Understanding 'Children's Construction of Biological Concepts' and Its Educational Implications

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YOUNG children possess knowledge about biological phenomenon. It enables them to make sense of what they observe about animals and plants.Motoyoshi (1979) reported that a five year old girl summarised her accumulated experiences with raising flowers by using the following analogy: "Flowers are like people. If flowers eat nothing (are not watered), they will fall down of hunger. If they eat too much (are watered too often), they will be taken ill. Motoyoshi (1979) has also reported an anecdotal example of causal attribution for an animal's unusual physical reaction. He reported an example of five year old children in a day care centre. These children were taking care of a rabbit. When one day they observed an unusual excretion, they concluded that it might be suffering from diarrhoea, as a person might suffer from diarrhoea. After a discussion amongst themselves they decided that the rabbit must be given some medicine for its diarrhoea.

Major investigations of young children's understanding of biological phenomenon agree that young children possess "theories" about biological phenomenon. The term 'theory' means a coherent body of knowledge that involves causal explanatory understanding. These theories concern internal processes involved in individual survival and reproduction of animals and plants and their external behaviours and properties relevant to these processes. Young children though are totally ignorant of physiological / behavioural mechanisms involved. They know that excessive eating leads to becoming fat but they do not know the biochemical or the physiological processes involved. The issue under debate here is whether young children possess naïve biology, a children's version of endogenous biology similar to ethno biology or folk biology which is separated from biology.

The acquisition of biological concepts can be divided as: (1) the "naïve theory of biology" that young children have before schooling and (2) naïve biology interacts with school biology to result in intuitive biology that ordinary adults in modern societies have.

Researchers have found that young children before being taught in school possess a fairly well developed body of biological knowledge that enables them to make reasonable predictions and explanations regarding biological phenomenon.

Many concepts that children develop about natural phenomenon derive from their sensory experiences. Researches undertaken in various countries have identified common features in children's ideas and developmental studies are giving useful insights into development of ideas during childhood years.

Children's understanding of the concept of Living

Researches in children's ideas of living have been carried out since 1920. The pioneering studies on children's ideas of living have been carried by Piaget who observed that children tend to regard many inanimate objects as capable of sensations, emotions and intentions. This was called as 'animism' by Piaget. Carey suggests that progression in the concept of living is linked to child's developing conceptual framework about biological processes. Young children (4-7 years) have little biological knowledge. By the age of 9-10 years, there is a marked increase in the knowledge of biology. Younger children explain bodily functions of living things and the activity of inanimate objects using a naïve psychology of human behaviour rather than the concepts of biological function. The naïve psychology is characterised by intentional causal reasoning in the child's explanations, for example, 'the sun shines in order to keep us warm'. As the biological function develops apart from human intentional causality, the animistic reasoning declines.

Some researches (e.g., Bullock, 1985; Massey and Gelman, 1988) have revealed that young children can distinguish animals and non living things in terms of ability to make self initiating movements.

Researches have also found that children use personification to identify living objects. Personification means using person analogy. Young children are familiar with humans and use their knowledge about humans to analogically attribute characteristics to less familiar animate objects. Vasniodou (1989) has reported that children tend to apply an analogy on the basis of salient similarity between the target (object to be identified) and the source. The closer the target object is biologically to a human being, the more often children recognise its similarity and thus apply the person analogy.

Some students have found that young children attribute human characteristics to targets in proportion to the extent that they are perceived to be similar to people (Carey, 1985; lnagaki and Sugiyama, 1988).

The authors of this paper had undertaken an action research in a primary school run by the Government of Delhi. It is located on the outskirts of Delhi. The research question was 'How do primary school children construct biology concepts?' The aspect of biology taken up to understand this was that of living and non living objects. The classes chosen were from I-V. Only one section of each class was taken up. Photographs of six living and six non living objects were shown to the students. They were asked to mark the objects that they consider as living. The students of classes III-V were interviewed on the

responses they had given. The next two portions of this paper are based on (1) the data collected and its analysis and (2) its educational implications.

