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Children's Questions in Science Classrooms: A potential source of learning

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ABSTRACT

In this paper activities were conducted with children of classes V, VI and VIII where they were encouraged to ask questions. Children's questions were recorded at three different phases of teaching – learning – before initiating the concept, during the classroom transaction and after the concept is covered. Then those questions were classified using Harlen and Elstgeest (1992) framework. The data was collected over a period of four months (around 3months in primary school and 1 month in middle school). Data was analyzed with reference to types of questions asked by children and how these questions become potential source of learning.

Keywords: Asking Questions, Children, Constructing Knowledge, Learning, Science Classroom

Introduction

'Why don't children ask questions in classroom?' This question has always bothered teachers. Being quiet is not the nature of children. Outside the classroom children ask lot of questions. The probable reasons of children being quiet are unfriendly classroom environment; a child may feel shy; other children in class may laugh at questions; teacher is strict and may not welcome questions; one may not be confident enough to ask questions; or there may not be anything curiously done in class which raises any questions in mind; and many more. Here, in this paper a case of science classroom was explored. Science learning is based on inquiry, which if built upon children's curiosity leads to amazing results. Thus, questioning or asking questions becomes fundamental to know and investigate about the physical environment and phenomena around us. It further leads to developing critical thinking and problem-solving skills leading to scientific inquiry.

"The Important Thing is to Never Stop Questioning"

One of the famous quotes by Albert Einstein, one of the greatest scientists of all times. Science actually begins by asking questions and seeking answers. Young children understand this intuitively as they explore and try to make sense of their surroundings. Now let's read the questions given below:

- Why is sky blue in colour?
- What is an oxidation reaction?
- Which mirror is used as rear view mirror in vehicles?
- What is the role of white blood cells in human body?
- Potato is a rich source of ____ (Protein / Carbohydrate).
- Is night blindness a genetic disorder?
- What are the main causes of pollution in metropolitan cities in India?

Are these questions asked by children? No. these are not. These questions seem to be a part of a test or examination. These can be labelled as closed ended; open ended; short answer type; long answer type; objective type; true or false type; one-word answer type like fill in the blank. A number of other types of questions like multiple answer questions (MCQs) or open-ended answer can be added to the list. The common thing about all these questions is that these were asked by a teacher either in classroom (formative assessment) or in a test (summative assessment). These question help teachers in analyzing level of learners, then they may design a lesson plan or activity accordingly and diagnose where children are facing problem in conceptual understanding. These questions are asked for the purpose of assessment. There are two main concerns. One, can questions be asked for learning? How the questions asked for leaning are different from questions asked for assessment? Two, do children also ask questions? Why should they ask questions?

In a science classroom, if a question is framed in a manner for which an investigation can be designed then it leads to learning. For instance, a question like 'do all heavy objects sink and light objects float?' in classroom, may lead to predicting, hypothesis formulation and experimentation. Children may investigate themselves with different objects and find answer to their questions. Such kind of questions lead to

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better learning of physical phenomena of floating and sinking. Thus, it is important that children are encouraged to frame investigative questions in science classroom.

Secondly, children ask questions to clarify their doubts, to find answer for their queries, or to bridge the knowledge gap between what they know and what is being taught in classroom only if classroom environment is friendly for asking questions (Shukla, 2015). Children's questions help teachers in understanding what the children have already understood and what they have not understood. Moreover, questions from children indicate that they have been thinking about the ideas presented and have been trying to link it with their previous experiences/ knowledge. Children actively construct their own meanings while going through an activity or experience or interaction. In all such processes children are active. According to the dynamic model of Chin & Brown (2000), questions help children in initiating a process of inquiry by hypothesizing, predicting, and experimenting. Thereby, they try to resolve contradictions and find answer to their questions. Research has also proved that questions asked by children stimulate thinking thus, inquiry. Questions play an important role in engaging students' minds more actively (Wadhwa 2017). Teachers may create situations in classroom which encourage children to observe and then raise questions.

Objectives of the Study

The following are objectives of the research:

- To encourage children to ask questions and then engaging with those questions in classroom for enhancing children's learning.
- To try out activities and strategies which would enhance questioning raising skills in children.
- To analyze kinds of questions asked by children.

