

## IDEAS ABOUT LIVING AND NON-LIVING: AN INDIAN CROSS-CULTURAL STUDY

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### ABSTRACT

*It has long been known that both children and adults attribute life to non-living objects. The concept of animism is however inadequate to characterise the richness of these ideas, which are explored here in a cross-cultural context. The study uses a variety of probes, to give some new results in a well-researched field. The subjects were fifth and sixth graders (ages 10-15) from one urban and two tribal schools in India. Data was collected in the course of intensive interactions with the students over two years, through questionnaires, individual and group interviews, and classroom discussions.*

*Results showed that students' judgements and justifications for life varied with task context as well as with socio-cultural milieu. Ideas of transformation between living and non-living were identified. Tribal students and boys performed better than did the urban students and girls. This study attempts to interpret the differences in performance of groups in the context of different tasks.*

### MOTIVATION

A few years ago, widespread hysteria was reported in different parts of India over the observation that idols of Lord Ganesh were drinking milk fed to them. Putting aside the specific religious context, this was another instance of the attribution of life to inanimate objects: a matter that has long been of interest to anthropologists and developmental psychologists alike. E. B. Tylor in 1871 used the term *animism* to refer to the belief in spiritual beings (Herskovits 1955).

Although anthropologists had observed these tendencies in adults, Piaget (1929) considered animism (in the broader sense of attributing life to inanimate objects) to be a developmental indicator, with children passing through four stages: from using any activity to judge life, through using movement, then spontaneous movement, and finally, at age 11+, identifying only plants and animals as living beings. Piaget related these stages to the child's gradual transition from intentional to mechanical causality.

Piaget's ideas have been challenged in several ways. Animistic judgements are known to persist into adulthood. Brainerd cited a review by Looft and Bartz to conclude that between 50% and 75% of adult subjects may be expected to attribute life to some inanimate objects (1978). University students display animism to almost the same extent as less educated adults. The issue of adult animism has never been properly reconciled with the developmental data.

Several studies of animism have looked at school and university students (Tamir, Gal-Choppin and Nussinovitz 1981, Brumby 1982, Watts and Bentley 1994). Anthropomorphic reasoning was found to be common in these students, who often rote-learned the formal criteria for life (Brumby 1982). Watts and Bentley (1994) argued for a positive value to animistic and anthropomorphic ways of thinking in school, especially with regard to girls. Carey's (1985) developmental studies with students aged 4-10 years identified two main sources of animistic responses: semantic problems for very young children, and inadequate biological knowledge for the older ones. Probing into children's justifications for life, she showed that they used multiple criteria, different from the simple ones assumed by Piaget. The phenomenon of animism since has been viewed in the framework of conceptual change.

The conceptual change approach however has not paid attention to cross-cultural issues in learning. Cobern (1991) suggested the use of the 'world view' concept in the study of science learning. Recently the importance of the effect of culture and language on the learning of science in non-western cultures has been more widely recognised (Lynch, Chipman and Pachaury 1985, Baker and Taylor 1995). McKinley (1996) reported an effort to write a science curriculum for the Maori of New Zealand, while Sable (1996) related the world-view concept to ideas about life held by the Mi'kmaq of Canada.

The biological criteria for life are inherently problematic. Most studies have looked at judgements of non-living objects as living; the opposite tendency of judging living things as non-living, which we term "inanimism" is generally understated. Both animism and inanimism result from an inability to

discriminate between living and non-living. In the Indian context, we feel that linguistic factors as well as religious beliefs could play a role in the understanding of 'life', 'living' and 'non-living'. We have considered socio-cultural variables through a comparison of tribal with urban students and also girls with boys. Notwithstanding the long history of research in this area, the uniqueness of the Indian setting prompted our study of students' ideas about life. A significant aspect of this study is the consideration of patterns of judgements and also justifications across a range of contexts.

