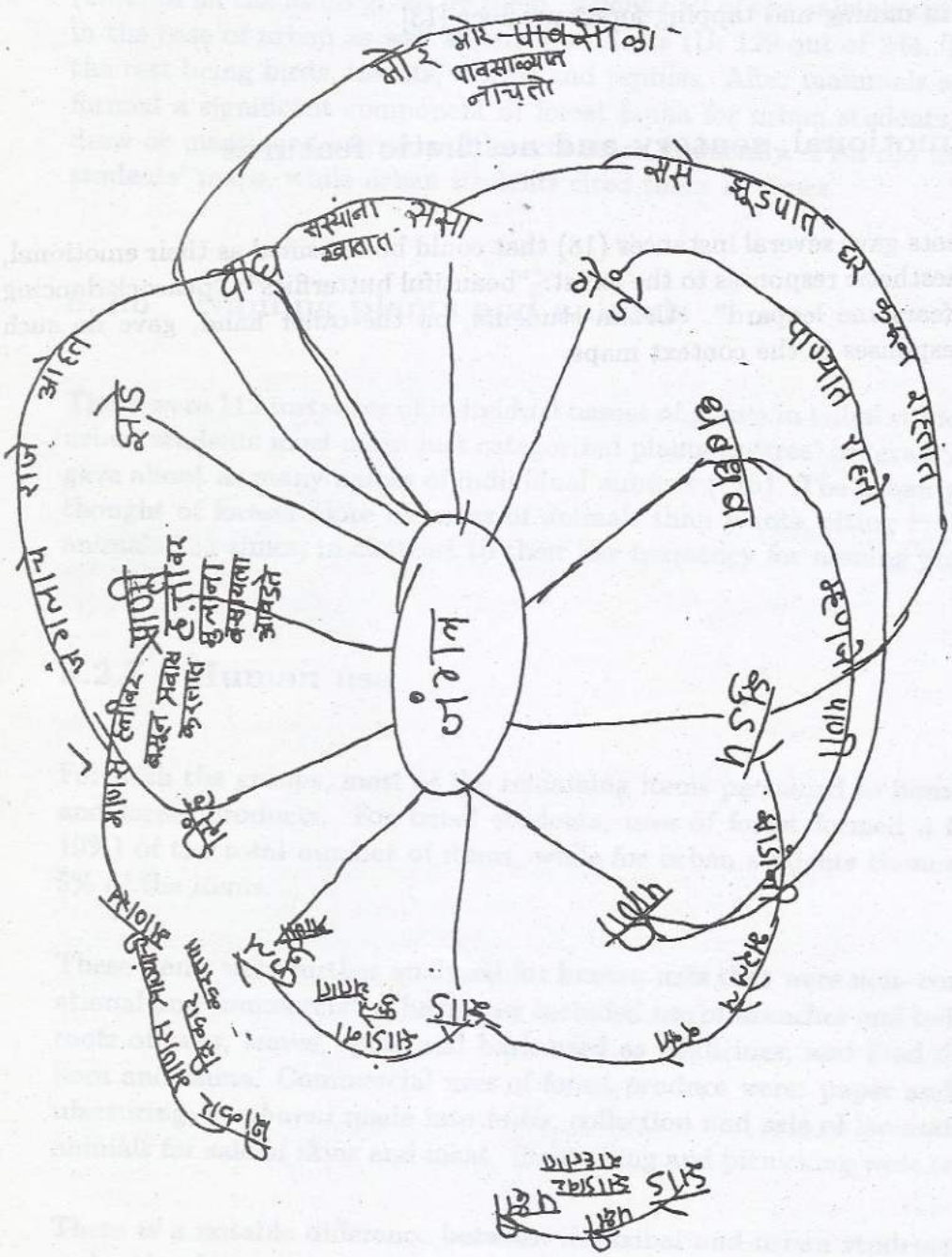


Figure 5.2: Context map of an urban student (U2).

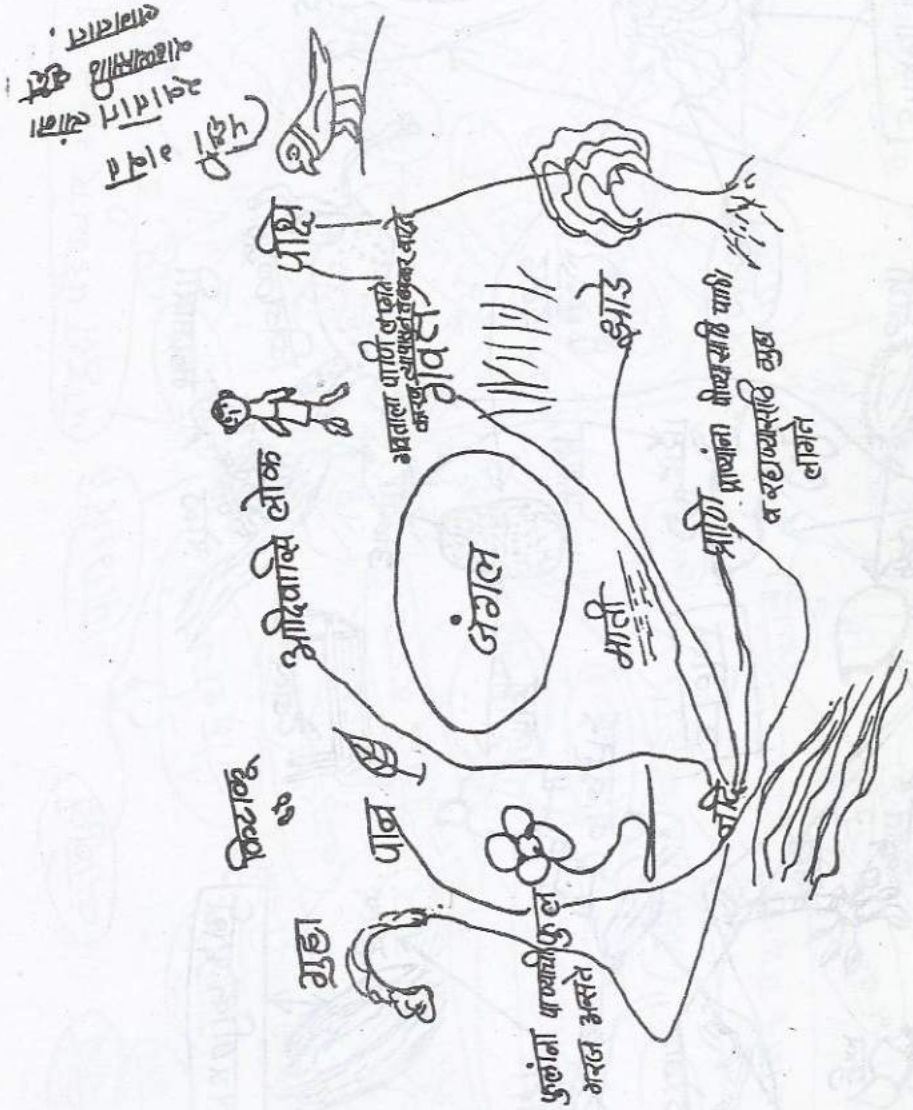


Figure 5.3: Context map of a tribal student (T1).