Theoretical Underpinnings

Chinese Whispers is a popular game for children in which one child whispers a sentence into the second child's ear then second child to the third and so on. The game continues. Finally, the sentence reaches to the last child. Last child announces the sentence. First child compared her version to the final version. Most of the times, there are too many variations in the first and final version of the sentence. Why does this happen? It is a game of communication based on listening and speaking. We as human are not robots, who records and speaks exactly same words. We attached meaning to a sentence then we say it again. Thus, whenever an information is presented in a classroom setting all children will perceive it and interpret it from their own experiences, perspectives or notions (Sethi, 2017). Jean Piaget, a Swiss phycologist, known for his theory of cognitive development proposed that children actively construct their understanding of the world using mental maps called 'schemas'. Whenever a new information is presented that does not fit in with their existing schemas, children add to what they know and elaborate their existing schema through the process of *"assimilation"*. There are also times, when children come across new experiences or ideas that are against their prior knowledge, then they form a completely revise their existing schema through the process of *"accommodation"*. This constant construction of knowledge rather than simply receiving or storing it, is going on in the minds of children all the time. Many other educationalists such as David Ausubel and Les Vygotsky emphasized on construction of knowledge by individuals.

The other aspect of learning in science is to break the stereotype where teacher is the only person talking in class and children are only passive listeners, and are expected to listen what is being delivered. According to Driver (1994) children have pre-conception and misconceptions about science concepts, and "what children are capable of learning depends, at least in part, on what they have in their mind". For identification of their conceptions, questioning is important. Questioning becomes an integral part of meaningful learning and scientific inquiry. It is one of the thinking process skills which 'promotes critical thinking, creative thinking and problem-solving' (Hadzigeorgion et al, 2012, Malik and Shanwal, 2017). Moreover, students' questions play an important role in the learning process as they are a potential source of both teaching and learning science. For teachers it is extremely significant to recognize the differences between different kinds of questions, as only few kinds of questions can be answered using scientific activity in a classroom context. For understanding the nature of questions asked by children Harlen and Elstgeest (1992) framework of classification of children's questions is used. According to the framework, children's questions are classified into the following categories:

- Comments in form of Questions: Children at times share their observations and comments in form of questions. These comment statements are not questions. These are their remarks. not really asked for information but are merely comments expressed as questions. For e.g. 'Why are birds so clever that they can weave nests with their beaks?'
- Simple Factual Questions: These questions have simple factual answers. Such questions are generally based on facts of natural phenomena. For instance, how many colours are there in a rainbow? How is a planet different from the star?
- Complex Questions: These questions would require complex answers which the child may not understand at that age. For instance, why do people wear glasses? Why is the sky blue in colour?
- Investigative Questions: These questions could readily be answered through investigations or inquiry.
- Philosophical questions: These questions are philosophical in nature and are generally linked to feelings. For instance, do plants get hurt/ feel pain when flowers are plucked from those?

The present study attempted to encourage children's questions in classroom. Later those questions were classified into the above five categories and investigative questions were dealt in class.

Methodology

Sample

The paper is based on interaction with a total of 169 children from classes V (43), VI (61) and VIII (65) during 16 weeks School Internship Practicum of an under graduate teacher education programme (Bachelor of Elementary Education, B.El.Ed.). The school internship practicum was conducted in the North Delhi Municipal Corporation School and Sarvodaya Vidyalaya located in Rohini.

Procedure:

During internship ample of opportunities were provided to children for exploration of their surroundings. Also, free environment of classroom encouraged them to raise questions for their concept clarity. Children asked questions at various points in the teaching – learning process. The following 'three phases' were identified:

- before introduction of the concept
- during the classroom transaction of teaching that concept
- after the concept/ topic was covered

During all three phases questions were recorded and then handled in the consecutive classes. Simulations in form of activities, demonstration and discrepant events were conducted. Activities providing opportunities for hands-on experiences, experimentation and demonstrations.