### PROBLEMS ADDRESSED

A three-year research project into students' learning titled 'Diagnosing Learning in Primary Science (DLIPS)' was carried out at the Homi Bhabha Centre for Science Education. It aimed at diagnosing the alternative conceptions of students of grades 5 and 6 in a few topics of the science curriculum and examining these in the light of socio-cultural factors. This paper reports the first of the above studies. The study attempted to learn whether there were gender and tribal-urban differences in the selection of examples of living, in judging the given examples as living, and in the justifications given for considering something living.

The data was collected over two academic years from three schools, one urban and two tribal. 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 the severe gender bias in schooling opportunities.

The two groups of students have some similarities and many stark differences. Both urban and tribal schools use the same textbooks and language of instruction, namely *Marathi*, the language of Maharashtra State. Marathi is the mother tongue of the urban students. The tribal students, however, speak dialects of Marathi further removed from the textual language and the language of the teachers. The two groups of students are comparable in their low socio-economic levels. However, despite them being separated by only about 150 kilometres, their exposure to various aspects of modern life is vastly different. For instance, the urban students are more exposed to advertisements and television with little experience of agriculture and natural habitats.

#### *Curriculum*

India has a uniform National curriculum with the States exercising a limited autonomy in choice of textbooks. The study of living and non-living enters early in the school curriculum, and forms a major theme in the primary school. The topic of 'life' is introduced in the Maharashtra State schools in grade 3 science when the criteria for life are introduced. These criteria are gradually refined through grades 5 & 6.

#### *Tribal background*

Indian aboriginal tribes belong to diverse races having diverse languages and social organisations. Over the years they suffered a marginalisation that intensified during colonial times. The Indian Constitution declares certain groups of people as Scheduled Tribes and provides special measures for their development, such as, facilities for education, and funds for tribal welfare in the States. The State tribal welfare departments run tribal residential schools to educate children of migrant tribes living in remote hilly areas. These residential schools provide free tuition, books, clothing and meals. Two tribal residential schools in Maharashtra State were selected for this study on the basis of accessibility of terrain and the recommendation of the State tribal welfare department.

Most of the tribal students in this study belong to the larger tribes of Western Maharashtra, such as *Katkari, Koli and Thakur*. Their parents generally make a living by marginal farming, working as agricultural labour, hunting and food gathering, selling firewood and charcoal (Sirsalkar 1972, Fuchs 1973). The students participate in agriculture, which reflects in a low attendance in schools during the sowing and reaping seasons.

#### *Urban background*

The urban school was selected for its proximity and the willingness of the school authorities to allocate some time each week for the researchers. The school is run by a charitable organisation and has a mix of (a) students from lower middle-class families, (b) students belonging to an orphanage, and (c) students institutionalised for vagrancy or delinquency. The school is located in a suburb of Mumbai, which is the commercial capital of the country.

## EXPERIMENTAL TASKS AND SAMPLE SIZES

A multiplicity of tasks provided a variety of contexts to probe students' ideas. Responses in one task or activity often led to the design of the next task. Five tasks were administered in the order given below to probe students' conceptions of life.

**Task 1: Examples** Students had to give one example each of a living and a non-living object (Urban 109; 37 G + 72 B).

**Task 2: Questionnaire** 20 items were to be judged as living/non-living with reasons. (Pilot 111: Urban 111; 37 G + 74 B; Final 302: Urban 203; 76 G + 127 B; Tribal 99: 31 G + 68 B).

**Task 3: I am a living being because:** Students had to write reasons to support the assertion that they were living (Urban 91; 43 G + 48 B; Tribal 41; 11 G + 30 B).

**Task 4: Rice Questionnaire** A questionnaire was framed on grains of rice at various stages, (Urban 61; 28 G + 33 B; Tribal 99; 32 G + 67 B).

**Task 5: Rice Interviews** Individual interviews on the rice questionnaire (Urban 8; 6 G + 2 B; Tribal 13; 3 G + 10 B).

## FINDINGS

### *Examples given by students*

The urban students (109) easily gave at least one example of living (117) and non-living (113). However, the exemplars of living were more likely to be animals (91%) than plants (9%). This is consistent with results from Tamir, Gal-Choppin and Nussinovitz (1981) and Carey (1985). Mammals were the largest category reported, followed by birds. The mammals reported were large ones like tigers, lions and wolves, generally encountered only in stories, television and zoos. Interestingly, the various animals that city students encounter, such as, rodents, flies and insects, were rarely mentioned. Humans were cited least often (3%) which is in contrast to Carey's results (1985), where the largest number of responses had been in the category people.

