Primary School Children's Ideas about 'Plants' and Use of Constructivist Approach

Mamta Singhal*

Abstract

Children come to the class with their own ideas about the natural phenomenon. Even before getting a formal exposure of learning scientific concepts, they have experienced them in their daily life. Their experiences and interactions about natural phenomenon are often unplanned and transcend into the domains of science, social science, psychology and culture. They form their own understanding about the world which interferes with their learning of scientific concepts in the school. Children's prior ideas are given different names such as pre-conceptions, misconceptions, alternative frameworks, etc., in different researches. Irrespective of the nature of these ideas, the most important step is to explore and acknowledge these ideas. This paper is based on the research conducted with primary school children studying in government schools of Delhi. The study explored children's ideas about plants using qualitative research tools and addressed them using constructivist approach.

Introduction

Research in cognitive psychology and science education in last several decades have shown that children and adults construct an intuitive understanding of the world which is based on their everyday experiences. Although different terms such as preconceptions, misconceptions, alternative frameworks, mental models, prior ideas, etc., have been used to describe these experiences and knowledge, there is a broad consensus that we may have a different understanding of natural phenomenon than the one that is provided in textbooks or is accepted by the scientific community. The learners come to the classroom with

* *Assistant Professor*, Institute of Home Economics, University of Delhi.

these experiences and knowledge and their first few years of schooling become very crucial in deciding whether they would hold on to their intuitive and unscientific ideas or would be ready for a conceptual change as they encounter scientific concepts in the classrooms. While it is agreed that some of their beliefs and ideas are often stable and may not change, it is the responsibility of the teachers to help the learners at least acknowledge the inconsistencies in their knowledge viz. scientific ideas.

The awareness would be important to bring a conceptual change in case they feel the need to do so. While it is important that learners modify their ideas and develop concepts that are aligned with the scientific worldview, the change however cannot be forced. It would demand changes in their cognitive structures. The teacher must therefore, provide the opportunities to the learners to evaluate their ideas and modify them on their own.

The review of literature suggests that children have naive ideas about the various phenomenon they observe around them. These ideas interfere with the ideas that are given in the textbooks or the ideas that the teacher is trying to teach in the class. Sometimes these ideas change through their confrontation with newer situations but sometimes they resist change. We often call them misconceptions and alternative conceptions. There is ample evidence of children's and even teachers' misconceptions and alternative conceptions about various socio-scientific concepts in the context of Environmental Studies (EVS). Therefore, it is important not only to address children's misconceptions but also to equip teachers to examine their own notions.

Bell (1981), in his research with children, found that there are misconceptions on the idea of trees. Some children do not think that trees are plants. Children believe that only those living organisms are plants which have specific features like flowers or stems.

K. Pine et al., (2001) conducted a survey of children's misconceptions in primary science. Children were reported to have naive ideas about many concepts including plants. They believed that bigger plants are healthier, seeds come into packets and not from the adult plants. These seeds contain a baby plant inside them. The plants need only water for their growth and light is not essential. These views were reported by the teachers who taught them science. The teachers who participated in the study also believed that it is important to acknowledge these ideas and a wide range of constructivist approaches could be used to bring a conceptual change. The study also found alternative conceptions related to other concepts of science.

Barrow, H. Lloyd (2002) investigated elementary children's conceptions about insects across grades. He found that older children

(K-6) exhibited broader understanding about insects' characteristics than (K-2), children but overall lacked understanding about the life cycle of insects. Also, children had prior knowledge about the harmful aspects of insects more than their useful aspects. The study suggested using students' personal questions and experiences for teaching.

Barman et al., (2006) conducted research around children's and adults' notions and concepts about physical and natural world, which are quite different than those presented by the scientific community. They argue that children come to school with knowledge about plants, which may be prior knowledge or resulting from their everyday experiences with the concepts they learn at school. It has also been argued that 'misconceptions are also introduced and reinforced at early ages. Understanding these misconceptions can help us to better address them in the classroom'. They interviewed different school age children on two questions— whether a specific living organism was a plant or not; and what do plants need to grow. Their findings suggested that older children (Classes VII–VIII) have more misconceptions than younger children in Classes (IV–V). They suggest ways in which misconceptions can be confronted through teaching.

Palmeri (2007) followed Barman et al., (2006) work to find out children's ideas and misconceptions around the theme 'animals'. She found that children's concepts of animals were fuzzy, as they use biological functions to categorise animals. She also found that children have a potential bias in recognising and categorising animals. Further, she found that children's knowledge about animals is skewed in favour of vertebrates. Palmeri's study has clear implications for confronting these misconceptions by working with teachers, and helping them organise their teaching frames.