Method

Photographs of six living and six non living objects were shown to the students of classes I–V. The photographs 'are given in Appendix I. The photographs of living objects shown to the students were: tree, butterfly, flower, elephant, dog and eagle. The photographs of non living objects shown were that of sun, teddy bear, radio, clouds, train and kite. A total of 54 students were taken up for study. The number of students taken up is a delimitation of the study. The socio-economic status of the students taken up for the study was similar. They all belonged to the lower socio-economic background. Random selection procedures were used to select students for the present study. The classwise distribution of students taken up for the study is given in Table 1.

Table 1: Number of students taken in each class

Class	*No. of Students*
I	3
II	10
III	12
IV	21
V	8
Total	54

Out of the 54 students taken up for the study, 34 were interviewed in detail regarding the answers given by them. This was the other limitation. The students were asked to give the reasons for why they considered a photograph shown as that of a living object. The data was collected in February 2006.

Data Interpretation

The data collected was tabulated class wise for percentage responses. The percentage responses show the percentage of students who have considered an object living. This data was

Table 2: Shows the percentage responses of students regarding the picture being considered as that of a living object.

Classes	*Sun*	*Teddy Bear*	*Tree*	*Radio*	*Clouds*	*Butter-fly*	*Elephant*	*Train*	*Flower*	*Dog*	*Kite*	*Eagle*
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
I	100	66.6	0	100	66.6	0	100	100	0	100	100	0
II	80.0	40.0	30.0	70.0	80.0	10.0	90.0	60.0	20.0	100	40.0	10.0
III	58.0	25.0	33.3	41.7	50.0	0	100	41.7	33.3	100	16.6	8.3
IV	71.4	14.2	14.2	38.0	57.1	4.7	100	38.0	17.2	100	28.6	0
V	75.0	37.5	12.5	75.0	62.5	12.5	100	37.5	37.5	100	37.5	12.5

then analysed for classwise trends if any. The data was also analysed for changes, if any, in conceptual understanding across classes I to V. The responses given in interviews were similarly analysed class wise and across classes I to V. The responses were analysed to see the accuracy of responses as well as the correctness of the reasons attributed for calling an object living.

Classwise Analysis of Percentage Responses

The delimitation of this study especially the less number of students at the class I and class V level is a big hindrance in generalising the results at every level. Yet an effort has been made to remain objective.

The percentage of students considering an object as living or non-living can be analysed classwise to see whether any trend emerges. In this section, classwise analysis of percentage responses of an object being considered living has been taken up.

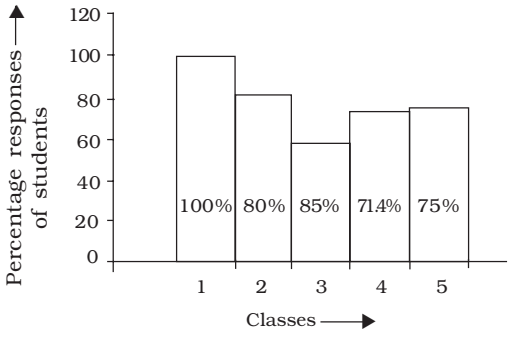

Figure 1: *Histogram showing percentage responses of students considering sun as living.*

By looking at Table 2, column 2 and Figure 1, it can be seen that the percentage of students considering sun as living comes down steadily from class I to class III and then increases from class I to class V. There is no consistent pattern of the percentage going down from class I to class V. But a broad conclusion can be drawn that with the exception of Class III, the percentage of students considering an object as living is fairly high in classes I to V.

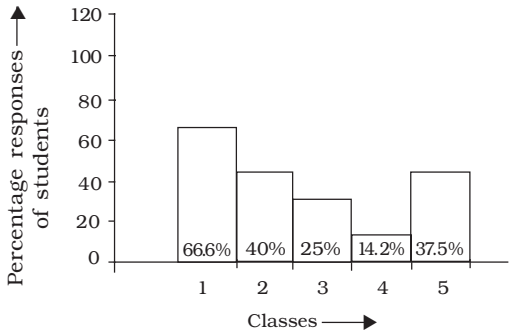

Figure 2: *Histogram showing percentage responses of students considering Teddy bear as living.*

Table 2, column 3 and Figure 2 clearly indicate that though the percentage of students considering Teddy bear as living has gone down from class I to class V, no trend has emerged. The percentage of students considering Teddy bear as living is the least amongst the class IV students.