Carey found that students, even at age 10, had difficulty in citing things that were not living. Their examples included 'dead animals', 'monsters', 'fairies', 'pictures', and 'people on TV' and dinosaurs. The students in our study found no difficulty with this task. Their examples of non-living included articles of common use and other artefacts. There was a significant gender difference in the types of examples of non-living given by the students. Girls cited many more articles of personal use (23%) than did the boys (4%). This result is consistent with a large body of research suggesting that women are more person-oriented (Goodenough 1957 in McGuinness 1993).

### *Judgements about life*

Results of the exemplars task (Task 1), suggested that in some cases at least, judgements of life might be derived from knowledge of category membership. Thus, large mammals were more easily judged living than were plants. In the case of human-made artefacts too, students seemed to be using category membership to judge life.

Tasks 2 and 4 explicitly elicited students' judgement of living and non-living. The Task 2 questionnaire had a pilot and a final version. The pilot questionnaire had been developed from the examples given by the students and had twenty items which students had to classify as living or non-living. The pilot version administered to 111 students in grade 5 of the urban school revealed that students did have animistic notions. Non-living and natural objects, like the earth (36%), sun (29%), moon (27%) and cloud (8%) were stated to be living. Students also demonstrated inanimism: saying that living natural objects like trees (17%) and germs (11%) were non-living. Human artefacts like aeroplane, watch, bicycle and camera was not often judged alive (about 2% students in each case). Fire, which might be perceived as either a human artefact or a natural phenomenon, was often (8%) judged living. The remaining items, either natural or non-living or human artefacts were guessed incorrectly by less than 5% of the students.

Following the pilot questionnaire, the number of 'living' was increased to nine out of twenty items. Five of these were either seeds or regenerative parts of plants. Only one human artefact was retained (aeroplane). To avoid a forced choice between living and non-living, this questionnaire included a third choice: 'not sure'. The students rarely used this option.

Table 1 summarises the incorrect judgements of life/ non-life in the modified questionnaire. As in the pilot questionnaire, animistic responses were common for sun, earth, moon and cloud. Besides, water, soil and split lentils also elicited animistic responses. All the seeds or regenerative parts as well as fungus and moss elicited considerable inanimistic responses.

Table 1: Incorrect judgements of life in Task 2 including gender and tribal/ urban differences

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

\* = Significant at 0.05 level

Statistically significant differences in the responses are indicated in Table 1. Interestingly, tribal students were more accurate than urban students in determining life in living things were. In judging the absence of life in non-living things, boys were more accurate than girls were. Thus, tribal students were about as animistic as urban students were, but less inanimistic than them. Boys and girls were equally inanimistic, but the boys were less animistic.

The large proportion of inaccurate judgements given for the seed and regenerative parts was surprising, since sprouted seeds are common dietary items in this region. This result prompted a detailed look at understanding of life in seeds. The familiar example of rice, the staple grain of this region was chosen. Rural students are intimately familiar with the process of rice cultivation, and even urban students are likely to have some knowledge of it. This questionnaire asked students to judge the living or non-living nature of grains of rice at several different stages. The 'not sure' option was present in this questionnaire too, but students rarely used it (0% - 1%).

As presented in the order, the first 3 items of the rice questionnaire are living and the remaining is non-living. Based on the results of Task 2, we expected that students might find the second item to be non-living (it is neither attached to a living plant nor is it sprouting). We were looking for transitions preceding and following this item. The variation in percentage responses given in Table 2 show clearly that a considerable fraction of students implied a transformation of the seed from living to non-living (item 1 to 2) and back again to living (item 2 to 3).