Several other researches— Pringle (2006); Henriques (2002); Tao and Gunstone (1999) and Driver et al. (1985), have documented children's alternative conceptions across grades and discussed their role in teaching-learning and conceptual change.

The present study focussed on finding primary school children's prior ideas about 'Plants'. These ideas may be pre-conceptions (knowledge that exists before any formal learning) or misconceptions (incorrect conceptual understanding despite being taught) or alternative conceptions (ideas or beliefs that exists along with formal conceptual knowledge), but for the present study no such classification was made. The idea was to explore their ideas and concepts, which may be different from the acceptable scientific knowledge, and hence may require attention. For convenience and for a broader meaning these ideas have been referred as 'alternative conceptions' in this study. Alternative conceptions essentially refer to all those notions of children which are different from the currently acceptable scientific view.

The researcher attempted to address these conceptions using constructivist approach. According to the constructivist perspective, learning is a process by which knowledge is constructed. This involves the active participation of learners who construct their own knowledge by developing connections or bridges between their existing ideas and the new ideas that are presented to them in the form of external stimuli. For instance, a learner might have an initial idea of the transport system based on the experience of travelling by road (bullock cart, cycle, bus, train, etc.). When presented with suitable activities (experiences) related to water and air transport systems, the learner will be able to construct mental representations (images) of the external reality (transport system) and thus reconstruct the initial idea of the transport system by incorporating new ideas. This structuring and restructuring of ideas will facilitate progress in the learning process.

Objectives of the Study

- To find out primary students' alternative conceptions about plants
- To use constructivist approach to address students' alternative conceptions about plants

Operational Definitions

Let us define and explain the terms 'alternative conceptions' and 'constructivist approach' in the context of the present study.

Alternative Conceptions

The use of terms such as alternative conceptions, misconceptions, intuitive theories, naive ideas, etc., became popular with the recognition of children's experience and knowledge in their learning. The rise of constructivist perspective of learning and research into children's ideas have been simultaneous. Misconceptions have been referred to as incorrect explanations of scientific concepts, whereas the term alternative conception is used by researchers who do not wish to call children's, ideas as incorrect, rather they refer to them as 'alternative conceptions', which do not match with the acceptable scientific knowledge. These ideas may be partially correct, incorrect or may be their cultural beliefs, which need to be acknowledged and challenged at times so that learners can themselves change them.

In the context of the present study, the term 'alternative conceptions' has been used to represent children's ideas and knowledge that may be partially scientific or non-scientific as per the currently acceptable scientific explanations of the concept.

Constructivist Approach

The constructivist approach to teaching-learning has its roots in the epistemology of 'constructivism'. Constructivism is an epistemological stance or theory that emphasises that knowledge is not out there, rather it is constructed by the subjects with

their physical and social interactions with the world. Glaserfeld (1989) believes that constructivism is a way of knowing that recognises the real world as a source of knowledge. The students and scientists try to explore the real world which is made of objects and events but one can never fully know it. They form approximations of reality but connot form a true picture of it. With regard to learning, Piaget (1971) and Vygotsky (1978) have emphasised different dimensions of constructivism. Piaget has highlighted the role of personal experiences and physical interactions with the world and Vygotsky has highlighted the role of social and cultural interactions in the construction of knowledge.

Based on the study of different meanings of constructivism, a suitable definition of constructivism in the present study can be given as follows.

Constructivism

It is a view of learning that believes that learners are active and construct their own knowledge based on their physical and social interactions with the world.

Research Methodology

The study followed the broad guidelines of action research within a qualitative framework. The qualitative tools— concept maps and interviews were used for data collection about children's alternative conceptions. Based on the analysis of data, children's alternative conceptions about 'Plants' were identified and suitable teaching-learning interventions were planned to address these. The details about sample, tools and interventions are provided further.

Sample

The data was collected in four government schools of Delhi with more than 50 students. The sample was convenient in nature and involved four MCD schools of South Zone of Delhi as the researcher had easy access to these schools due to the ongoing internship of B.El.Ed. (Bachelor of Elementary Education) pre-service teachers. Class IV students from each of the selected schools were selected for data collection and intervention. Each class had a strength of 30–40 students but not all of them were regular in coming to the schools.

