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Understanding Students' Alternative Conceptions: A Mirror to their Thinking

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ABSTRACT

The concepts of knowledge in specific context vary among the young kids and adults. The Adults find many contextual concepts (knowledge) as vague or incorrect when children describe particular concept. It needs to be understood that children have their own way of thinking and have their logic. This paper explores various alternative conceptions of children, their sources and impacts on child's learning. During this action research in a primary and middle school a deliberate effort was made to understand children's alternative conceptions. A number of tools like questionnaire, discussion, observation, interview and checklists were used. Alternative conceptions were identified for 'Who is a scientist? What is Science? Heat, plants and food. It was found that children's alternative conceptions were so strong (due to the most INFLUENTIAL SOURCES) that they cannot be changed easily in a short period of time. Teachers and family members need to challenge these alternative conceptions continuously regularly so that they form scientifically correct ideas.

Keywords: Misconceptions, alternate conceptions, primary and elementary school children, children's notions of scientists

Introduction

Children's conceptions are deeply rooted in their daily life experiences. These are often not scientific, also called "Alternate conceptions". When children hold view that differs from scientific explanations these are often referred as "alternative conceptions". These are influenced by sensory experiences, language experiences, cultural background, peer groups, mass media and even science instructions (Duit and Treagust, 2003). The terms misconception, preconceptions or children's alternate ideas, also called as alternative framework were used by Rosalind Driver (1985) with reference to children's understanding of scientific concepts. According to her, children develop ideas or schemes about the world around them as they start making sense of it from their sensory experiences. Every child has her/ his own personal construction of conceptions. At the same time, they are also not unique to any child. The initial conception of children across world about the earth is flat, irrespective of culture, region or language. It is shaped by personal experiences with the phenomena (Shukla, 2019).

Following is an excerpt of a conversation between a teacher and class 4 children on the topic 'birds'

Teacher: Where have you seen birds?

Child 1: On trees, on wires, on pillars, on wall

Child 2: In school park, in my home's balcony, in my colony's park

Teacher: Which birds have you seen on pillars?

Child 3: Pigeon, crow, sparrow and some others birds. I don't know their names..

Teachers: Why don't birds get shock, when they sit on current carrying wires?

(After thinking for a while)

Child 4: These birds are now used to of electric shocks…. That's why they don't feel it.

Child 5: They do feel electric shocks but, they fly off the wires quickly. That's why they are safe.

Child 6: There is a polythene kind of things in their feet. That's why they don't get electric shock.

Child 7: Humans only get electric shocks, not the birds.

Child 8: Birds move all around. Their feet are full of mud, that is why they don't get electric shock.

Such conversations do not stand alone but happens every day. This triggered me to investigate deeply into the area of children's misconceptions, understand how children make their own logics, their thinking process and impact of these ideas on their learning (Wadhwa et.al., 2017). Is it possible to change these strong conceptions? If yes then how should they be changed? Are these ideas be seen as hurdles or facilitator in Child's learning process? (Malik, 2017) In this paper, an attempt has been made to find out the answers to these questions.

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Objectives

The following are the objectives of the research:

- To identify children's scientific alternative conceptions.
- To explore reasons behind such alternate conceptions of children.
- To address and modify these alternate conceptions.

Methodology

The data was collected from classes III and V of a Municipal Corporation Primary school, located in Rohini Sector 2, Delhi. The middle level classes VI, VII and VIII were from a Government Senior Secondary Girls School, Pooth Kalan extension, Sector 20 Rohini, Delhi. The tools used for collecting data are also influenced by Chen et.al. (2016) wherein they have used combination of writing and talking to children for eliciting children's ideas. The class size, concepts explored, tools for data collection for finding misconceptions are given below in the table:

Class	Size	Concepts and Procedure	Tools
III	24	Food: parts of plant Textbook (pg-95); Milk- importance	Interview Discussion Questionnaire Observation
V	30	Healthy and Unhealthy food	
VI	80	Scientists- Who are scientists?; What do they do? Name 3 scientists. Nature of science- checklist was provided to students. Heat- students were asked to fill up a questionnaire. Plants – students were provided with a Questionnaire and asked to name the part of plant.	Drawing and written statements. Checklist
VII	75		
VIII	80		

Data collection and analysis

Conceptions of 'Scientists'