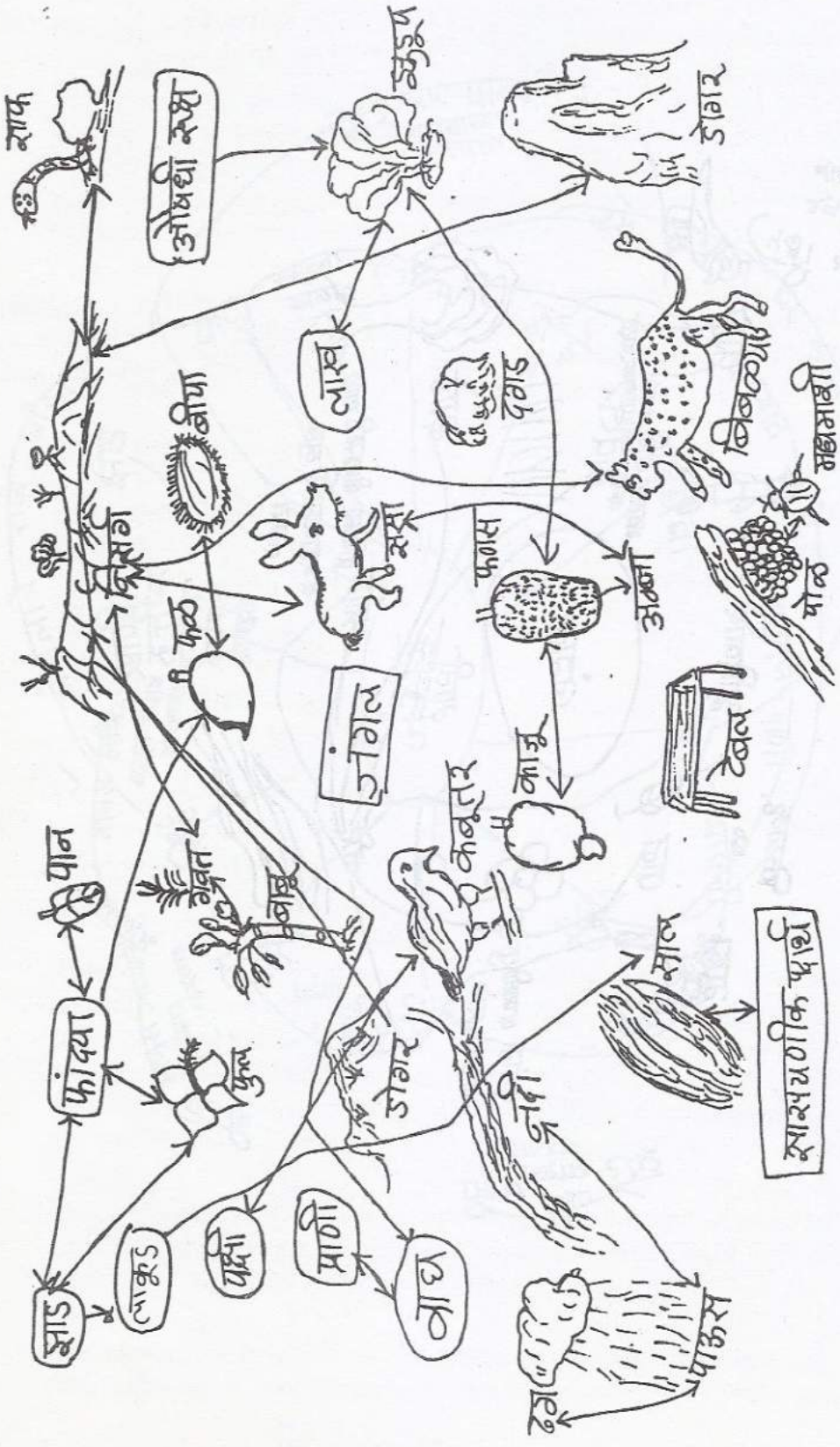


Figure 5.4: Context map of a tribal student (T2).

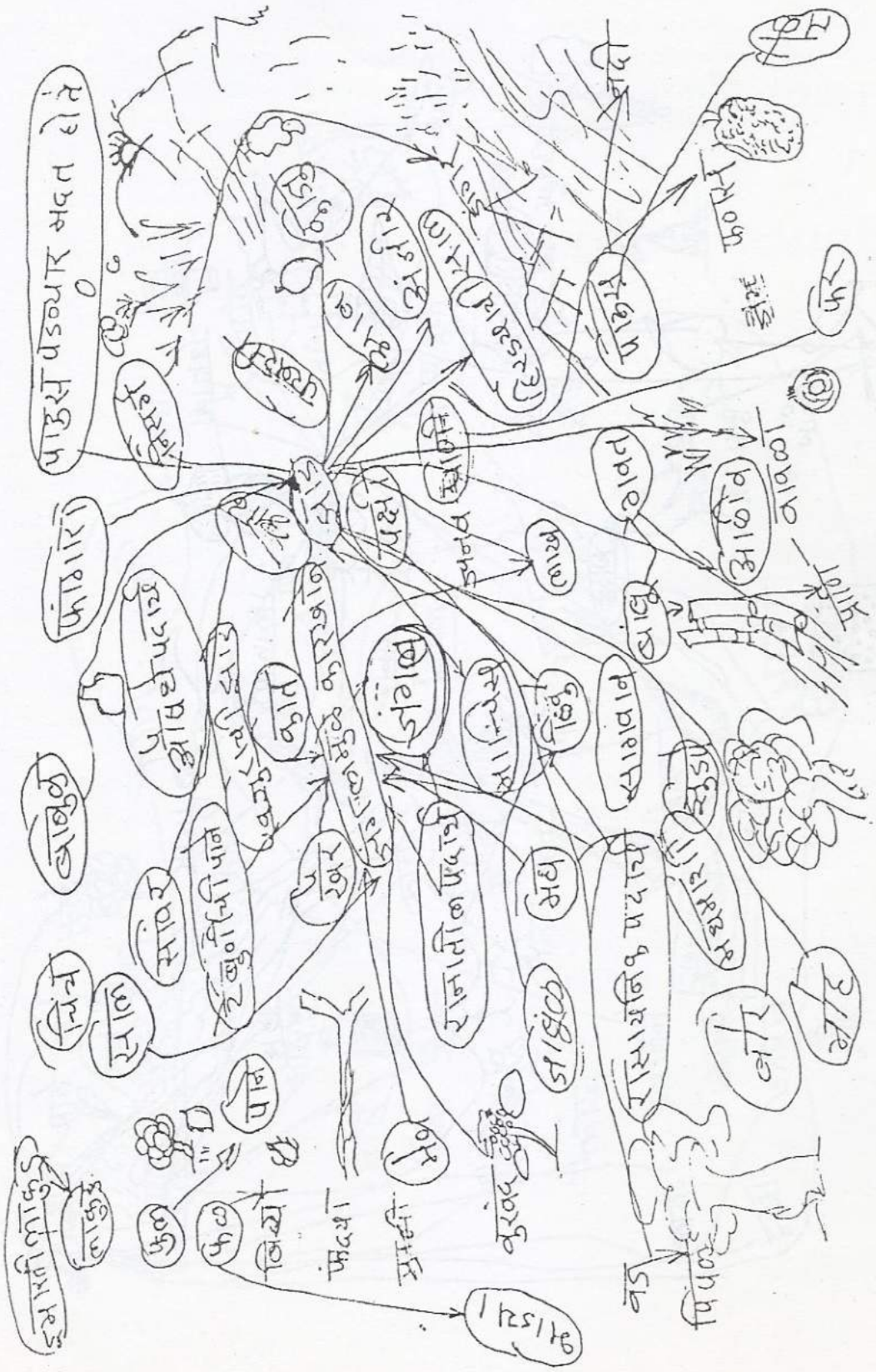


Figure 5.5: Context map of a tribal student (T3).