Referring to Table 2, column 5 and Figure 3, it can be clearly seen that the percentage of students considering radio as living goes down from class I to class V. No particular trend though has emerged. The least percentage of

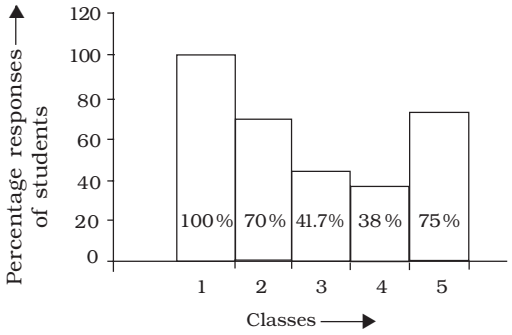

Figure 3: *Histogram showing percentage responses of students considering radio as living*

students considering radio as living is in class IV where only 38% students have considered radio as living.

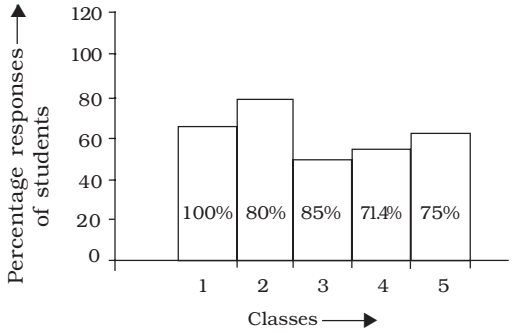

Figure 4: *Histogram showing percentage responses of students considering clouds as living*

From Table 2, column 6 and Figure 4, it emerges clearly that the percentage of students considering clouds as living decreases from class I to class V. There is a marginal increase in percentage in class IV and class V. In class III only half of those who were part of the study considered clouds as living. There, of course, is no trend that has emerged.

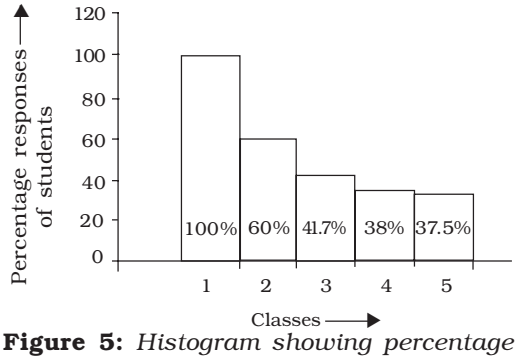

Figure 5: *Histogram showing percentage responses of students considering train as living*

From Table 2, column 9 and Figure 5, it emerges clearly that the percentage of students who consider train as living goes down steadily from class I to class V. In class V, only about one third students consider train as living. Here a trend has clearly emerged.

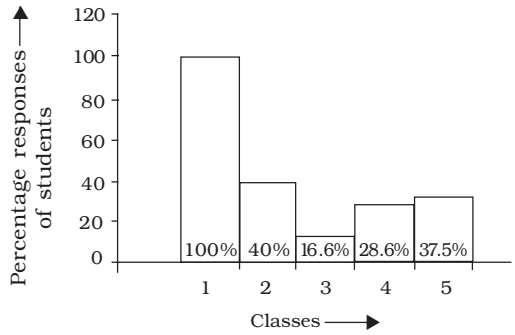

Figure 6: *Histogram showing percentage responses of students considering kite as living*

It can be seen from Table 2 column 12 and Figure 6 that all students of class I consider kite as living. The least percentage of students who consider kite as living is in class III.