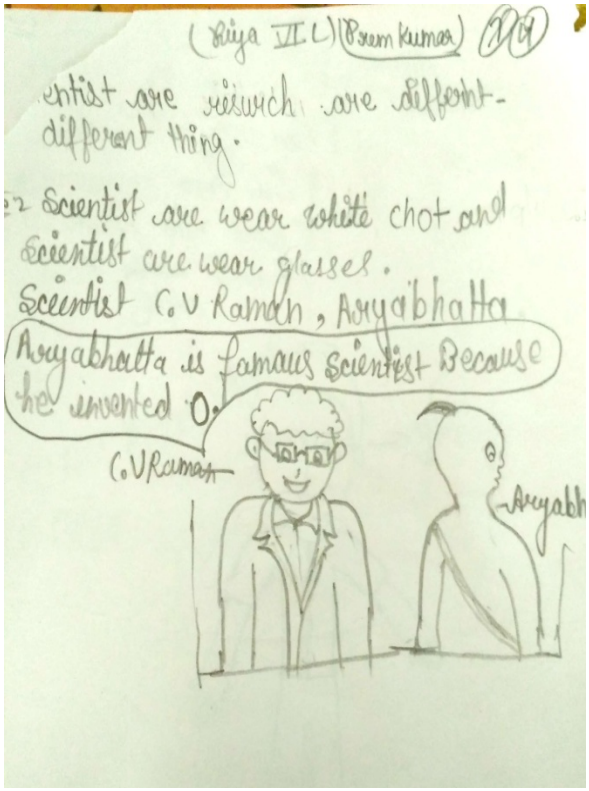
Students were asked to draw a 'scientist'. Their drawings were analyzed and following inferences are drawn:

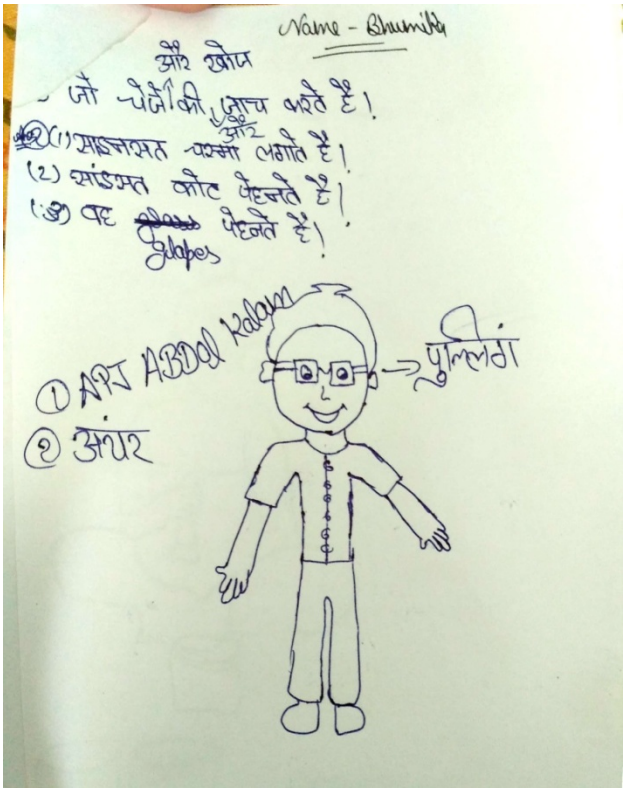
Students drew scientists as wearing a white coat having curly, long and white hair; wearing spectacles, old (middle aged) not young at all, and mostly males. They also described scientists as some lost in his world. Many children did not know the name of any scientist, a few listed by them were APJ Abdul Kalam, Aryabhata, Archimedes, CV Raman, Kalpana Chawla, Thomas Edison. Some children confused Ambedkar and Mahatma Gandhi with that of scientists.

Generally, media, comic books, cartoons, magazines represent scientists as described above (Kaur, 2015). Although the pictures given in textbooks (as that of Newton, Galileo, Einstein, Robert Boyle, Robert Koch, Edward Jenner, Alexander Flemings and Louis Pasteur, Hans Christian Oersted, William Nicholson) are quite different from the descriptions of students (written above). Incidentally scientists and their achievements or brief biographies or interesting narratives are presented in boxes in textbooks, which are hardly discussed and the misconceived image remains unaddressed by the teacher.

Kalpana Chawla was an astronaut but according to students she was a scientist because students generally perceive astronaut as a scientist. Women scientists were not known by children. Students perceived astronauts, mathematician, and TV character of scientist as real, scientist as a male figure only because their categorization of scientist work includes all these and the main reason behind these Alternative conceptions is lack of knowledge, media, no importance given to scientists in the classroom and the way portraying scientists in classroom.