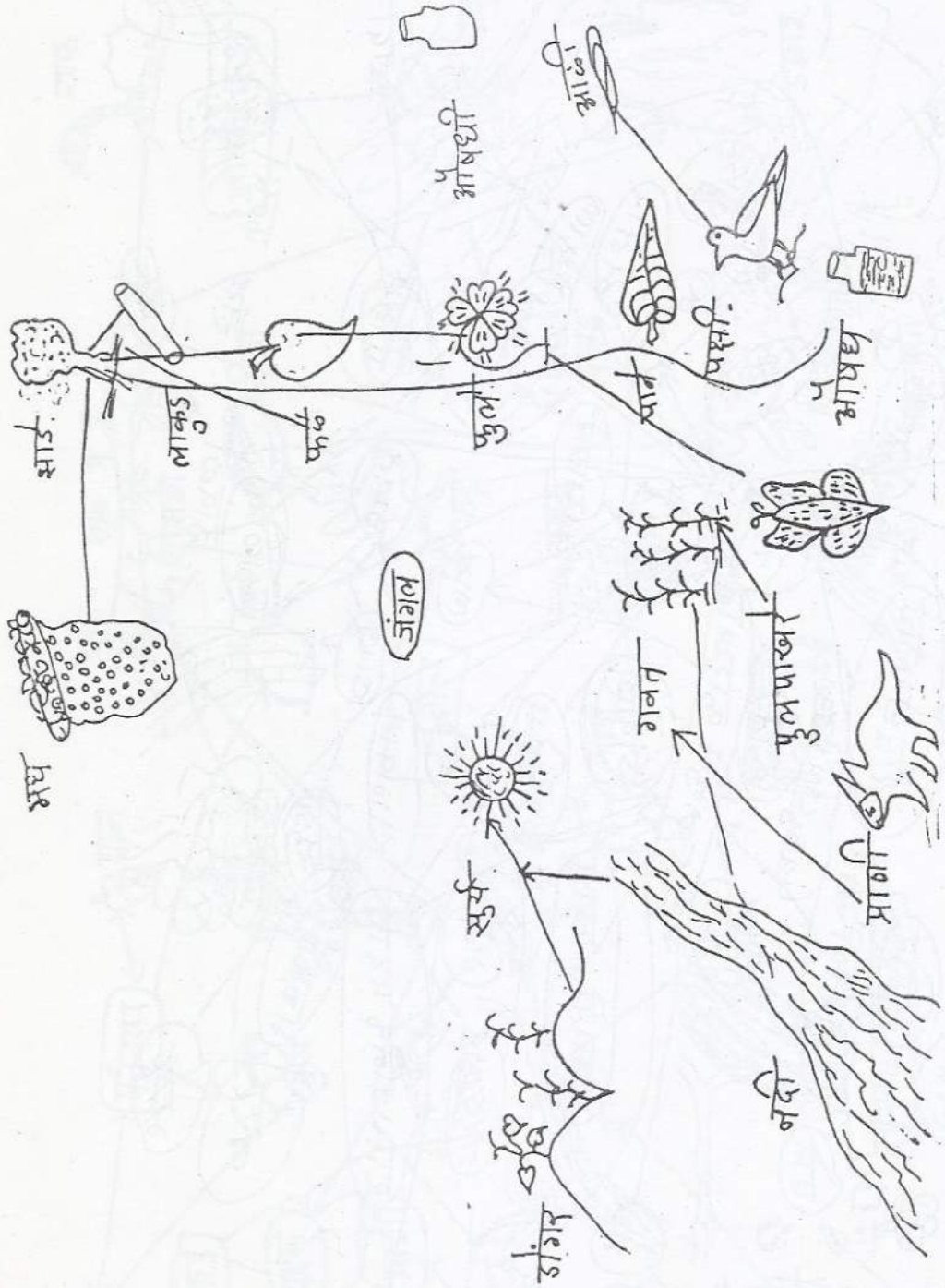
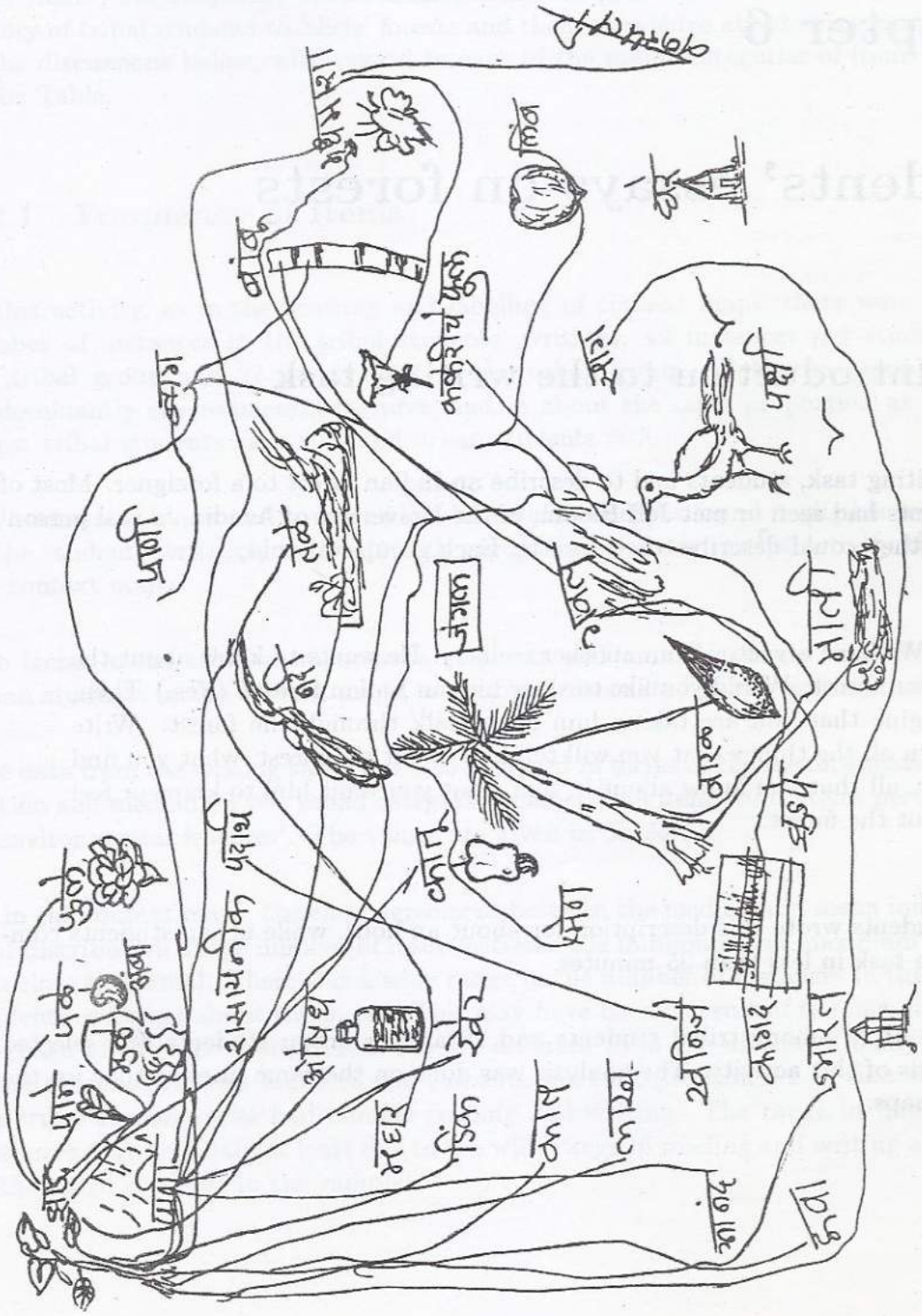


Figure 5.6: Context map of a tribal student (T4).



Chapter 6

Students' essays on forests

6.1 Introduction to the writing task

In the writing task, students had to describe an Indian forest to a foreigner. Most of the students had seen or met Jeff Bloom, of the University of Acadia, 'a real person' to whom they could describe 'their forest'. Each group was told,

> We have a visitor from another country. He wants to know about the Indian forest. Would you like to show him an Indian forest? (Yes.) Then, imagine that you are taking him for a walk through the forest. Write down all the things that you will tell him about the forest, what you find in it, all that you know about it, and what you want him to know or feel about the forest.

Tribal students wrote this description for about an hour, while urban students completed the task in less than 35 minutes.

A sample of 25 among tribal students and 20 among urban students was selected for analysis of this activity. The analysis was done on the same lines as that for the context maps.

6.2 Results

Tribal students, on the average, wrote more about the forest and often referred to it as 'our forest'. The urban students described the forest in only a few lines, with fewer items. The frequency of items under each category is shown in Table 6.1. The affinity of tribal students to 'their' forests and their knowledge about it is exemplified in the discussions below, with regard to each of the major categories of items given in the Table.

6.2.1 Frequency of Items

In this activity, as in the drawing and labelling of context maps, there were larger number of instances in the tribal students' writings; 42 instances per student in the tribal group and 22 per student in the urban group. Both the groups gave predominantly environmental features, and in about the same proportion as in the maps: tribal students gave 80% and urban students 90%.

Environmental issues and concerns and biological concepts found negligible mention in the students writings, although both groups fared better in this activity than in the context maps.

The trend in the relative importance of plants and animals among the tribal and urban students in the context maps, was more accentuated in the writing task.

The data from the writing tasks was also analysed in terms of the mean, standard deviation and median, in two broad categories, namely, 'all items' and 'items pertaining to environmental features'. The values are given in Table 6.2.

As in the context maps, the close agreement between the median and mean indicated that distribution of the number of items between the minimum and maximum values was close to normal. There was a wide range in the number of instances in the tribal students' writings about the forest. This may have been a result of the fact that the language of the school and textbooks are different from the dialect of many of the tribal students. It was found in the classification task (Section 3.2.1) that some of the tribal students also had trouble reading and writing. The range in number of instances may be partly at least due to the wide range in reading and writing abilities of the tribal students in the sample.

Table 6.1: Number of instances in the writing task

	Category	Tribal (N=25) subcat. No.	%	tot.cat. No.	%	Urban (N=20) subcat. No.	%	tot.cat. No.	%
I	Envt.Feat.			**541**	**80**			**327**	**90**
I-1	All Plants			252	37			52	14
a	Trees	195	29			29	8		
b	Shrubs	23	3			5	1		
c	Grass	8	1			7	2		
d	Vines	11	2			4	1		
e	Herbs	15	2			7	2		
I-2	P.Parts			61	9			16	4
I-3	P.Names	217	32			11	3		
I-4	Animals			180	27			260	60
a	Mammals	83	12			111	31		
b	Birds	73	11			61	17		
c	Fish	4	1			11	3		
d	Reptiles	11	2			26	7		
e	Insects	9	1			10	3		
I-5	A.Names	158	23			178	49		
I-6	Seasonal			13	2			4	1
I-7	Gen.Des.			35	5			31	9
II	Uses			102	15			13	4
a	Non-comm	61	9			6	2		
b	Recreatn	7	1			2	1		
c	Comm.	34	5			5	1		
III	E.S.A.			5	1			4	1
IV	Other			10	2			14	3
V	Biol.Con			16	2			5	1
	Total			674	100			363	100

Note:
Envt. Feat. – environmental features; P.Parts – plant parts;
P.Names – plant names; A.Names – animal names;
Seasonal – seasonal and climatic variations; Gen.Des. – general description;
Non-comm – non-commercial uses; Recreatn – recreational uses;
Comm. – commercial uses; Biol.Con – biological concepts;
E.S.A. – Emotional/ Sensory/ Aesthetic

Table 6.2: Statistical data for the writing task

		Mean	Std.Dev.	Median	Min.	Max.	Range
Tribal	Envtl	21.6	12.0	20.0	5	57	52
$N = 25$	All	27.0	13.4	24.5	7	61	54
Urban	Envtl	16.4	4.1	16.0	9	24	15
$N = 20$	All	18.2	5.0	19.0	10	27	17

Note:
Envtl — subtotal of items under environmental features,
All — total of all items.