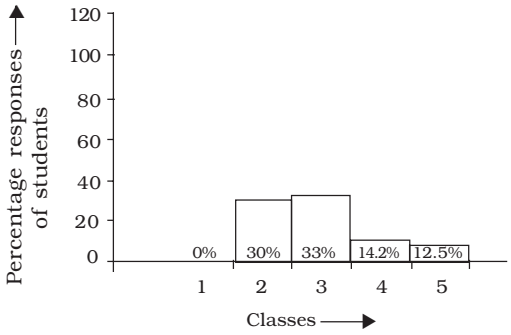

Figure 7: *Histogram showing percentage responses of students considering tree as living*

Taking up Table 2, column 4 and Figure 7, it can be seen that none of the students of class I have considered tree as living. The percentage of students considering tree as living increases in classes II and III but comes down again in classes IV and V.

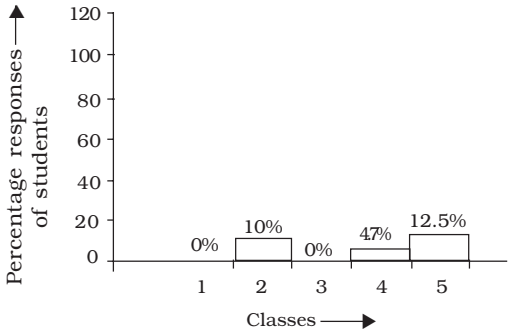

Figure 8: *Histogram showing percentage responses of students considering butterfly as living*

None of the students in classes I and III have considered butterfly as living. For rest of the classes II, IV and V no pattern has emerged. The percentage of students considering butterfly as living is though the greatest in class V. This can be seen from Table 2, column 7 and Figure 8.

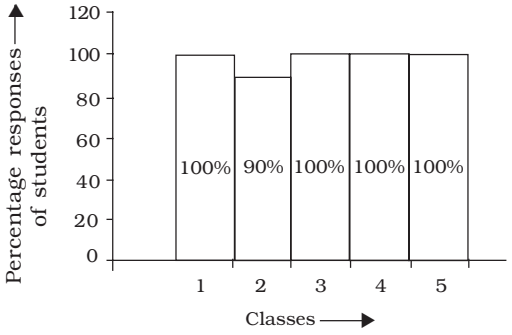

Figure 9: *Histogram showing percentage responses of students considering elephant as living*

Table 2, column 8 and Figure 9 show that except for class II where 90% students have considered elephant as living, all students (100%) of other classes have considered elephant as living.

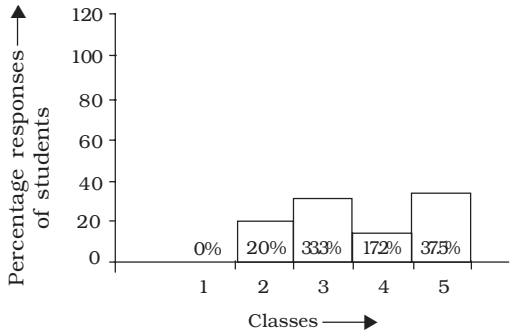

Figure 10: *Histogram showing percentage responses of students considering flower as living*

From Table 2, column 10 and Figure 10, it becomes clear that none of the class I students considers flower as living. No

trend has emerged from classes II to V. The least percentage of students considering flower as living is in class IV and the maximum percentage is in class V.

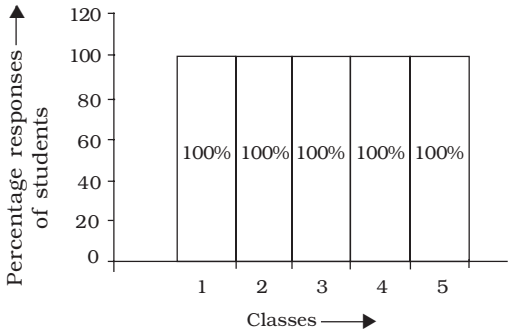

Figure 11: *Histogram showing percentage responses of students considering dog as living*

It can be clearly seen from Table 2, column 11 and Figure 11 that all students of all classes have considered dog as living.