Some pictures drawn by students:





The responses of students from class VI, VII and VIII are similar to each other. They described that scientists use machines or instruments like telescope, complicated electric circuits, space craft like 'Chandrayaan' or experimental set up for inventing new things; they predict about weather conditions (daily weather forecast, tsunami), work with chemicals. They are very busy, intelligent, solve every problem and have no family time. Students identified the works of scientists as, "the one who uses chemicals, work with technology and invent new technological things and astronaut." The scientists involved only in chemistry, technology and space are identified as scientists.

Conceptions on the Nature of Science – Nature of science is understood as tentative, empirical, inferential, multiple ways of doing science, and social and culturally connected. A checklist was prepared according to which students classified science as follows:

- Inventing new things is science
- Using chemicals in laboratory and doing experiments
- Facts written in textbooks are universal truth which can't be wrong or questioned.
- Science is abstract which can't be used in daily life.
- There are fixed answers in science not more than one answer is possible.
- Science is reading the chapter, memorizing the question answers given at the back of the chapter.
- It includes only abstract concepts which are hardly used in daily life experiences.
- Only theoretical no process skills are developed.

These alternative conceptions are because of the approach of the teacher and curriculum towards science in the classroom. The concept delivered to children is basically textbook reading, and question answers written on blackboard (as it is observed in the middle school), hardly any laboratory work or experiments, skills like question raisin, problem thinking or critical reasoning were not focused while teaching science.

Conceptions on Heat

Why it is advised not to wear black colour clothes in summer?

The Alternative conceptions identified, as follows:

- We will fall ill as black colour clothes make as warmer and due to heat we fall ill. This was the experience of the child that when I wore black clothes, I suffered from fever and now my mother said black cause fever so I never wear it. The explanation written was partially correct as black colour absorbs heat and excess heat might cause illness but the student had generalized that black colour have something wrong and wearing it will cause illness. She associated black colour with illness. So, the personal experiences of the child created a misconception.
- Black colour is used for 'black magic' so we should not wear black. Sometimes, people put black cloth and lemon on crossings, it is said when someone crosses it over, there is some magic on that person, and that person becomes mad.
- Black colour cloth is not auspicious so we should not wear it in functions and celebrations.
- Black colour cloth is used for 'nazar utarne ke liye' so we should wear it.
- Black colour attracts mosquitoes which cause dengue and malaria so we should not it.

Student's conceptions are their personal constructs; it all depends on the personal, social and cultural experiences of the child. Although these conceptions are individual construct but still there are similarities in the alternative conceptions within the similar socio-cultural environment. If, same question would be asked from a child with different cultural background, the responses might not be the same. Hence, socialization process is the major source of creating misconceptions.

How does the steel pan (which was on the fire) get cooled after sometime when we placed it aside?

The Alternative conceptions identified, as follows:

- Steel gets cooled more quickly
- Due to air, when air blows things get cooled
- If we get off something from fire it cools down.

Children observed it in their daily life experiences. They may not be able to connect it with scientific concepts, as concepts are taught in an abstract way. Thus, students use their own logics. The abstraction of science is in classrooms is also one of the reason for these alternative conceptions.

Plants

Students of class VI were questioned regarding plants and their responses are listed below:

- Fungi are plants
- Grass is not a plant as it does not contain all parts of a plant, like it does not have bark and stem.
- Creepers are different from plants as these don't have stem. Stem holds plants and support it to stand upright.
- We don't eat roots and stems of plants; we only eat fruits.
- Tulsi (Basil) plant is a non-flowering plant. It does not have flowers. This may be because students perceive flower as something colourful and has a particular shape.
- Sepals are always green in colour. (Because in our introductory instructions we define sepals as the green part). Similarly, petals are always larger than sepals.
- A plant has parts - roots, stem, flower, leaves, and bud.

Students were confused between -Sepals and leaves; Stamen and pistil; Ovary as an extended part of stem; Filament and style; Stigma and anther. It may be because it is not visible, a magnifying glass is required to make observations. These alternative conceptions were formed with the personal experiences, generally constant and difficult to change. Sometimes, a discussion of non-examples in the class, showing pictures or actual samples help in addressing misconceptions.

Food

In an activity with class III students, a list of few food items - ginger, carrot, flower of kachnar, mango, gram, lotus stem, bottle gourd, jackfruit, French beans, spinach, mustard, cauliflower, curry leaves, radish, banana was given to them. They were asked to identify from which part of plants is it?