Data Collection and Analysis

The data on children's ideas about 'Plants', which is a theme in the EVS (Environmental Studies) curriculum, was collected by using concept maps and personal interviews.

Concept Maps

Concepts mapping by children was used as a strategy to explore children's ideas on various themes. Children were divided in group of 5–6 and were asked to write, draw and illustrate their knowledge about the theme. The researcher divided the class into small groups of 5–6 students making sure that one student in each group

could write and clearly map out the concepts and present coherent ideas. Each group was provided with an A-3 size sheet. No content knowledge was given to the students, only an brief introduction was given. Groups were asked to map out the theme, i.e., their understanding about plants. This phase of the study was explorative. These ideas could either be vague or well fleshed out. To elicit ideas from children, they were asked questions related to the theme and also encouraged to connect their ideas to form a clear concept map.

With a group of 50 students, 8 concept maps of the theme 'Plants' were collected finally. These concept maps represented similar notions but were put in different ways. Given hereby are three concept maps made by children, wherein they represented most of their ideas similarly in other concept maps also.

Interviews

The concept maps helped the researcher to understand the basic ideas of children about plants, but in order to gain an in-depth understanding of their notions, personal interviews were conducted. The researcher asked children to elaborate, give examples and give reasons for their ideas represented in the concept maps. For example, children were asked to explain how plants clean the air?; why do they think tribal people cut trees?; have they seen ghost on trees?; why do they think plants eat soil?; etc.

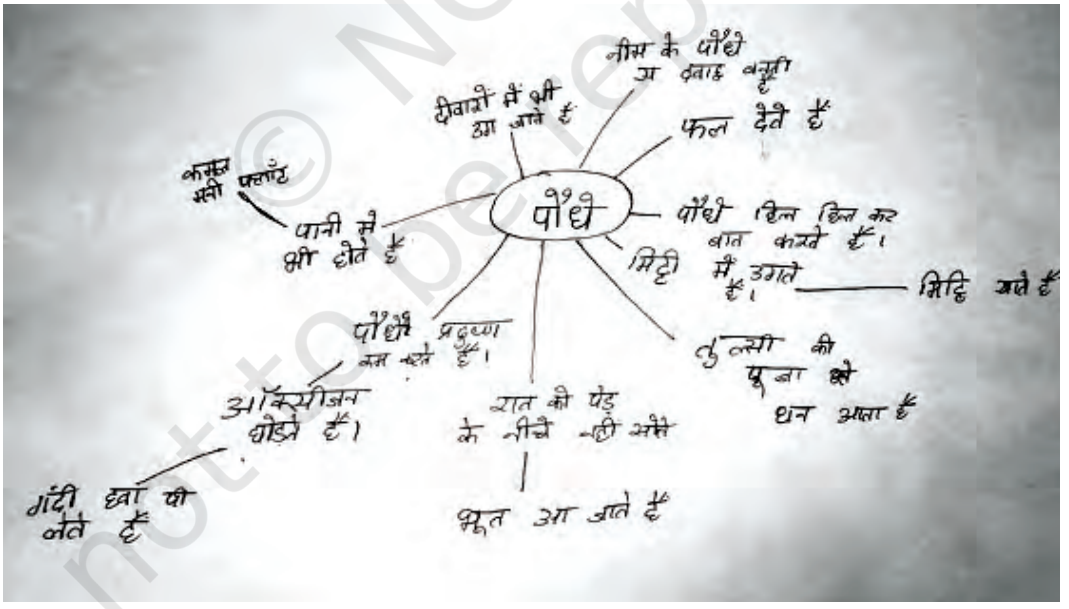

Fig. 1: Concept Map 1 (By Group 1)