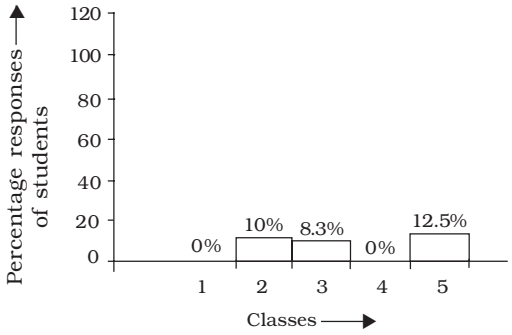

Figure 12: *Histogram showing percentage responses of students considering eagle as living*

Eagle has not been considered living by class I and class IV students as is evident from Table 2, column 13 and Figure 12. The maximum percentage of students considering eagle as living is in class V.

From the above classwise analysis of percentage responses it becomes clear that no particular trends have emerged but on the whole the following broad conclusions can be drawn:

- The percentage of students considering non living objects as living decreases from class I to class V although no trend can be established. Only in the case of train a trend of increasing percentages can be seen.
- The percentage of students considering living objects as living increases from class I class V though no trend could be established.
- Dog and elephant have been considered living by almost all students from class I to class V.

Classwise Analysis of Interviews

Students of classes I and II could not be interviewed. Only students of classes III to V could be interviewed. They were interviewed on why they considered a particular object as living.

For class III. some of the responses to the question asked have been listed below:

- Sun is living because it moves. *(Suraj zinda hai kyunki chalta hai)* - Locomotion.
- Tree is living because it moves in wind. (*Ped zinda hai kyunki hawa mein hilta hai)* - Locomotion.

- Clouds are living because they move. (*Badal zinda hai kyunki chalta hai*) Locomotion.
- Elephant is living because it moves. (*Haathi zinda hai kyunki chalta hai)* Locomotion.
- Teddy bear is not living because it does not move. *(Gudda zinda nahi hai kyunki nahi chalta*) - Locomotion.
- Train moves. (*Rail chalti hai)* - Locomotion. Sun grows. *(Suraj ugata hai)* - Growth.
- Tree grows. *(Ped ugata hai)* - Growth. Flower grows. *(Phool ugata hai)* - Growth.
- Tree grows, has green leaves. (*Ped bada hota hai, hare patte rahte hai)* - Growth.

From the above quoted examples it can be seen that in class III the students have considered two characteristics of growth and locomotion to call an object shown as living. The characteristics have been taken separately and not together to consider an object as living. Sun is therefore considered living because "it moves during the day". For the same reason clouds, train and kite have been considered living by many of the Class III students. Teddy bear according to some students is not living as it does not move. Tree and flower have been considered living as they grow. Growth to them means becoming big in size. By the same logic some students have considered sun as living According to them the sun grows bigger during the day and hence is living. The attribute of locomotion in living is their common observation of their natural surroundings. This observation has been extended to the generality that everything that moves is living. As an extension of this therefore sun, clouds, train and kite have been considered living. The other reason of attributing locomotion to these non living objects is use of erroneous language at home and later in school. Hindi is the mother tongue of these students and is also the medium of instruction in school. In Hindi, *sura} ugata hai* is used for sun rises. For flower and tree also the same term *ugata hai* is used. The children therefore erroneously consider sun as living. Similarly, use of *sura} chalta hai* in common language attributes the characteristic of locomotion to sun. The children therefore consider sun as living in the same way as dog and elephant are considered living. Dog and elephant have been considered living as they can move.

Teddy bear has been considered living by some students. They have considered the open eyes of teddy bear as a characteristic of living *(Gudde ki aankhe khuli hai).* Another student has quoted "Teddy bear sees" *(Gudda dekh raha hai).* These examples show that students have considered seeing as an attribute of living. They know that animate objects can see through their eyes. This is derived from their common everyday experience of watching dogs, cats and other animals that they come across in their lives. There are some students who have considered teddy bear as non living as it is a toy.