- Amla, beans, bottle gourd were not identified as fruit. Children labelled these as vegetables. In vocabulary of science, fruit is the part of plant in which plant's food is stored. This meaning is different from the one used in our day to day life.
- Most of the children were unfamiliar of the Lotus stem. However, the word 'stem' gave them a clue and so in cauliflower and classified it under 'flower'.
- In another discussion on milk, the following alternative conception emerged:
- Milk is more important for boys than for girls, as boys go out for work and girls remains at home. Boys need more physical strength than girls.

These alternative conceptions come from social – economic and cultural background of children. The Indian society, even today celebrates birth of a boy than girl and this preference for male child is seen even in upbringing. It can be clearly seen how culture - the values, beliefs, customs, and skills of a social group- is transferred to the next generation and here also gender stereotypes of the society were transferred to the child through family.

The following alternative conceptions were found among children of class III, using a questionnaire on 'healthy and unhealthy foods':

- If we eat unhealthy food specially pizza we would suffer from asthma (breathing disorder). One girl in the class has asthma and she shared that a lot of pizza eating has resulted in this.
- Chocolates with dry fruits are healthy and chocolates without dry fruits are unhealthy.
- Bitter chocolates (dark one) are unhealthy and sweet one's are healthy. They believed that the bitter part in the chocolate is pure chocolate which is harmful and 'sugar and dry fruits' are healthy in it.
- Bottled water is healthy and tap water is unhealthy. The bottled water is good for health as it is packed by machines and tap water is unhygienic as it is transported by pipes and contains a lot of germs.
- Curd is unhealthy, as it contains bacteria, small living creatures.
- Desi ghee is healthy than butter, as it contains, 'minerals, vitamins, proteins. Students were confused between fat as a 'nutrient' and 'obesity'.
- Desi ghee comes from village is pure and healthy but butter is not pure so unhealthy.
- Non vegetarian food like chicken, fish etc is very unhealthy because they are dead living beings and contain lot of germs.
- Non vegetarian food is unhealthy only for girls because girls' stomach is soft and they cannot digest hard foods
- Momos (a food item containing maida and cauliflower) and Maggie are nutritious as they contain vegetables which are healthy. Here they focused on vegetables only, and ignored steamed maida.

Strategies for Addressing Alternative Conceptions of Children:

Use of specific tools like magnifying glass, encouraged children to observe to observe various parts of flowers. They were able to identify all the parts (pistil, stamen, filament-style, anther- stigma, ovary and bud) correctly.

Detailed discussion was done on scientists using their textbooks of classes VI, VII and VIII focusing on their discoveries, how they work, laboratory conditions and team work. Another discussion on curd and useful bacteria for digestion; non- vegetarian food – rich source of protein; water – mineral water and distilled water. In these areas' students had misinformation, which was addressed in discussion and follow up videos.

Results

Students across classes VI to VIII have similar alternative conceptions which is due to non-addressing of these misconceptions by teachers and family members at any age Pradhan, 2019). So, misconceptions remain are age independent.

Misconceptions are also gender independent. Our society is deeply influenced by gender stereotypes and gender roles which were found in all irrespective of their gender.

Misconceptions created due to society, family, (black as un-lucky, or un-auspicious) personal experiences (pizza causes asthma) have existed for long time. These are very difficult to change in a few classes (Driver et.al (1994, 2005) and Read (2004)). It requires a continuous challenging of their notions. Alternate conceptions created by the child due to lack of scientific knowledge (curd or non-vegetarian food as healthy foods, parts of flower) can be changed by providing scientific age appropriate information using proper tools and strategies (Virmani, 2015).

The sources behind these misconceptions were found to be family, society, media, peer group, scientific terminologies, child's personal experience and over generalization (Joung, 2006)

These alternative conceptions are so strong due to the sources (senses) and age (early) at which they were constructed that they cannot be changed easily. Sometimes they are so rigid like in the case of black colour that it became next to impossible to change. It was also found that although alternative conceptions are individual constructs as everyone have different perspective and apply different logics but still there is a similarity in those logics due to similar age factor and cultural background.

Conclusion

Research on children's ideas emphasized that children's ideas are stable, thus it was not easy to change their beliefs in few classes only. But certainly, an attempt like this has made the issue important for teachers in school and pre-service teachers that this area can't be ignored. This provided teachers an understanding about children's thinking. By knowing children's ideas or notions about any concept, it could be easily addressed during classroom transaction. If children's ideas or conceptions are ignored then we are depriving children from a meaningful learning experience.

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