The following is the table indicating total number of questions asked by each group during three different phases:

Table 1: No of questions asked during different teaching - learning phases

Concept	Activities Conducted	Questions asked	Total No of Questions
Space Class V	Discussion based on Satellite Images of the Earth Presentation of the Model of the Earth in form followed by activity of locating different cities and countries on that Video on how different phases of the moon happen. Chart for Indian festivals related to moon's phases.	Before	53
Shelter Class V	Small group task for observation of various pictures of different types of shelter followed by a discussion on where such houses are found In groups children created models of different types of houses like igloo, multistoried building, wood house, stilt house, bungalow and it was followed by discussion on what material is used for making those houses.	During	41
Germination Class V	Observation and Identification of Varity of seeds – black gram, wheat, rice, kidney beans, Moong dal, chhana, Urad dal. Experimentation on seed germination where children sow seeds and recorded their observation for two weeks. Seeds were sown in different containers; some were kept in sunlight and some were in classroom. Some were watered regularly; some were not watered and some watered only to moist the soil. Children made their observations and drew inferences about necessary conditions for germination Videos on paddy trans-plantation and harvesting were shown and it was followed by discussion on the steps of farming.	After	38
Pollution Class VI	Reading and discussion on newspaper clippings on increasing air pollution in cities in India; identifying main causes and steps to be taken by government and individuals for reducing air pollution Watching videos on water pollution in India followed by discussion on how to conserve water and reduce water pollution Making posters for creating awareness on rising pollution and displaying in school	Before	36
Magnetic effects Class VI	Experiments with magnets – bar, horse-shoe, square and circular type magnets; Identifying poles of magnets; discovering laws of attraction and repulsion with magnets Making magnetic lines of forces with bar and horse shoe type magnets using iron fillings	During	30
Electrical circuits Class VI	Identifying components of a simple electrical circuits – switch, battery and bulb; Experiments with electrical circuits using parallel and series circuits; Discussion on role of a fuse in an electric circuit.	After	30
Light Reflection and refraction Class VIII	Experiment using plane mirror for discovering laws of reflection; Identifying characteristics of images formed by a plane mirror; Experimenting using glass slab and discovering how rays of light bend when it passes from one medium to another medium (from air to glass and glass to air); discovering laws of refraction; Identifying when refraction of light happens in our every-day life activities Watching videos for the scattering of light and discussing why is sky blue in colour?	Before	22
Human cell and reproduction Class VIII	Charts on reproductive structures in male and female and drawing differences in their reproductive organs Discussion on myths related to mensuration in girls – 'one should not eat curd during mensuration; one should not tell anyone about it' Discussion with girls for their queries about the process of mensuration like - Why does this happen every month? What will happen if this unfertilized egg remains in our body and it does not come out? Why is it important to maintain hygiene during the time of mensuration?	During	36
Human hormones	Displaying charts for names and functions of various human hormones and their role in development followed by quizzes.	After	37

Data Collection:

Given below is the selected sample of questions asked by children during three different phases of teaching – learning process. For the ease of counting, similar questions were not counted. These questions are classified according to the Harlen and Elstgeest (1992) framework.

Comments in form of Questions:

- We see stars smaller, though they are bigger
- There is no oxygen on Moon, still astronauts survive there
- Sclera cannot change its size, but pupils can change
- Igloo is made of snow still it provides warmth to Eskimos
- Saturn is the only planet with rings
- We have different types of houses in different places.
- Majorly Earth is covered by water still it looks too green from space

Simple Factual Questions:

- Why it is advisable that one should keep magnets away from electrical appliances?

- How many satellites are connected with India?
- How much time does it take to reach Moon?
- Which is the coldest/ closest/ smallest planet?
- Do the borders between different nations or cities visible from the space?
- How much time is needed for reaching space?
- Who is the first person to go in space?
- Write difference between Rabi and Kharif crops?
- What all are the benefits of technology in farmers life?
- Apart from domestic sources, what are the other possible causes of land pollution?
- Why do paddy fields need much water?
- What is vermicomposting?
- Can magnet be construct by us?
- What makes RBC red in color?
- Why you cannot see an object in dark?
- Why does sperm have tail, but egg lacks it?