6.2.2 Plants: number and variety

Tribal students gave significantly greater number of plants (average > 10 per student) than did urban students (average of 2.6 per student). Large trees were the most commonly cited plants by either group of students, followed in frequency by shrubs, herbs and vines for tribal students. Tribal students also cited parts of plants a larger number of times than did urban students.

Urban students referred to plant parts, relative to plants as a whole, less often in the writing task than they did in the context maps. The reason may lie in the two tasks calling for different levels of familiarity with the forest. In the context maps, students could merely draw or write the name of a plant part, and were not compelled to link it verbally to the forest. In the writing task on the other hand, students had to make up a sentence involving plant parts in the context of the forest. For example, tribal students made statements like, "Rabbits eat tender leaves of this plant, and rats eat its fruits and seeds." Considering the urban students' lack of familiarity with the forest, this would have been a difficult task for them.

6.2.3 Animals: number and variety

Urban students referred to animals in the forest four times as often as they cited plants. Most often they mentioned large mammals, and cited birds less than half as often. They listed mammals like lion, tiger and elephant .. one after the other, suggesting their coexistence in the forest. These were followed in frequency by reptiles.

Tribal students, in contrast, cited mammals and birds in the forest with almost equal frequency. The relative frequency of occurrence of the various categories of animals was similar to that found in the context maps task.

6.2.4 Naming plants and animals

Tribal students referred to plants by their names almost as often as they cited them. Urban students tended to refer to the plants in the forest merely by their category, as 'trees', 'grass', etc.

Urban students gave names of animals (total=178, 9 names per student) 16 times as often as they gave plant names (total=11), the trend being similar to the context maps. They also sometimes cited non-forest-dwelling animals like camel and kangaroo. These instances are discussed in the framework of their ecological ideas in Section 7.3.

Not surprisingly, tribals cited names of plants (total=215, 9 names per student), about 1.5 times as often as they gave animal names (total=158, about 6 names per student), an increased relative frequency in the writing task than in the context maps. Besides the frequency of names, there was also variety in the names given by the tribal students; a few students cited a series of 6 to 10 animal or plant names.

6.2.5 Human use

As in the context maps, tribal students mentioned a larger number of uses of forest and forest products as compared to urban students. Uses formed 15% of all instances, an average of 4 per student. As in the context maps task, these included non-commercial, recreational and commercial uses. In fact, tribal students named a large number of plants and plant parts in the context of their use, both commercial and non-commercial. They explicitly mentioned that plants, such as *khair* (*catechu*), *hirda*, and *mahua*, form the basis of their subsistence. Human uses and needs ranged from food, fuel, fodder and fibre to medicines, clothing, housing, boats, furniture, and materials for spiritual and recreational needs.

Urban students, on the other hand, hardly cited human uses for forest: 3% of all instances, averaging to less than one per student. The proportion of uses for tribal and urban students remained the same across commercial and non-commercial uses. Hunting for food by *adivasi* people (referring in this case to forest dwelling tribal people) were mentioned most often by urban students.

6.2.6 Emotional, sensory and aesthetic features

Possibly because a writing comes closer to a regular classroom activity than drawing and labelling, there were fewer emotional and aesthetic items in this activity. But the tribal students described the forest more vividly than did urban students. For instance, they mentioned that "The *kokila* (koel) was singing sweetly", or the "Water was 'gurgling' downstream " (*Paani khal-khal vahaat hotey* – referring to the sound of water). All tribal students referred to the forest as "our forest", or sometimes even as "our beautiful forest", while some urban students called it "our forest in Mumbai". An urban student described that, "rains made the birds very happy." One student wrote that the animals in the forest lived in "beautiful cages", an obvious reference to the cramped urban zoo. These ideas are also discussed in Section 7.3.

Chapter 7

Ecological ideas

Various ecological ideas were given by students in the context maps and writings. Many of these arose as associations, or links, between items in Tables 5.1 and 6.1. The links were analysed using categories close to those used by Bloom [4]. Over and above the categories in Bloom's study, a category of 'action links' was needed to describe instances like, "hunter hunts animals", "wolf eats a rabbit", "bees gather honey"; "bees make hives". The examples given below derive from our own data.

- Action links (A)

  "Hunter hunts animals."
  "Wolf eats rabbits."

- Causal links (C)

  "It rains more in the forest because of all the trees."

- Spatial links (S)

  "There are insects in the grass."
  "Rabbits live in a burrow."
  "Minerals are found in the forest."

- Temporal links (T)

  "These trees are in bloom from the month of May through October."
  "Animals come to the pond at dusk."

- Links of requirements or functions (F)

  "Animals eat the fruits of the trees."
  "Humans consume honey from bee-hives."

- Classificatory or descriptive links (D)

  "Cows, goats, and buffaloes give milk."

- Attributional links (At)

  "Waterfall means water."
  "Forest is a place with all the trees."

7.1 Links in context maps

Very few students, tribal and urban, explicitly linked the items in their context maps, and fewer still explained the links. The links given by 10 tribal students and 7 urban students, the nature of which could be inferred unambiguously, have been categorised. Frequency of occurrence and the mean number of links among the tribal and urban groups, averaged over the number of students in the group, are summarised in Table 7.1. It was recognised that ambiguities could arise in the classification of links as requisite/ functional or spatial. The link had to be inferred from the way it was worded. Many links given by the students were deeply meaningful, and hence beg an independent study. The categorisation here facilitated a cursory discussion.

Table 7.1: Distribution of links in the context maps

	Tribal ($N = 10$)		Urban ($N = 7$)	
	No.	Mean	No.	Mean
Required or functional	103	10.3	18	2.6
Classificatory	9	0.9	3	0.4
Spatial	20	2.0	30	4.1
Causal	13	1.3	1	0.1
Temporal	3	0.3	1	0.1
Action	6	0.6	4	0.6
Attributional	2	0.2	2	0.3
Total	154	15.4	60	8.6

Tribal students

Ten tribal students gave a total of 154 links, two-thirds of which were functional links. These included not only human uses of the forest and forest produce, but also functions of plants, animals, and even of natural elements, like rain and sun. Grass was linked to cow, as "cow needs grass". *Saag* was linked to building or house

(*imaarat*) as "*saag* wood is used to build houses", or that, "paper is made from bamboo."

Spatial links were the next most frequent in tribal students' maps. A few students wrote names of many animals in the same region of the paper, encircled them, and labelled them "the carnivorous animals". In one instance, a student separately clustered names of birds and names of trees, linked the two clusters and wrote "birds live on trees." Thus a link of this kind was both classificatory and spatial. This was followed by causal links, of which there were 8 instances: "It rains because of the clouds"; "When many streams come together, they form a river". One student explained the water cycle by linking the river, sun, clouds and rain. These links together were classified as a causal link.

Urban students

Of the 60 links given by 7 urban students, about half were spatial: "animals live in caves"; "there are mountains in the forest"; "there is grass in the soil". In contrast to tribal students, requirement/ function formed less than a third of the links, while other categories of links were very few in number.

7.2 Links in writing about forest

The very nature of the task, of writing sentences involving the various items related to the forest, required explicit associations between these items. Hence there were many links that could be analysed in the writing task.

7.2.1 Frequency of links

Tribal students often clubbed many trees or animals together in a sentence and associated them with an action or use. This is reflected in the large number of classificatory links in their writing. They also tended to repeat the same idea. A particular association, say "plants give us medicines", was counted only once for each student (Table 7.2), no matter how many times it was repeated in that student's writing. These factors may explain why the number of links do not reflect the fact that tribal students wrote more than the urban students did.

On the average, each tribal student gave over 3 links in the 'functional', 'classificatory' and 'spatial' categories, while urban students' links were mostly in the 'spatial' category (a mean of 6), followed by 'functional', 'causal' and 'classificatory' links. 'Action' and 'temporal' links were rarer.

Table 7.2: Distribution of links in the writing task

	Tribal ($N = 25$)		Urban ($N = 20$)	
	No.	Mean	No.	Mean
Required or functional	124	5.0	41	2.1
Classificatory	98	3.9	17	0.9
Spatial	83	3.3	119	6.0
Causal	18	0.7	24	1.2
Temporal	18	0.7	1	0.1
Action	3	0.1	7	0.4
Attributional	1	—	1	—
Total	346	13.8	210	10.5

7.2.2 Requirements or functions

Functional associations formed the largest category (36%) in the case of tribal students (124 out of 346 links). Of these the human uses (102) were accounted for in the analysis of instances in Section 6.2.5. As discussed there, they gave a wide variety of links that could be classified as 'functions or requirements'. In fact, associations of requirement or functions given by tribal students went beyond human uses, and included uses of forest and forest produce by other animals, birds and plants. Sometimes these were stated in anthropomorphic terms: "Bees depend on the nectar from flowers for their livelihood" (*Phulanpasoon madhmaashaa aapley udarnirvaha kartaat*).