Tribal students were significantly better than urban students in judging the non-living stages. What was surprising, especially in the light of Task 2 above, was that a significantly smaller fraction of tribal students considered a rice seed to be living. There were significant gender differences on two of the items, namely 'rice on the stem' and 'polished rice', with boys giving a higher proportion of correct answers.

Table 2: Responses to rice questionnaire (Task 4)

% Correct Responses

Items	Girls n=60 r=337 %	Boys n=100 r=552 %	Tribal n=99 r=584 %	Urban n=61 r=305%	Total n=160 r=889 %	Girls-Boys Z values	Tribal Urban Z values
<b>Living:</b>							
1. Rice seed on stem	86	99	92	100	95	-2.619 *	-2.919
2. Rice seed	51	59	46	78	56	-0.929	-4.119
3. Planted seed	88	95	94	89	92	-1.382	0.988
<b>Non-living:</b>							
4. Husk of rice	92		97	80	92	-----	2.848
5. Polished rice	53	77	85	30	69	-2.926 *	7.358
6. Cooked rice	88	91	96	76	90	-0.555	3.118

\* Significant at the .05 level

N = number of students

R = number of responses

#### Criteria for life

A suitable classification system had to be devised to study students' spontaneous justifications, which were elicited in all the tasks from 1 through 4. For Tasks 1 and 2, we found Carey's (1985) system, with a few additions (indicated by #) adequate. Our classification system therefore consisted of I. Use, fact, existence (tautology #); II. Movement, activity; III. Anthropomorphic traits, comparison to people/things; IV. Built by people, autonomous motion (intervention by external agent #); V. Growth, death, reproduction, composition. This system had to be further modified for Task 3 where students had to write reasons for stating that they themselves are living beings. Anthropomorphism, was an irrelevant criterion here, instead we used the term *human specific characteristics*.

The criteria used in the analysis of Task 4, the rice questionnaire, were somewhat different from the ones used for the other tasks. There were some responses, like, "a grain of rice is non-living as it has lost its energy" or "a seed of rice planted in soil is living as it is filled with vitamins", which did not fall into the existing categories. Hence, a category, 'others' was created for such responses.

Table 3: Criteria for life in the four tasks: percentage responses

		Responses types (%)						
	r	I	II	III	IV	V	Others	
<b>Task 1</b>								
Girls	81	12	27	18	16	27		
Boys	149	11	33	11	17	27		
Total	230	11	31	14	17	28		
<b>Task 2</b>								
Girls	1817	29	17	10	2	40		
Boys	3204	19	13	10	1	56		
Tribal	1673	26	14	4	1	53		
Urban	3348	21	15	13	1	49		
Total	5021	23	15	10	0	50		
<b>Task 3</b>								
Girls	351	10	16	20	0	54		
Boys	497	9	22	26	1	43		
Tribal	345	10	20	33	2	36		
Urban	503	9	19	17	0	55		
Total	848	9	20	23	1	47		
<b>Task 4</b>								
Girls	337	24	0	8	0	63	4	
Boys	552	16	0	1	0	76	6	
Tribal	584	19	0	5	0	71	5	
Urban	305	19	0	1	0	71	9	
Total	889	19	0	4	0	71	6	
Carey's (1985) results		18	33	25	11	13		

r = No. of responses

Columns in bold represent the two most frequent categories stated

Table 3 summarizes the criteria for life used by students on Tasks 1 to 4. The last row reproduces data reported by Carey (1985). Statistical comparison between Carey's sample and ours is not appropriate.

Table 4 presents the mean number of responses for each criterion given by each of the sub-samples for Tasks 1 to 4. The statistical significance of the differences in the means is determined by t-tests. Statistically significant gender and tribal-urban differences are enclosed by squares.

Table 3 indicates that in Task 1, 'movement' (II) was the most frequent justification for life. The second most frequent justification was based on biological knowledge (V), including concepts of growth, reproduction and death. Similar findings have been reported by Tamir, Gal-Choppin, Nussinovitz (1981) and Carey (1985). The category 'built by people', is conspicuous by its presence here and its absence in other tasks.