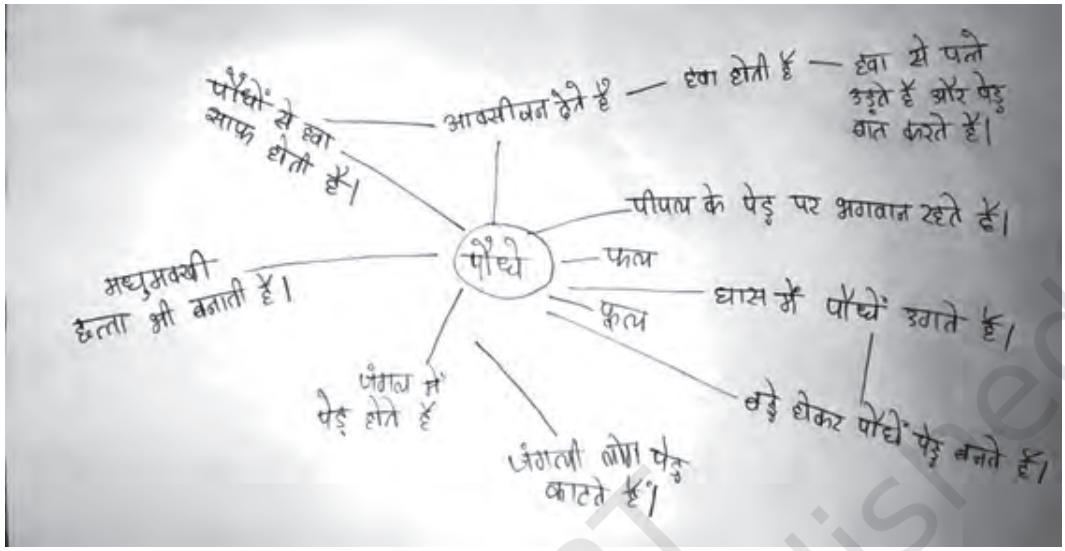

Fig. 2: Concept Map 2 (By Group 2)

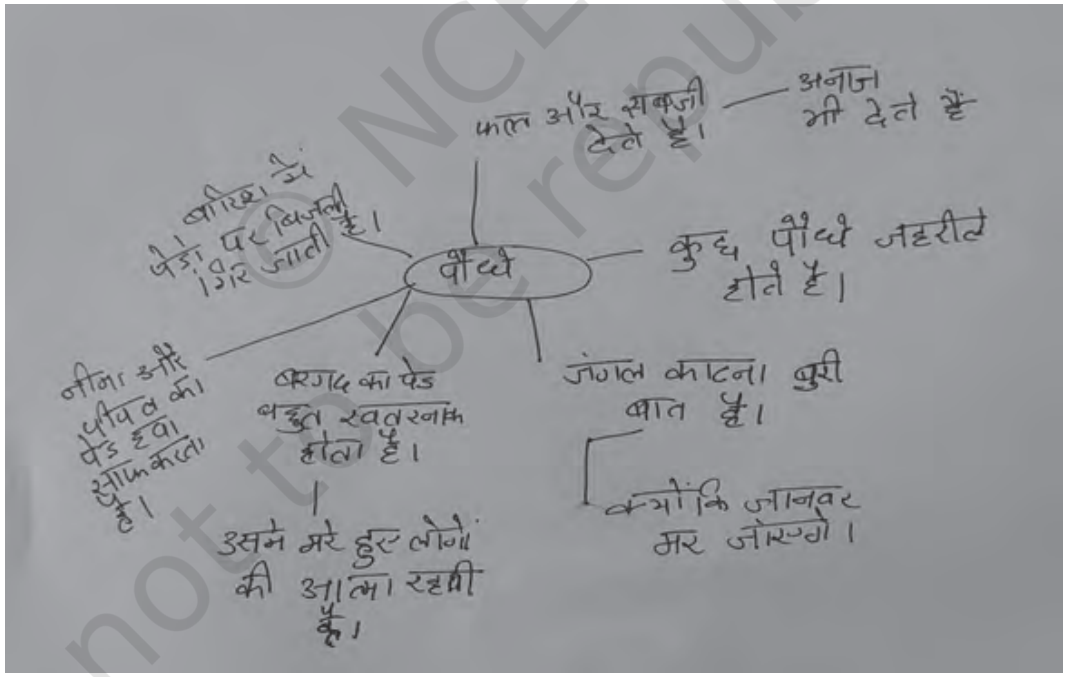

Fig. 3: Concept Map 3 (By Group 3)

Children's Ideas About Plants

Based on the analysis of their concept maps and their responses during the interviews, the following notions about plants were identified and some of them were addressed using various teaching-learning strategies based on constructivist approach.

- Oxygen is air.
- Plants eat soil.
- Plants become trees as they grow.
- Plants talk to each other by moving their branches and leaves.
- We should not sleep under trees as ghosts live on them at night.
- Tribal people cut trees.

Interventions to Address Children's Alternative Conceptions

The constructivist approach advocates that children's prior ideas, which may be their beliefs or alternative conceptions, should be explored and then appropriate teaching-learning strategies can be used to address them. However, it may be possible that children hold on to their notions even after teaching. The traditional teaching approaches do not take into account children's ideas and often ignore them. Research has shown that children as well as adults maintain these ideas despite being taught. However, constructivist approaches to teaching help the teachers to take into consideration children's prior or alternative ideas and attempt to bring a conceptual change by challenging them. Below is an account of some alternative conceptions and activities that were used in the present study to address children's conceptions.