In the writings of urban students, requirements ranked third in the frequency of links, numbering only 41 of the 210 (19.5%) links given by them. There were references to tribals obtaining their food through hunting, making clothes from the leaves of plants and building their houses of twigs and branches. There were only a few references to their own dependence on the forest or its products.

7.2.3 Spatial links

Associating items — animals, plants, minerals — with a location in the forest formed the largest category (57%) of links in urban students' writings. They ranked third in tribal students' writings (24%).

While both urban and tribal students associated many animals with their habitats, urban students' references indicated alternative conceptions about habitats and niche. These are discussed in Section 7.3.4. One of the correct statements made by urban and tribal students was "Grass grows around ponds in the forest". There were many locational links like, "There are leaves, flowers and fruits on trees" and "The forest provides a place for many animals and birds to live".

Tribal students were often more specific and gave detailed location links. They wrote about "parakeets' nests on mango trees", "*karanj* trees on the bank of the river, on which were *baya* weaver birds' nests".

7.2.4 Classificatory or descriptive links

Statements of the kind "Cows, goats, and buffaloes give milk", or phrases of the form "many trees like *vad, peepal, babhul* in the forest", "wild animals like lion, tiger, elephant, leopard", "*mogra, jai, jui, shevanti* are the flowers found in the forest", were classificatory links. Description of a tree (round, big), statements like "Forest has mountains, rivers and ponds", "*Sag* is not attacked by termites" were a few of the descriptive links.

For tribal students these, at 28%, formed the second most frequently occurring associations after functional links. Urban students gave very few links of this category ($< 0.1\%$, less than 1 per student).

7.3 Ecological ideas and alternative conceptions

Context maps and urban and tribal students' writings about the forest helped in understanding their ideas about plants and animals, through analysis of the names, uses, and general descriptions that students drew or wrote. However, the maps and writings were a source of much more than that: they indicated several important ecological ideas of students.

It is interesting to see how the textbooks deal with this aspect. On the whole, textbooks seem to be more concerned with scientific facts than with their ecological implications, devoting more pages to the taxonomy of plants and animals and giving details of their parts. All this information is not related to environmental experiences of students. Many incorrect ideas found in this study could perhaps be traced to fragments of information about unfamiliar animals, plants and situations given in textbooks, from which the students had constructed their own meanings.

Alternative conceptions in ecology, a subject that came into its own only in the '70s, had been a neglected area of research by cognitive scientists until a decade ago [20]. Since then, its relevance for science education as well as environmental education has been recognised.

7.3.1 Context Maps

Students' understanding of ecology could be inferred from the names of plants and animals that they cited in their context maps, the surroundings that they sometimes drew them in, and the links between the various items in the map.

Some of the links, like the water cycle and food dependence of various animals and plants, depicted by them were laudable. Several tribal students drew and linked clouds, rain, rivers, and trees, and some of them mentioned that trees helped form clouds and rain. In lesson 15 of the new Maharashtra State science textbook for grade 6, there is a discussion with illustration, on the water cycle. There were several instances of food chains: "leopards and wolves eat smaller mammals, which (in turn) eat worms or grass". A few maps had a pond or river with animals and birds linked to it.

Some alternative and weak concepts could also be inferred from the maps. For example, many students, more among the urban group than tribal, included elephants, lions, tigers, camels and giraffes as living in the forest. In fact many of these animals live in distinctly different ecosystems, and therefore are unlikely to be found in the same forest. Incidentally, none of these animals are found in the Sahyadri ranges. Lions are found in Girnar, a lion sanctuary about 500 kilometres north of Mumbai, while elephants are to be found in the forests over 1000 kilometres to the south. However, one does not have to look far for possible reasons for these animals in students' context maps. The lion and the elephant are favourite characters in children's stories. Besides, it is not unusual to find domesticated camels on the beaches around Mumbai, or trained elephants at select temple locations on the outskirts of the city. Camel and giraffe are cited in the textbook, in the description of animals adapted to their surroundings.

7.3.2 Writing task

The links and instances in the writings of students about the forest were further analysed for the ecological ideas they may indicate. Based on the analysis of links in the preceding section, the ecological ideas given by students were first listed and then sorted in terms of a few categories. For example, the high frequency of human uses in students' writings prompted the category, "human dependence on the environment". Correct ecological ideas are discussed below under different categories, with illustrative examples from students' writings. The frequency of occurrence of each category for tribal and urban students is also indicated. Where possible, we hazard a guess about the origin of students' ideas. A list of alternative coceptions from students' writings is given in Appendix D.

7.3.3 Correct ecological ideas

One of the most striking features of tribal students' writings was the large number of instances indicating correct ecological ideas. In contrast to the 175 instances given by 25 tribal students (an average of 7 per student), the 20 urban students writings had only 33 such instances. Their variety is discussed below.

Human dependence on environment

This category included those instances in which students described human dependence on the forest:

- "Tribal people make houses of twigs and branches." (Urban student)
- "We make *kaat* (catechu) out of the *khair* tree, *bidi* with *temburni* leaves."
  "We get medicines from trees, plants and herbs, lac, wax and gum from the forest, fibre (*lokar*) from animals"
  "They build multistorey building (*imaarat*) and boats with *saag* wood." (Tribal students)

Over half the ecological ideas given by tribal students were of this type. Students' ideas about human dependence have also been discussed in Section 6.2.5 and Section 7.2.2.

Habitats and niches

Several spatial links indicated the specific niche of flora or fauna in the environment. A tribal student's "many insects live on trees" or an urban student's "grass grows around the pond" were examples of this. Over a fifth of the ecological ideas given by tribal students were of this type, while for urban students this formed only 6% of the ecological ideas. This is in apparent contrast to the context maps, where half the links (there were fewer links) given by the 7 urban students indicated locations. The large number of locational links could be reconciled with the low incidence of habitat ideas by looking at the qualitative difference between the links given by the urban and tribal students.

Spatial links given by tribal students revealed their understanding of habitats and niches, and were often embedded in the context of describing the functions of plants and animals they referred to: "River emanates from mountains in the forest"; "Birds have eaten insects from ... and come to rest on the branch of a tree"; or "Many birds like, koel, kite ... live in the forest because they get their food, like honey (nectar?), insects, ... there". Hence these detailed links were a part of their context maps and writings. Urban students on the other hand, often merely stated that an animal or plant was located in a particular place: "There are mountains in the forest" or "River flows through the forest." An interesting statement made by a tribal student conveyed his understanding of the forest as a habitat for a large number of flora and fauna: "Forests generate nature" (*Jungal nisarga nirmaan kartaat*). This summarised the tribal understanding of forest as a complete habitat.

Food chains and webs

Students referred to food of various animals. More often they were individual animals, like in "Goats eat the leaves of the *umber* tree". But there were instances of a chain or web of food related dependence. These were exemplified by "Snake eats rat and snakes are eaten by the eagle"; "Python eats a (smaller) snake which eats a frog."; "Tiger needs flesh to eat, while deer eats tender leaves of trees." This type of eco-ideas formed about 12% of both urban and tribal students' writings. One tribal student's statement indicated the complex web of interdependence of species: "*Dhaaman* eats rats and helps the farmer."

Environmental degradation

Both tribal and urban students mentioned that forests help "purify" air (*Jungal hawa shuddha kartey*). Two urban students wrote, "(People) cut down trees, make roads, and wantonly destroy the forest." (*Jhade todoon rastey banavtaat ani janglachi nasaadi hotey*) One of them added, "... and then there is no place for birds and animals to live." (*... aani mag pashu-pakhsheena rahanyaachi jaaga naahi.*) This indicated a sensitivity, among urban students, to deforestation and habitat destruction.

History

There were three instances where urban students linked forest to prehistoric humans. One of them wrote, "In ancient times, people living in caves were attacked by tigers. Hence they lit fires that scared away tigers from the caves." Others wrote, "In ancient times, people lived in the forest and wore clothes made of barks of trees" and "In ancient times people lived in the forest and ate fruits." Naturally enough, tribal students did not link the forest with people of long ago.