In Task 2, which had an eclectic collection of items, students' criteria for life also varied. The most prevalent criteria for judging life were the biological ones followed by a combination of 'use', 'fact', 'existence' and 'tautology'. The prevalence of the 'tautology' justification was curious as also its greater appearance among tribal students. This may well be a consequence of the Marathi language, in which the word for living is *Sa-jeev*, or 'with-life', and that for non-living is *Nir-jeev*, or 'without-life'. However, such a terminology also makes it plausible that the notion of having *jeev*, or 'life', might be interpreted in an explicitly vitalistic way. A material concept of *jeev* also helps to make concrete the abstract notion of life. The possibility of such ideas among students was explored in Tasks 4 and 5.

Table 3 indicates differences in the responses of the tribal/urban groups and girls and boys to Task 2. Urban students gave more anthropomorphic (III) justifications than tribal students who gave more use-oriented (I) justifications. Girls gave more of these use (I) justifications as compared to boys who gave more biological (V) justifications.

Task 3, (giving reasons for the self being living) elicited a large proportion of biological (V), III (human-specific) and II (movement) criteria. The rice questionnaire Task 4 elicited many more of the biological (V) and the use, fact, existence, tautology (I) criteria.

Table 4: Mean number of criteria for life in the four tasks

Task	n	Responses types (mean)				
		I	II	III	IV	V
Task 1						
Girls	37	0.40	0.89	0.62	0.54	0.89
Boys	72	0.35	1.01	0.35	0.54	0.86
Task 2						
Girls	107	5.70	3.75	2.30	0.54	6.92
Boys	195	3.75	2.33	1.71	0.29	9.36
Tribal	99	7.83	2.59	0.81	0.27	8.64
Urban	203	2.79	2.95	2.46	0.43	8.42
Task 3						
Girls	54			1.31	0.00	3.50
Boys	78	0.63	1.06	1.63	0.08	2.72
Tribal	41	0.55	1.40		0.15	3.00
Urban	91	0.80	1.68	0.92	0.00	3.05
Task 4						
Girls	60				0.00	
Boys	100	1.35	0.00	0.45	0.00	3.45
Tribal	99	0.90	0.00	0.08	0.00	4.15
Urban	61	1.14	0.00	0.31	0.00	4.12
		0.95	0.00	0.07		3.51

n = No. of students  
 =Significant at 0.05 level (t-test)

Table 4 indicates that in Task 1, (the examples of living and non-living) there were no significant difference in the justifications provided by girls and boys. The difference however, surfaced in subsequent tasks. In the anthropocentric context of Task 3, girls gave more biological responses than boys did. In Tasks 2 and 4 on the other hand, they gave more responses in the 'use, facts, existence, tautology' category and less in the biological category. Girls also gave human-centred responses (III) more often than boys did in Task 4.

In Task 3, tribal students gave many more movement and human-specific criteria. The smaller number of human-centred responses by urban students in a task, which encourages such responses, may indicate their ability to distance themselves from the task context. This ability is known to be an effect of schooling and urbanisation (Scribner and Cole 1973, Harris 1984). Girls used biological criteria more often than did boys, while the boys gave more movement criteria. This task, which was more human-centred than the others, elicited a greater frequency of the scientific justification criteria from girls. This might be another indication that girls are more person-oriented.

#### Ideas about transformation

In classroom discussions students were presented with seemingly paradoxical statements, like, "an aeroplane 'breathes' air and 'drinks' fuel"; "some people never reproduce"; "the sun moves without anyone pushing it"; "life on earth is possible only because of the sun". The greatest confusion occurred in relation to seeds: whole, de-husked or cooked and bulbs like onions, and potatoes which are often seen sprouting inside the house in the monsoon season. Transformation from living to non-living, and then back to living was a predominant idea. Students maintained that seeds and bulbs "become alive" because they get *kas* (essence, nourishment) from the soil. Remarkably, all the four teachers in these classes expressed similar ideas.