Oxygen is Air

Children in primary classes often use the terms: gas, air, oxygen and carbon dioxide, without understanding the difference between them. To address children's notions about air, they were asked to explain what is air, how do they know that there is air around them and in what ways air is useful for them. Children gave varied responses such as air is felt only when it is blowing. We take air in our body when we breathe. Carbon dioxide is bad air and so on. Although the topic of 'components of air' is not a part of primary classes, it seemed important to discuss it with children. The teacher took them for a visit to the school garden and open spaces. She asked them to take a few deep breaths. After that they returned to the class. The teacher asked them to wait for a while outside the class and created a bit of smoke by burning some papers in one corner of the class. She closed all the windows and asked children to enter the class and take a deep breath as they enter. The children experienced discomfort and went outside again. The students and teacher now sat comfortably outside the class and discussed the difference in the two cases.

Teacher: How was your experience of taking deep breaths in the garden?

Did you face any difficulty in breathing there?

Students expressed that they felt good. They had no difficulty in breathing. Some of them also mentioned that, "There were trees around. So, we breathed oxygen".

Teacher: How did you feel when you entered the class with smoke inside?

The students expressed their discomfort in various ways such as:

"I was coughing".

"It was suffocating".

"One could die, if you breathe such air for long".

The students also shared their previous experiences and knowledge during the discussion. One of them shared an instance that had come in the newspaper some time back. He said, "My father told me that we should never use *angeethee* in closed rooms as it leads to suffocation.

In another class, children were asked to observe the sunlight coming through a small window opening. All the doors and windows were closed and the room was made fairly dark by covering the windows with newspaper. The children could observe dust particles in the beam of light coming from the small opening. The activity showed the presence of dust particles in air.

Another simple activity was conducted with children to show breathing in plants. The teacher took a bowl filled with water and submerged a freshly plucked leaf into the water. A small stone was used to keep the leaf submerged and not float on the surface. The bowl was kept in sun for few hours (almost 3 hours) and it was observed that small bubbles were formed over the leaf. The teacher could explain that exchange of gases is happening over the surface of leaf.

It was also discussed that air around them consists of various gases like oxygen, carbon dioxide, nitrogen and water vapours. When we breathe in, we take air inside the body but the oxygen present in air gets mixed with haemoglobin present in the blood. For the other gases like nitrogen and carbon dioxide, there are no carriers in our body and they are exhaled out. Carbon dioxide is used by them in the process of making their food. Children were not burdened with terms like 'respiration' and 'photosynthesis' but it was explained that these two processes are separate and plants have a special pigment (chlorophyll) that makes them unique in terms of using the carbon dioxide present in air. The children actively participated in the discussion and activities. The discussions helped students to bring their previous knowledge in the class and also understand that 'air'— the commonly used term, has different components such as oxygen and carbon dioxide. Considering that children belonged to Class IV, complex activities such as fractional distillation, experiments to show the presence of oxygen and carbon dioxide were not suitable for them. However, the activities and

discussion held made it evident to understand that air has different components and these components have different properties.

Plants Eat Soil

Children seemed to have different notions about plants' food. But the most common notion that came across was that plants eat soil. The soil travels to the different parts of plant after getting mixed in water.

These ideas were challenged through the following activity.

The teacher took few pots and filled them with soil up to the top. Some plants like tomato and brinjal were planted in these pots. It was ensured that the plants get adequate water and sunlight. After few weeks, children observed new leaves and fruits on these plants. The teacher pointed out that the soil in the pots has not reduced. She pointed out how plants produce kilos of fruits in one season without reducing the quantity of soil in which they are grown.

The teacher also showed them a stem and cut it from the middle. She discussed if soil had dissolved in water and travelled to various parts, then there could have been soil in the stem cutting. Although the concept of photosynthesis would be taught in middle school, it is important to explore their ideas and also address them as much as possible right from the beginning.

Plants Become Trees as They Grow

Although only few children had this notion that young plants will eventually grow to become big trees, it was important to teach them about the diversity of plants in their surroundings. The teacher took them for a visit in garden and helped them to notice the variation in their size. Children observed the difference in their height and width and concluded on their own that all small plants would not grow as tall as others. They would learn to classify plants on the basis of their height, type of stem, type of leaves and roots in appropriate grades.