For class IV some of the responses to the question asked are as follows:

- Eagle flies, breathes, and eats food. *(Cheel udati hai, saans leti hai, khana khati hai).* – Locomotion, breathing, nutrition.
- Elephant runs, breathes, and eats food. *(Haathi bhagata hai, sans leta hai, khana khata hai).* – Locomotion, breathing, nutrition.
- Butterfly flies, eats food. *(Titli udati hai, khana khati hai).* – Locomotion, nutrition. Eagle breathes, makes noise, and flies. *(Cheel saans leti hai, bolti hai, udati hai).* Breathing, making noise, locomotion.
- Elephant walks, breathes. *(Haathi chalta hai, saans leta hai).* – Locomotion, breathing.
- Flower breathes. *(Phool saans leta hai).* – Breathing.
- Butterfly flies, breathes. *(Titli udati hai, saans leti hai).* – Locomotion, breathing. Tree breathes. *(Ped saans leta hai).* - Breathing.
- Flower grows. *(phool bada hota hai)* – Growth. Tree grows. *(Ped bada hota hai).* – Growth.
- Dog takes birth. *(Kutta janam leta hai).* – Reproduction.

The characteristics of living taken up by students of class IV are: locomotion, breathing, nutrition, growth, and reproduction. The students have attributed breathing and growth to both animals and plants. Some of the students have considered three characteristics together to term an object as living. For example, locomotion, breathing and nutrition to term an object as living. One of the characteristics of making noise considered by one student to term an object living is not considered as a characteristic of living by biologists. Reproduction has been taken up as a characteristic of living by one student. E.g. dog takes birth.

Many students in class IV have considered sun, train, clouds, kite, teddy bear and radio as living. The reasons quoted are the same as that quoted by students of class III. The characteristic of locomotion has been accorded to train, clouds, kite and sun for considering them as living. Radio is living for some because 'radio chalta hai'. Again the use of faulty language leads to erroneous conclusion of radio being a living object.

Students of Class V have taken up attributes of nutrition, death, growth and locomotion to consider objects shown as living. Some examples are given below:

- Eagle eats meat. *(Cheel maans khati hai)* - Nutrition.
- Flower gives fragrance and *on* cutting dies. *(Phool khushboo deta hai aur kata ho to marjata hai)* – Death.
- Trees and plants grow in (sun) light. *(Roshni se ped, paudhe badhte hai)* – Growth.
- Tree grows and if its root is cut it dies. *(Ped badhta hai aur agar jad kaat dein to mar jata hai)* – Growth and death.
- Elephant walks and eats food. *(Haathi chalta hai aur khana khaata hai)* – Locomotion and nutrition.
- Tree grows. *(Ped badtha hai)* – Growth.

- Flower grows and blooms. *(Phool badhta hai, khilta hai)* – Growth.
- Dog runs. *(Kutta bhagta, daulta hai)* – Locomotion.
- Eagle flies and eats things. *(Cheel udati hai aur cheezon ko khati hai)* – Locomotion and nutrition.
- Tree breaks when it dies and its leaves dry up. *(Ped marne par apne aap tut jata hai, pattiyan sookh jaati hai)* – Death.
- Elephant walks and eats food. *(Haathi chalta hai, khaana khaata hai)* – Locomotion and nutrition.
- Elephant roars, walks and eats sugarcane. *(Haathi dahata hai, chalta hai, ganne khaata hai).* – Locomotion, nutrition.
- Eagle eats food just as we eat food. *(Cheel hamari tarah khaana khati hai)* – Nutrition.
- Butterfly flies and sucks nectar from flowers. *(Titli udati hai, phoolon ka ras choosti hai)* – Locomotion and nutrition.
- Tree gets strength from water (grows) and it breathes. *(Ped ko jal se taakat milti hai aur woh saans leta hai)* – Growth and breathing.
- Tree uses fertile soil, sun's rays and gives fruits. *(Ped upjao mitti, sooraj ki kirne leta hai, phal deta hai)* – Nutrition.

The students of class V have been able to specify the type of food eaten by animals. E.g. eagle eats meat; Elephant eats sugarcane. Though the characteristic of death is not included in the biological definition of living, the students implicitly understand that living objects die. This might be their common observation. They have exemplified this through statements such as: flowers die on cutting, tree breaks up when it dies and leaves dry up. One of the causes of death cited is – if the root is cut the tree dies. This is termed as the use of vitalistic causality (Inagaki and Hatano, 1993) to differentiate between living and non living. The student understands that growth is associated with living and that roots are vital for life. Cutting down of roots therefore leads to death. It is different from intentional and mechanical causality. When intentions are attributed to a biological phenomenon, it is called as intentional causality, e.g. "we take in air because we want to feel good". When mechanical explanations are attributed to a biological phenomenon, it is called as mechanical causality, e.g. "lungs take in oxygen and give out carbon dioxide". Another example of vitalistic causality is: the tree uses fertile soil and sunlight and gives fruits. The student here is able to understand the process behind the formation of fruit at least in vitalistic terms. This also helps in building a living - non-living distinction.