Complex Questions:

- Do, with age, hormone content decreases in our body?
- Can we separate all the transported material (nutrients, O_2, hormones) from the blood?
- Which is more important- Moon or Stars?
- What does iron have which enables it to stick with magnet?
- How can we identify the North Pole and South Pole?
- What will happen, if there is no Sun?
- Why Saturn is the only planet with rings?
- Why life does not exist in space?
- Is the temperature on Sun always remains constant?
- What all makes life possible on Earth?
- Why some animals live in colonies, while other in isolation?
- Why life does not exist in space?
- How do we construct tall buildings?
- What is the special designing/ techniques used in constructing disaster-resistant buildings?
- How do we plant seedless fruit plants?
- Are fertilizers equally important as manures?
- How does quantity of sunlight affect crop growth?
- Can we transform garbage into some useful means that won't harm us?
- Why only some material can be degraded?

Investigative Questions:

- What happen during Sun eclipse?
- How do people survive in extremely cold regions?
- Is foul smell an indicator of degradation process?
- If human hormones are put in plant's body, then do plants also change into human body?
- Why we all look different from each other?
- What gives trigger to hormones for getting active?
- How does lunar/ solar eclipse happen?
- How does Moon change its size daily?
- Is it nutritious to eat same type of grain daily?
- Can we make our own magnets?
- Why when 2 magnets are bringing closer repels sometimes, but it never happens with any iron object?
- Why magnetic crane is used for segregating waste initially?
- What all are needed in formation of an electric circuit?
- Can we construct our own switch?
- Is sclera elastic in nature?
- How mirrors are formed?
- How human cell does look?
- Are all human cells looks alike?
- Does trans-gender lack reproductive hormones?
- Do plant bodies also have hormones?
- What would happen if the hormone content decreases in our body?
- Is menopause an indicator of finished progesterone in female body?

Philosophical Questions:

- Do ants enjoy making its house?
- We had never seen God still why do we have faith in him?
- Does iron have friendship with magnet as it only sticks with iron objects?
- Can God identify woman having periods when they go in a temple?
- Do Sun and Moon have any partnership among them?
- Do astronauts enjoy in space?
- Are farmers happy with their conditions?
- Millions of years ago, was Earth like a magnet?
- Who are aliens?

Data Analysis

Children from classes V, VI and VIII asked 132, 96 and 95 questions respectively. A total of 321 questions were asked by three groups collectively. The above table shows number of questions asked before and during the teaching -learning process is more than number of questions after completion of the concept. The probable reason may be that children are curious and wanted to find solutions to their questions. In case of science teaching, it is very essential for a teacher to know about the prior knowledge and conceptions about the very

concept, which her children are carrying so that she can plan the strategy and decide the content appropriately.

Table 2: Types of Questions asked vs No of Questions asked

Type of Questions asked	No of Questions asked	Percentages
Comments in form of Questions	31	0.96%
Simple Factual Questions	100	31.1%
Complex Questions	65	20.2%
Investigative Questions	88	27.4%
Philosophical questions	37	11.5%

The table shows that out of total 321 question being asked 31% are simple factual-based type questions. Maximum number of simple factual questions are asked by children followed by 27% of investigation type questions. 20% of the total questions are questions that require complex answer, which children at that age may not be able to understand. Only 11% are philosophical questions and with minimum not of comments in form of question. These are only about 1%. Probable reason of this is that children are old enough to make distinction between comments and questions. In all about 88% of questions were asked by children to satisfy their curiosity either as factual or complex or investigative questions. A large of questions were investigative in nature, it actually helped the teacher to plan activities and exploration around those questions and building upon the curiosity of children.

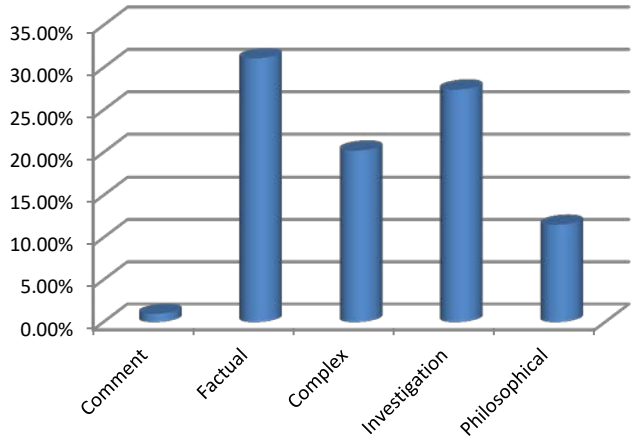

Figure 1. Graph showing percentage of different types of questions asked by children

According to Piaget's theory of cognitive development children through investigation children are actively interpreting and forming or extending their mental representations / 'schemas'. It is also observed that children of class V asked maximum number of questions. As age of children increases or grade (class) level increases number of questions asked decreases.