Other ecological ideas

Besides the above ecological ideas, students also connected climate and vegetation, made explicit statements about regenerative processes in the environment, and gave a few scientifically correct concepts. An urban student wrote, "Birds build their nests on trees, in which they lay eggs and their young ones hatch out." (*"Jhadaavar pakshi gharti bandhoon, tyaat andi ghaltat. Andyapasoon tyachey pillu nightaat."*) One tribal student described regeneration by sprouting thus: "The tamarind seed falls in the water, swells, and sprouts." (*Chinchechi bee paanyaat padte, ani fugatey ani tila komb yetey*) Seven urban students mentioned that, "there is more rain in the forest." One tribal student related vegetation to the climate: "The forest is cooler because of the trees." (*Jhadaanmule junglaat gaarva astho.*) Another wrote, "When wood grates over wood, there is (forest) fire." They also described processes like, "The roots of tall trees go deep down into the soil, absorb minerals and water and sprout leaves and flowers. " (*Uncha jhadanchi mule khole jaatat, kshaar-paani shoshoon ghetaat, ani tyanna paan ani phuley yetaat.*)

The following sentence by a tribal student is an explicit statement of the government policy towards forests and the people therein: "In order to safeguard forests, the government has, through the forest department, designated reserved forests ... For-

est is a national wealth." *Janglaachey samrakshan karnyasaathi shaasanaaney vanavibhaagatarfey vanakhaatey keley aahey ... Jangal ek raashtriya sampatti aahey.* Yet another factor differentiating urban and tribal students' perceptions of the forest is revealing. While most urban students referred to hunters in the forest, and even made explicit references to tribal people hunting animals for food, there was a near total absence of this in tribal students' writings or context maps.

7.3.4 Alternative conceptions in ecology

Ideas expressed by students in all the tasks — herbarium questionnaire, drawing and writing about plants, and the context maps and forest writings — gave clues to many possible alternative conceptions in biology and ecology. Munson [20], in a review of literature on alternative conceptions in ecology has used the major concepts of ecology identified by Cherret to classify these conceptions. Food webs, ecological adaptation, ecosystems and niche are four of the concepts used by Munson, in which urban and tribal students in the present study have alternative conceptions.

A list of phrases or sentences in which urban and tribal students' alternative conceptions were manifest are given in Appendix D. Most items in the list were given by more than one student. A few, like naming many large animals in the same forest, occurred in the writings of several students. Repetitions of phrases when they occurred in more than one student's writing have been avoided. It is evident from the list of 26 phrases given by urban students and 5 given by tribal students, that (as is perhaps to be expected) tribal students had fewer alternative conceptions.

One of the most common misconceptions of both tribal and urban groups was that all large (and well-known) wild animals lived in the forest. For instance, 3 tribal students and as many as 17 urban students listed elephant, tiger and lion as animals living in the forest. This might have been acceptable if they were describing 'forests' in general, as is often done in textbooks. Placing all the three animals in the same forest meant that they lived in similar environments and ecosystems. This may have been the result of students inadvertently adopting a 'textbook' style of writing, compounded, in the case of urban students, by their lack of familiarity with a forest.

The appearance of 'giraffe' in the writings of 3 students — two urban and one tribal — might be traced to the textbook, which discusses the long neck of the giraffe as an adaptation that enables it to nibble tender leaves on tree-tops. One student in fact quoted this textbook statement. Also, an elephant and a giraffe, in what appears to be a grassland with a lone tall tree, are included in a graphic repeated at the beginning of every lesson in the grade 4 new Maharashtra State textbook [11]. "Deer live in caves" and "Cranes live in the water" were other examples of mistaken

habitat. Almost all the urban students drew caves in their context maps and wrote about them.

Urban students did not understand that the different animals and plants lived in competition with others in any ecosystem, and that each animal or plant occupied a unique niche in terms of where they lived and what they ate. It would thus be unlikely for an animal to be living everywhere in a forest. The concept of niche is not explained in textbooks till grade 9, by which time, several related misconceptions have already been accumulated with the increasing number of plants and animals that are introduced. Yet, this concept appears to be 'internalised' by tribal students, as is apparent from their descriptions of forests. They not only cited a large number of plants and animals, they also mentioned them in correct contexts, in terms of food or habitat relationships, which have been discussed in the previous sections.

Not only are urban students unfamiliar with the forest ecosystem, at least a few students thought that the city (*Mumbai*, in this case) had a forest. This showed a lack of knowledge about the differences between urban and forest ecosystems, which is clear from the statement of two students who wrote: "There are very large animals in this, our *Mumbai* forest ... some animals are in beautiful cages." "There are wells in the forest," or "Animals drink water from the wells," are also examples of confusion between ecosystems.

The statement given by two urban students, "people live in all parts of the forest," were possibly from two sources: the absence of a niche concept, and lack of differentiation between ecosystems.

Food needs of animals was another probem area for urban students. The scientific conception about food webs is that organisms higher in a food web feed on some organisms lower in the food web. A few students' writings, for instance, "lions eat all animals," suggested that organisms higher in the food web eat everything that is lower in the web. The lion is called the 'king of the forest' in folk tales.

Urban students also state that tribals hunt (and eat?) all animals. Tribals are known to hunt small game, and include in their diet even those animals which have been taboo among most people of the majority community outside the forest [13]. But their diet does not include all animals. Besides, they are also known to hold certain animals as totems and to refrain from hunting them. Thus urban students overgeneralised the features of certain tribals. Other examples of this were descriptions of tribals as wearing colourful tattos on their bodies and headgear of sticks and leaves.

Urban students presented the forest as a very unwelcome place for people in stark contrast to tribals who almost gushed on about its beauty and use. Urban students

collectively described it as a cold, dark place, home of all kinds of wild animals, including poisonous snakes that bite anybody entering it. In fact, they wrote that only those people without a shelter would live in the forest. One student even went to the extent of stating that there were no flowering or fruit-bearing trees in the forest. A dreary place indeed!

Statements like "Wild boars bathe in the water" and "The hunter, when thirsty, drinks river water, lying down like an animal", clearly indicated anthropomorphic and zoomorphic ideas. Both urban and tribal students made anthropomorphic and anthropocentric (the many human uses of the forest) statements.

An amusing, but grossly mistaken idea of waste and resource, dirt and riches, in the context of the forest, possibly common to most urban dwellers, was expressed by a student thus; "The parakeet sits on a tree, eats fruits and drops them down; this makes the forest dirty."

Chapter 8

Conclusions

The study was a novel attempt to probe the differences in ideas about plants held by students in urban and tribal settings, and expressed by them through a variety of activities — out-of-class herbarium collection, drawing and writing about a plant, drawing a 'context map' of a forest, and writing about it.

The study aimed to link the differences to the settings, social and physical, of the two groups of students. This included taking into account the relationship of tribal and urban students sampled in this study, with the plants in their surroundings. It also meant examining the treatment of plants in the textbooks used by the students.

The series of investigations reported here threw up many results. Some of the results confirmed those already found in different anthropological studies. For instance, tribal students in this study, like children in indigenous cultures in general, had knowledge of many plants and animals. This observation was followed up with several tasks meant to probe the nature of this knowledge, particularly as seen against the knowledge-base of urban students.

Urban and tribal students were found to have different perceptions about plants and forests — different enough to merit cognisance in the classrooms. These led to specific inputs for the teaching of botany to tribal and urban students.

8.1 Students' perceptions of plants

Students' spontaneous categorisations of plants were used to analyse the variety and frequency of plants cited. Tribal students gave a greater variety of plants than urban students did, which were more evenly distributed over the categories of fruit trees, flowering trees and garden plants. Urban students responded with a larger number and variety of common garden plants. This was despite the fact that a large variety of garden and vegetable plants are found near the *Ashramshalas*, and many flowering trees exist near the urban school.

Urban students use vegetable and garden plant products in their daily lives, and many of them are familiar with these plants. On the other hand, the tribal students in this study do not perceive vegetable and garden plants as important, but know and recall a wide variety of fruit, flowering and other socially significant trees of the forests. Traditionally, the food of tribal people, many of whom are nomadic, has been small game, edible roots, tubers and fruits, all found in the tropical forests. They did not use vegetables, especially those that needed cultivation. With increasing number of these people taking to agricultural labour, they have begun to use some vegetables. However, it seems from this study that their perception of vegetables continues to be different from the importance they attribute to forest products.

The study suggests that access to plants in the surroundings, everyday use of plants and plant products, perceptions of their importance in daily life, and the textbooks, interact in a complex way to determine students' ideas about plants. The plant products students use in everyday life, the plants they have in their environs, and the ones they read about in their textbooks, are all often different from each other.

The drawing and writing task also exposed the wide gap between students' spontaneous ideas about plants, which are varied and rich in ecological content, and the knowledge in the textbooks. Urban students either drew picturebook-like scenes and road scenes as surroundings of their trees, or drew common garden and potted plants. Tribal students drew realistic pictures of a large variety of forest fruit and flowering trees; often correct in overall shape of the trees and leaves, and location of fruits and flowers. They incorporated many features that reflected their understanding of ecology, like leaves floating to the ground, a sapling near the tree, dried leaves, twigs and logs on the ground. The tribal students' keen observations were further seen in the writing task, which evinced many seasonal features, like references to time of flowering, shedding and sprouting of leaves, etc.

The experimental tasks elicited another characteristic of tribal students' responses, namely, the high incidence of uses of plants, and feelings about them. This was particularly seen in the herbarium task and in writing about the forest. The uses

given by tribal students for many of the trees in their environment compared well with advanced botany textbooks.