Personification (person analogy) has also been used to term the picture of an object shown as that of a living object. One example is: "The eagle eats food just as we eat food".

The living - non-living distinction has also been made in terms of the ability to make self initiating movements by Class

V students. An example is the statement given by one student: train runs by electricity and therefore it is non living. That is, train does not make self initiating movements. The student has applied the external agent principle, which is applied to objects which do not move on their own.

To summarise, major findings of the interview conducted can be listed as follows:

- Class III students have taken up locomotion and growth as characteristics of living. Both the characteristics have been taken up separately. Common experience has helped the learners to differentiate correctly between living and non living. But, the use of faulty language at home and in the school has also led learners to reach faulty conclusions about the distinction between living and non living.
- Students of class IV have considered locomotion, breathing, nutrition, growth and reproduction as characteristics of living. More than one characteristic has been taken up by many students to distinguish between living and non living. The use of faulty language at home and in school has again led to erroneous conclusions of distinction between living and non living.
- Class V students have taken up characteristics of nutrition, death, growth and locomotion to distinguish between living and non living. Besides this, vitalistic causality, personification (person analogy), ability to make self initiating movements have also been considered by students to differentiate between living and non living. The use of faulty language has led again to erroneous conclusions of distinction between living and non living at many places.
- There are seven characteristics of life: movement, respiration, sensitivity, growth, reproduction, excretion and nutrition as considered by biologists. Children from Classes I to V have considered only five of these seven characteristics to consider an object as living. Excretion and sensitivity have not been taken as characteristics by any student.
- The students were asked to give more examples of living. These are summarised classwise below:

  I. Class III: Cat, birds, animals, crow, truck.

  II. Class IV: Camel, pigeon.

  Ill. Class V: Man, lion, snake, monkey, parrot, donkey, horse, cow, pigeon, aero plane, ox.

Discussion

From the findings discussed above, a few more broad generalisations can be drawn:

- The children in class I (5-6 years) do not possess an adequate living non living distinction. Though no generalisations can be drawn as the data available is also not adequate. Plants are not considered living by these children.

- Some of the children in class II start recognising plants as living
- Non-intentional causality and personification start developing by the time the child reaches ten years of age.

It is clear from the data collected that children at six years of age have acquired some form of biology. Biology is not taught in classes I and II. The early acquisition of biology may be due to their wide ranging interactions with the environment. The children may also have pets at home. Some form of gardening / cultivation practices may also have been followed at home. Naïve biology is thus gradually constructed through daily experiences during early years. There are of course many innate constraints as children seldom need biological knowledge, since they do not have to find food or take care of their health. By innate constraints we mean cognitive constraints. Acquired prior knowledge which is limited in young children especially regarding biological phenomena, may therefore pose an innate constraint. It is possible that young children in whom biological knowledge is limited may borrow psychological knowledge to interpret biological phenomena.

Naïve biology may also be affected by cultural and linguistic constraints. The activity based experiences in the culture the children are brought up in contributes to the formation of naïve biology. For e.g. if children are actively involved in raising animals, they acquire a rich body of knowledge about them. This knowledge can then be used by them along with the knowledge about humans as a source for analogical predictions and explanations for other biological kinds. Similarly children who are involved in gardening/ cultivation will acquire a rich knowledge about plants as living organisms. This knowledge can be used by them in analogical predictions. This does not mean that the children acquire a richer knowledge about animals or plants in general. They acquire only a richer procedural, factual and conceptual knowledge about the animal they have raised. But, in effect, this knowledge can be used to make analogical predictions.