Students' responses in Task 4 (Table 2), also suggested a transformation of the seed from living to non-living (item 1 to 2) and back again to living (item 2 to 3). To probe this idea further, 21 students (T=13, U=8, G=9, B=12) were interviewed about their responses to the rice questionnaire. Four of these students had given tautological responses, 12 had clear transformational responses, 6 had stressed the importance of water, and 4 had given anthropocentric criteria for life. Since each student could give many responses, these numbers do not add up to twenty-one.

In the interviews, 9 students used vitalistic notions to justify life. They used terms like *power (shakti)*, *flame of life (praanjyoti)*, *miracles (kimaya)*, *self-confidence (aatmavishwas)* and *soul (aatman)* as important for living. Vitalistic responses were more frequent among tribal students (7 of 9). Seven students gave both the transformations, that is, from living to non-living as well as from non-living to living. Each of these transformations was justified by different criteria. The reasons for the transformation from living to non-living were: separation from living, e.g. a leaf breaks from a tree (2 students), and lack of water or drying up (12 students). For the transformation from non-living to living, 3 students mentioned availability of water, miracles, the flame of life and power. Four students could not say what caused the transformation from non-living to living.

Water played an important role as a life-giver. This could be an over-extension of the idea that living things need food, air and water. Students stated that a non-living can become living by water in-take and a living becomes non-living when it dries up or loses water. An extreme over-extension of this idea was that cooked rice is living, as it is bloated with water. Other ideas which came up during the interviews were, something is living because it is useful to humans (anthropocentrism); something can be both living and non-living, such as, an egg which is living on the inside and non-living outside; there are things which are "a little alive" because of "less power". This suggests an idea of continuum of life.

## CONCLUSION

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

Girls were more person-oriented (Task 1), anthropomorphic (Task 3 and 4) and animistic (Task 2). It is important not to facilely dismiss this as scientifically immature thinking. Considering the lack of a gender difference in inanimistic responses, the animism in girls seems likely to be related to affective factors. These results support a case for making science textbooks more person-oriented than they are at present.

Tribal students were comparable to urban students in their biological responses in all the tasks, except in Task 3 which had an anthropocentric context. Both in Task 3 and Task 4, contexts close to their way of life, they were more susceptible to human-centred criteria. This perhaps reflects a relative inability, compared with urban students, to distance themselves from the task context. Gender and tribal/urban differences in relation to scientifically correct estimation of life/non-life indicated that tribal students and boys were more accurate. It is remarkable that tribal students, who are known to be more animistic in their religious practices, were not more animistic than urban students in any of the tasks. On the other

hand they were less inanimistic in their judgements. Their judgements were therefore closer to the scientific ones. This may be a result of their proximity to the natural environment.

The concept of 'transformation' of life emerged through the idea of inanimism evident on three occasions: in Tasks 2 and 4, and in classroom discussions. Seeds, embryos and bulbs were often considered non-living. These cases showed up two unexpectedly common alternative conceptions: a) that a living thing can become temporarily non-living, and b) that the transitions back to living might imply a vital force.

At least part of the reason for the vitalistic ideas and also the tautological responses might be traced to language. The term *jeev* has complex connotations in the Marathi language. Further, the word for living is *Sa-jeev*, or "with-life", and that for non-living is *Nir-jeev*, or "without-life". Both these are used as nouns. The first is a technical word, introduced via the textbook, while the second is a colloquial term. The cultural connotations of technical terms are known to affect the learning of concepts (Baker and Taylor 1995).

The study has implications for making the curriculum relevant to tribal experiences. Along with curriculum initiatives, studies are called for, both to explore the nature of the tribal students' superior knowledge and the paradox of their poor performance in the school context (Natarajan, Chunawala, Apte and Ramadas 1996). The scenario in India is complex, given the multiplicity of languages and cultural experiences. In New Zealand, curricula meant to increase the participation of the Maori are already in place (McKinley, Waiti and Bell 1992). The Maori curriculum links the concept of living things with that of Mother Earth (McKinley 1996).

The study has thrown up two specific issues that merit further research. One is the existence of appropriate contexts that elicit biological responses about life. The other is the transformational view of life, which needs to be explored across several cultures.

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