The ideas expressed by students in the writing and drawing tasks, exposed a few alternative conceptions in biology and ecology. Some of these alternative conceptions may be reinforced by textbooks rather than challenged.

8.2 Students' ideas about the forest

Tribal students' perceptions of plants had to be seen in the context of their ideas about forests, with which they were intimately familiar. In contrast, it appeared from the writings of the urban students, that none of them had ever seen a forest. Their ideas about the forest seemed to be based on the small collection of caged wild animals and birds in the city zoo, on stories they had heard, or pictures they had seen. As for the plants and trees in the forest, they did not have a clue, and the textbooks did not help either.

The context maps and the writing task provided two complementary sources of information on the perceptional differences between the two groups — urban and tribal. In the absence of more comprehensive testing and confirmatory interviews, these may have given only a partial glimpse into the richness of either the propositional knowledge of the students or their personal contexts of meanings. However, the tasks provided many significant pointers to the contexts in which urban and tribal students 'construct their meanings' about plants, animals and forest, thus offering some possible inputs to pedagogy.

In context mapping and writing about the forest, students from the tribal group gave almost twice the total number of items compared with the urban students. The tribal students' familiarity with the forest, arising from their living in it and using its products extensively in their everyday lives, could be an important reason for this difference. This was also reflected in the details of the environmental features given by the two groups.

Daily life experiences and socio-cultural factors clearly influenced students' ideas about the forest. Students' ideas of specific plants and animals in the forest, also revealed confusions, probably created by the combined effects of textbooks, stories, and lifestyles, especially among urban students.

8.3 Teaching implications

The information possessed by tribal students ought to place them at an advantage in formal schooling, which in grades higher than 5, deals with plants and forests in the botany and geography curricula. Since this advantage is not translated into performance, there is a need to analyse the lacunae in teaching and evaluation in formal schools. One shortcoming of the curricular treatment for tribal students could well be the delinking of plants from forests, which, in the students' minds, are connected intimately.

This study focused on the content of tribal students' knowledge with respect to that in the science textbooks, and found several incompatibilities. There may also exist a mismatch in the method of 'transmission' of this knowledge, perhaps in the manner suggested in Section 2.2, though this was not explored here in detail.

The new textbooks of the Maharashtra State Board include many examples of plants, but very few flowering trees, which seem to be important to tribal students. There was relatively little overlap between the plants cited in the textbooks and those familiar to tribal students.

Textbooks in India are written at the National and State levels. Whether the diversity of physical and socio-cultural settings found in one State can be reflected in a single textbook, is a matter of debate. India has a large variety of climates: ecosystems range from the tropical desert to tropical forests, from the Himalayan tundra to the plains and plateaus. Getting a significant overlap between the plants in the texts and the environment of the students would be a near impossible task. The problem would be compounded by differing socio-cultural backgrounds that influence the use and relationship with plants. Under these conditions, the onus for substituting in the classroom the appropriate plants from the surroundings and their everyday use falls on the teacher.

Textbooks rarely depict whole plants or trees, although students naturally relate to whole trees rather than parts. Attention to structural details, on the other hand, does not seem to come naturally to students, and this is a teaching point which therefore deserves emphasis. Perhaps it would be appropriate to first teach structural details in relation to a whole plant, and then extend this to the teaching of leaves, flowers, seeds etc..

Some of the alternative conceptions in ecology may have been reinforced by textbooks rather than challenged. They also may have added to the confusion about what they set out to teach. It was apparent from the study that the textbooks did not consider the familiarity of students with the plants in their surroundings.

Textbooks do not incorporate affective or ecological features, which figure prominently in ideas of tribal students. It was clear from the the analysis of the drawings and writings that 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. In the teaching of science in general, and with particular reference to teaching of botany to tribal students, the classification and cause-effect relationships, the processes and procedures, have to be seen as convenient tools for ordering the world that the students already know much about.

Failing this, we risk continuing alienation of textbook lessons from students and their everyday living. What may be worse, such schooling will accelerate the alienation of a whole populace from their environment, having replaced their rich 'situated knowledge' with incomplete formal knowledge.

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Appendix A

Plant names: Local and botanical

List of plants given by the students in the writing task

Local Name	Botanical Name	Common Name	Category
Acash, Khair	Acacia catechu	Catechu	S
Agastya	Sesbania grandiflora	Sesba/ Agasta	Fl
Alimb	Agaricus	Mushroom	
Amba	Mangifera indica	Mango	Fr
Anantamul	Hemidesmus indicus	Indian Sarasaparilla	
Ananta tree			Fl
Ashok	Saraca indica	Ashoka	S
Awala	Emblica officinales	Amla	Fr
Babhul	Acacia arabica (milotica)	Babal	S
Badam	Terminalia catappa	Bengal Almond	Fr
Bael	Aegle marmelos	Bael Tree	Fr
Bhamara	Phyllanthus fraternus	Phyllanthus	G
Bhavara/Bhuvari			Fr
Bhendi	Thespesia popullnea	Bhendi Tree	Fl
Bhendi	Abelmoschus esculentus	Okra	V
Bhokar	Cordia myra(dichotoma)	Sebesten(Rasora)	Fr
Biti	Thevetia nerlifolia		Fl
Biti (red)			
Biti (yellow)			
Bor	Zizyphus mauritiana	Indian Jujube	Fr
Button shevanti	Chrysanthemum indicum	Chrysanthemum	G
Chapha	Plumera alba	Pagoda Tree	Fl
Cherry	Prunus (aviun)	Sweet Cherry	Fr

Local Name	Botanical Name	Common Name	Category
Chikana			Fl
Chikhali			S
Chikku	Achras sapota	Sapodilla Plum	Fr
Chinch	Tamarindus indica	Imli (tamarind)	Fr
Chini gulab	Hibiscus rosa-sinensis	China rose	G
Dahisiri			Fl
Dalimb	Punica granatum	Pomegranate	Fr
Durva	Cynodan dactylon	Bermuda grass	Gr/W
Ghaneri	Lantena camara	Lantana	G
Ghewada			V
Gond/Genda	Tagetes erecta	Marigold	G
Gulab, Rose	Rosa damascena	Rose	G
Sheng	Arachis hypogea	Groundnut (Peanut)	V
Gulmohar	Delonix regia	Goldmohar	Fl
Jai	Jasminum grandiflorum	Jasmine (var.)	G
Jambhal	Syzygium cumininn	Jamun	Fr
Jaswand	Hibiscus rosasinensis	Shoe Flower	G
Jeena			
Jui	Jasminum auriculatium	Jasmine (var.)	G
Kaanda	Allium cepa	Onion	V
Kadulimb	Azadirachta indica	Neem	S
Kadipatta	Murraya koenigi	Curry leaves	V
Kaju	Anacardium occidentale	Cashew	Fr
Kamal	Nelumbium speciosum	Lotus	Gr/W
Karanj	Pongamia glabra	Indian Beech	Fl
Karawand	Carrisa carandas	Bengal Currants	Fr
Kardal	Canna indica	Indian shoot	G
Karela	Momordica charantia	Bitter gourd	V
Kela	Musa paradiciaca	Banana	Fr
Krishnakamal	Passiflora foetidas		Gr/W
Kurudu	Celosia argentea	Qual grass	V
Kusar	Jasminum malabaricium	Jasmine (var.)	Fl
Lavhala	Cyperus rotundus		
Makhmali			G
Medi			
Methi	Trigonella foenum graecum	Fenugreek	V
Mirchi	Capsicum annum	Chilli	V
Mogra	Jasminum	Jasmine	G
Moh	Madhura indica	Butter Tree	Fl
Money plant			G

Local Name	Botanical Name	Common Name	Category
Naral	Cocos nucifera	Coconut Palm	Fr
Nigad	Vitex negundo	Indian Privet	Fl
Nilgiri	Eucalyptus species	Blue Gum tree	S
Palak	Spinacea oleracea	Spinach	V
Palas	Butea frondosa	Flame of the forest	Fl
Panbudi/ Panphuti	Bryophyllum pinnatum	sprout-leaf plant	G
Papai	Carica papaya	Papaya	Fr
Parijat/Parvati	Nyctanthea arbartristis	Coral jasmine	G
Peepul	Ficus religiosa	Pipal	S
Peru	Psidium gugava	Guava	Fr
Phanas	Artocarpus heterophyllus	Jack Tree	Fr
Raatrani	Cestrum nocturnum	Night Jasmine	G
Ramphal	Annona reticulata	Bullocks heart	Fr
Ratalee	Ipomea batatos	Sweet potato	V
Rui	Calotropis gigantea	Crown Plant	Fl
Sadafuli	Vinca rosea	Vinca	G
	Catharanthus roseus	Periwinkle	G
Sag	Tectona grandis	Teak	S
Satrangi	Lantana camara	Lantana	G
Seetafal	Annona squamosa	Custard apple	Fr
Sevri	Salmalia malabarica	Silk cotton	Fl
Shevanti	Chrysanthimum indicum	Chrysanthemum	G
Shirish	Albizia lebbeck	Rain Tree	Fl
Sontakka	Hedychium coronarium	Ginger lily	G
Subabhal	Acacia arabica	Babul, Gum Arabica	S
Suryaful	Helianthus annus	Sunflower	G
Tagara	Eravantamia coronaria		G
Takla	Cassia tora	Foetid Cassia	V
Terda	Impatiens balsamina	Garden balsam	G
Tondli	Cephalandia indica		V
Tulas	Ocium sanctum	Holy Basil	G
Umbar	Ficus glomerata	Cluster Fig	Fr
Vad	Ficus bengalensis	Banyan	S
Vatana	Pisum sativum	Pea	V
Vavala	Holoptelea integrifolia		V
Zadful			
Zendu	Tagetes erecta	African marigold	G

Note on symbols used

- S - Socially significant tree
- Fl - Flowering tree
- Fr - Fruit tree
- G - Garden plant
- V - Vegetable plant
- Gr/W - Grass or Water plant

Appendix B

Plant and animal names in classification task

Set of 50 cards of animal and plant names for classification.