The use of language also affects the acquisition of biology concepts in young children. Use of language that erroneously provides a living status to non living objects makes children reach wrong generalisations. Many examples have been discussed in classwise analysis of interviews of children. On the other hand, language many a times helps in the proper concept formation.

Biology is a subject which is based on complex, hierarchically organised categories. It relies on mechanical causality. As children grow older, the personifying and vitalistic biology gradually changes towards truly "non - psychological" biology. The development of category based inferences and mechanical causality takes place. Intentional causality is rejected. A fundamental restructuring of knowledge takes place.

Educational Implications

Many conclusions regarding educational implications can be drawn from this study:

- In school while teaching as well as in books care must be taken about the linguistic aspect. For eg, the use of *Suraj Chalta hai* is incorrect. The correct sentence for sun rises is *suryodaya hota hai.* Also, while building a curriculum for biology instruction, the cultural perspectives must be taken into account. The children coming from an agricultural background will carry with them a rich procedural knowledge about the animals and plants that are raised on the farm. The curriculum designers can keep this in mind while framing the curriculum. Examples with which children are familiar due to their cultural backgrounds should be incorporated in the text.
- For classroom, teaching concept attainment (Jerome Bruner, 1956 and Joyce and Weil, 1972) could be followed where concepts are taught using exemplars and non-exemplars. This method can be used in classes IV and V. One example is described below:

The teacher announces in the class that "I have a category in mind. I am going to show you some examples that fit into the category and I am also going to show you some examples that do not fit into the category. What you must do is to figure out the category for the positive examples that I show you". She then pastes pictures on a flannel board as follows:

Dog ☺ Yes (A smiling face with examples enhances interest in children)

Train No

The students start their discussion as follows:

Manu says : I think we are talking about pet animals.

The teacher then shows:

Eagle ☺ Yes
Kite No

Rakesh says : I think, it cannot be about pets. It is about all animals.

The teacher then pastes pictures as follows:

Elephant ☺ Yes Neem Tree ☺ Yes
Teddy-bear No

It is very confusing as neem tree is a 'Yes' says Manu.

The teacher intervenes at this point and asks learners to identify the commonality in the examples cited:

Mamta who was sitting perplexed says: Ma'am they all can walk but the eagle flies.

Deepak who was very quiet till this intervenes and says: But, neem tree cannot walk. So, this can not be the commonality.

Rakesh: But, they all grow from small to big.

The teacher can use pictures here of a pup, baby elephant, small neem-plant etc. The discussion continues along with more examples and non-

examples till all the characteristics of living are identified. At the end the teacher lists out all the characteristics and declares that these are all examples of living objects. The non-examples are all non-living objects. The non-living objects do not show the characteristics shown by living objects. The movement of living and non-living will be differentiated by telling the difference between self-initiated movement and movement due to external agent. Plants do not show movement of the same kind as of animals yet they are considered as living can also be discussed. The concluding event of this concept attainment procedure will be asking learners to quote more examples of living.

- The stories that the children read or hear should have less of animism i.e the inanimate objects should not be associated with intentions, sensations and emotions.
- Children tend to generalise this impression.
- Field trips to various zoological and botanical parks can be organised to create awareness about the living world. Field trips within the school campus can also be arranged. The children can become familiar with plants as living beings. These should be followed by classroom discussions.
- Educational CDs can be used to create more awareness about the living and the non-living world. MCD/Government Schools also have access to at least one/two computers. These computers can be used for group instructions. The only requirement here is a lot of pre-planning associated with group instructions. A follow-up to assess the understanding of the children can also be organised. The students can be asked to give more examples of living objects along with their characteristic features by which these objects have been termed living.

Conclusions

Further research by taking up more number of students can be carried out for better generalisation of results. Also, various misconceptions regarding concepts as animals, plants, cell, rusting, gravitation can also form the basis of further research. The educational applications derived from such research will go a long way in improving teaching methods. Also, curriculum designers will be able to incorporate corrections of language in books so that such misconceptions are taken care of. Examples of concepts keeping in mind the cultural background of students can be incorporated in books by curriculum designers.

APPENDIX-I

NAME :_____ CLASS : _____ ROLL NO. : _____

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