Ghosts Live on Trees at Night

The children's beliefs about ghosts living on trees were evident in the concept maps made by them. The Concept Map 1 and Concept Map 3 given hereby have statements like, "*Raat ko ped ke neeche nahi sote. Bhoot aa jaate hai" (Concept Map 1)* and *"Bargad ka ped sabse khatarnak hota hai. Usme mare hue logon ki aatma rehti hai."* (Concept Map 3). The statements are indicative of children's beliefs about ghosts residing on trees. They have expressed fear and danger associated in going near them. The interviews tried to explore reasons behind these statements.

The teachers (researchers) asked them questions like, 'Who told them about ghosts living on trees? Have they seen them?'

The students shared several narratives and experiences in the class. One of the students mentioned that he has seen movies where people have committed suicide by hanging themselves on trees. Such trees are bound to become haunted. Several students agreed with him.

Another student said, trees make scary noises at night and he has heard these noises often when they go to their village. When he asked his mother about the noises, she told him that ghosts come on trees at night and chat. Some other student claimed that his grandfather was attacked by ghosts while he was sleeping at his farm (in his village) under a tree.

The discussion with children revealed that their idea of ghost living on trees came from certain stories and narratives told to them by their parents or other known people who told them to stay away from plants at night. It may be possible that the elders who told them such narratives themselves were not aware that plants stop photosynthesis at night and hence there may be excess of carbon dioxide under trees at night, which is not good for health. The other reason could be that at night, some animals that take shelter on trees should not be disturbed and hence it is better to avoid sleeping under the trees.

Not all students agreed with the idea of ghosts during the conversation and challenged their friends by saying things like, 'Ghosts do not exist'; 'Movies that show ghosts are baseless'; 'I will sleep under the tree and show you that nothing happens'.

Although the teachers encouraged children to observe the plants at night and discussed scientific reasons for not sleeping under the tree at night, it can not be ensured that their beliefs have changed. The constructivist approach advocates the children to bring their experiences and prior notions in the class and the teacher tries to challenge or deconstruct them if possible. They also listen to the diverse views from their peer group and may be willing to change their notions. However, the conceptual change is a slow process and not all the ideas could be changed.

Also, cultural notions and beliefs are very deep rooted and more difficult to change as compared to unscientific notions that arise due to lack to discussion and teaching-learning support at the right time.

Tribal People Cut Trees

The discussion with children revealed the biases and prejudices held by them about educated and uneducated people. They believed that tribal people (they called them *Junglee*) are uneducated. They cut trees for their living as they do not have employment. Some children mentioned that government is rehabilitating the *junglee* people away from forests as they will destroy the forests.

The teacher took out some articles from internet and discussed that tribal people live in harmony with

nature. One of the articles mentioned the tradition of 'Halma' performed by Bheel tribe of Madhya Pradesh, where people of the community get together to discuss their problems and make strategies to save the forests. These people had planted thousands of trees in nearby villages and dug canals for conserving rainwater. Similarly, Saara tribe of Odisha decided to protect their forest from intruders who came from nearby villages to cut trees and formed their organisation to guard the forests day and night from intrusion.

Children were very surprised to read these articles and seemed open to change their beliefs about tribal people. They were also interested in gathering more information and discussing the role of government policies for tribal people.

Conclusion

Children do not come to class as empty vessels. They bring their experiences and beliefs about natural phenomenon and things around them. The teachers should give importance to these experiences and should make conscious attempt to build their understanding of these phenomenon. Concept mapping is one of the ways through which children can be encouraged to express themselves freely about any scientific concept before the teachers begin to teach it through the textbooks. Children's drawings, personal interviews and their classroom questions could be other ways of exploring their ideas. The constructivist approach is based upon taking these ideas into cognizance, while planning classroom experiences. The teacher may use activities, field visits, peer group discussions or any other strategy to challenge these notions so that children experience the contradictions themselves and are better prepared for a conceptual change. It may be possible that some of the concepts in primary classes may not be addressed fully as their scope is beyond the primary classes curriculum. However, an awareness of these concepts would help children to be open for learning and exploration in further classes. If their ideas are ignored or suppressed in early years, they would co-exist in their mind along with the acceptable scientific knowledge and would often create conflict when applying them in daily life.

The present study has attempted to use constructivist approach for teaching about plants in primary classes and advocates using this approach for teaching other concepts also.

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