Animals

human	scorpion	crabs
deer	earthworm	ant
cow	mosquito	snake
squirrel	bear	mouse
tiger	owl	hen
salunki (a bird)	*sasana* (a bird)	bat
peacock	crow	kite
frog	butterfly	bombeel
hippopotamus (*panghoda*)		

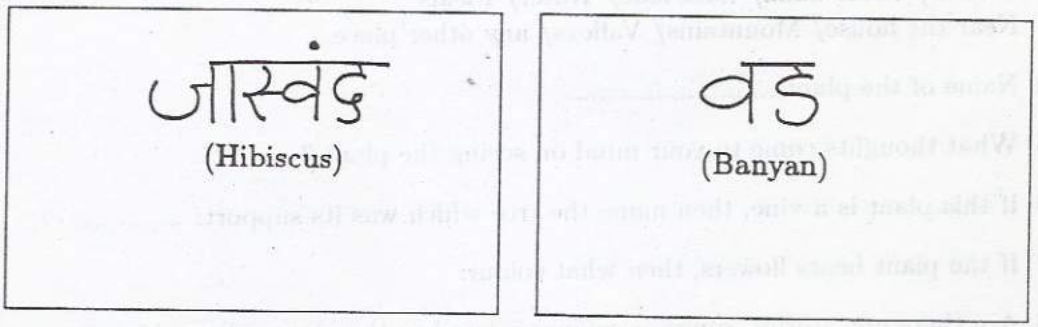
Plants

snake-gourd	grapes	pumpkin
bamboo	eucalyptus	teak
jowar	onion	orange
castor (*yerandel*)	*toor* (lentil)	banyan
cactus	mango	sugarcane
basil	coconut	*taad* (palm)
betel palm	*bhendi*	*moong* (pulses)
chapha (flower)	gulmohor	rice
mataki (pulses)		

Set of 56 cards consisting of names of plants.

rose	*jai*(flower)	*sadafuli*(flower)
gulmohor	hibiscus	lotus
chameli(flower)	black gram	*maka*
rice	raagi	*moong* (pulses)
waal (pulses)	*chawali* (pulses)	garlic
onion	*math* (leafy vegetable)	Fenugreek
gawar	*karale*	*alu*
turmeric	carrot	potato
snake-gourd	raddish	bringal
palm	cucumber	*pumpkin*(gourd)
guava	*jamun*	sweet lime
banana	betel	jackfruit
cocum (fruit)	sweet potato	sugarcane
khajalu (shrub)	basil	*durva* (grass)
tamarind	*lavhali*	*nirgudi*
lajalu (flower)	teak	banyan
ashok	mango	eucalyptus
neem	*palas* (flowering tree)	coconut
bamboo	*chapha* (flower)	

Sample of cards used in the classification task



Appendix C

Herbarium questionnaire

Name of the student:.....

Std:..... School.....

1 Sample: A twig from a Tree/ Shrub/ Grass/ Vine/ Others
(with flowers and fruits if possible)

2 Date of collection: .....
Place: Varsai School/ Borgaon School/ other.

3 Where did you find the branch?
Forests/ River bank/ Lake-side/ Water/ Fields
Near the house/ Mountains/ Valleys/ any other place.

4 Name of the plant .....

5 What thoughts come to your mind on seeing the plant ?

6 If this plant is a vine, then name the tree which was its support: .....

7 If the plant bears flowers, then what colour:

8 Are there any stories, songs or sayings related to the plant collected?
Yes / No

9 What part of the plant is used and how?
(stem/ branch/ root/ leaves/ flowers/ fruit/ bark)
Fill the information in the chart given below.

Use	Part	How?
As food		
As beverage		
Medicine		
Toys/for playing		
Building material		
As clothes		
For fire/coal		
To use as tools		
Others		

Appendix D

List of alternative conceptions

Alternative conceptions in the writing task given by urban and tribal students.

Urban

1. *Junglaamadhye hatthi, kolha, waagh, simha astaat*

   There are elephant, fox, tiger, lion in the forest

   ... Kangaroo ...
   ... *Ghode* (horses) ...
   ... *Genda* (wild boar) ...
   ... Giraffe ...

2. *Poorna junglaat maanse rahtaat.*

   People live in the whole of the forest.

3. *Simha saglya praanyana khaau shakto.*

   Lion can eat all animals.

4. *Jangal, hey dongraavar, kiwha dongraachya paaythyashi asthey*

   Forest is on top of mountains or in valleys.

5. *Aadivaasi lokancha vesh asaa astho ki dokyala kaadya laavtaat, angaavar ti rangaachi pattey kaadhtaat*

   Tribals wear sticks in their head and draw colourful stripes on their body.

6. *Haran guhet rahtaat*

   Deer live in caves.

7. *Popat jhadaavar basoon jhadaachi phale khaaoon khaali taakat astho. Tyaamule junglaat ghaan hotey*

   Parakeet sits on a tree, eats fruits and drops them down. This makes the forest dirty.

8. *Aadivaasi loke kutlyaahi pranyaana pakdoon tyachi shikaar kartaat*

   Tribals hunt and catch all animals.

9. *Janglaat viheer asthaat*

   There are wells in the forest.

10. *Bagala paanyamadhye rahato*

    Crane lives in the water.

11. *Ya aamchya Mumbaichya janglaat motthey motthey praani aahet*

    There are very large animals in this, our Mumbai forest.

12. *Janglaat ekdam sagleekadey kalookhach kalokh astho.*

    It is very dark everywhere in the forest.

13. *Vaadal sutly ki thithli maati udoon jaatey.*

    The soil there flies away during a storm.

14. *Paoos padla ki tethil more naachtaat.*

    Peacocks there dance when it rains.

15. *Janglaat ekdam sagli jhadey aahet.*

    All trees are there in the forest.

16. *Kaahi kaahi praani cchaan pinjryaat asthaat.*

    Some animals are in beautiful cages.

17. *Kadhi kadhi joraat paoos aalaa ki janglamadhyey aag laagtey.*

    Sometimes, when it rains heavily, the forest catches fire.

18. *Janglaat khoop thandi asthey.*

    It is very cold in the forest.

19. *Aadivaasi loke paanaanchi topi ghaaltaat.*

    Tribals wear hats of leaves.

20. *Raandukkar kiwha genda paanyaat anghol kartaat.*

    Wild boars bathe in the water.

21. *Janglaapaasoon praani tayaar hotaat.*

    Animals are produced by the forest.

22. *Praani vihireetil paani pitaat.*

Animals drink water of the well.

23. *Janglaat phulaanchi va phalaanchi jhaadey nastaat.*

There are no flowering and fruit trees in the forest.

24. *Janglaat vishaari saap koneehi gele tar chaavtaat.*

Poisonous snakes bite anyone going into the forest.

25. *Jyaa maansaanna gharey nasthaat ti maansey janglaat rahataat.*

Those people who have no houses live in the forest.

26. *Mungoosaala maasey laagtaat.*

Mongoose need fish.

Tribal

1. *Draaksha janglaat jhaadavar miltaat.*

Grapes are found on trees in the forest.

2. *Waagh, simha, hatthi, ghoda, ghenda, laandga hey suddha aaplyaala baghayala miltaat.*

We get to see tiger, lion, elephant, horse, wild boar, and jackal in the forest.

3. *Kaahi praani aamchya janglaat aahey — maamsahaari — simha, waagh, cheetah; shakaahaari — harin.*

Some animals live in our forest carnivores like lion, tiger, cheeta; herbivores like deer.

4. *Giraffe hey atyanta uncha asthey, jhaadache shendyache paala khaatey.*

Giraffe is very tall, it eats leaves at the tops of trees.

5. *Tahaan laagli ki shikari nadeeche paani praanyasarkhey jhopoon pitat.*

The hunter, when thirsty, drinks river water lying down like an animal.

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