There may be number of reasons for this – children at the age of 13 to 14 years are more familiar with their surrounding environment; they have other sources of information like peer, books and encyclopedias, internet or other adults.

Challenges

There are several obstacles like children's knowledge of different types and levels of questions, the teacher-pupil interaction and teachers' attitude towards children's questions that may prevent children from asking questions in the classroom. Furthermore, there is individual differences in

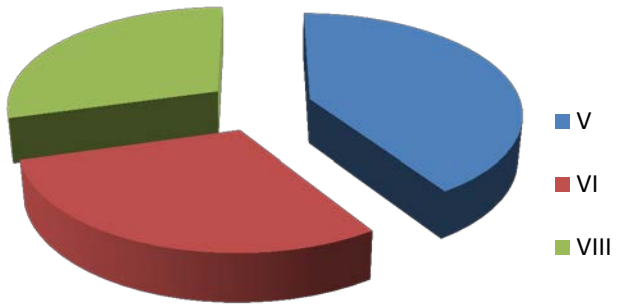

Figure 2. Graph showing frequency of questions asked by children of classes V, VI and VIII

children too; some raise questions easily, while for other's it becomes a difficult task. This difference may depend on the individual's predisposition to taking risks, learning style and ability to tolerate uncertainty (Meij et al. 1994). Some children try to clear their doubts immediately, while other sustain their doubt just to avoid explicit questioning. They may be anxious about what if their question is silly, what if other children make fun of them. Such thoughts discourage them for asking questions. They feel that they are avoiding public embarrassment, or ridicule.

In a typical classroom setting, it is the teacher who asks questions (Sharma 2015). Asking question is not considered a task for children. They are expected to answer the questions raised by a teacher. Teachers may also sometimes avoid children's questions. According to Alsop and Watts (2003) children's questions may not be direct or straightforward and may lie outside the teacher's sphere of knowledge. Thus, teachers who are unsure of their own knowledge base might tactically avoid or repress students' questions to avoid problematic issues. According to Woodward (1994) teachers who perceive science teaching as transmission of facts, and who feel that tight control is a necessary feature of teaching, are also unlikely to invite students' questions.

Implications for Science Teaching and Learning Process

There are number of ways which may be used in science classrooms for enhancing question raising skills among children. It is important to provide stimuli to children either in form of an activity or reading material, newspaper clips or videos or visuals or any other kind of cognitive activity which generates disequilibrium in the minds of children. In the present paper a number of activities (detailed given in table 1) were conducted with children for encouraging then to ask questions. Certain exemplars of good questions when shared with children help in facilitating further more questions. Children may be asked to write questions in their notebooks or on a question board or in a question corner in the classroom. It was also observed that brainstorming session with children help in eliciting questions. Tasks like 'question of the week' or 'framing questions' for homework or in a test also motivates children for asking questions. It is only possible in a non-threatening classroom atmosphere where students feel free to ask questions. Above all it is extremely essential to handle questions and make children work in a manner to find answer to the questions, then only questions become potential source of learning.

Conclusions

Activities conducted during science teaching learning process motivated and encouraged children to ask questions. It was complemented by friendly, comfortable and fear free environment of the class, which stimulated more and more questions. Questions provide insights into children's thinking, conceptual understanding and conceptual difficulties. Moreover, all types of questions were welcomed in the class. The number and type of questions asked by children may be influenced by their age, experience, previous knowledge and skills, the teacher's attitude, teaching strategy, topic's nature, reward structure, classroom evaluative environment and social interaction patterns (Chin and Osborne, 2008). When children questions are addressed in classrooms, it enhances their interest. However, there were a large number of direct factual questions. This large number is also attributed to a 'stereotypical science classroom' which promotes only one right answer to the question.

Secondly, children's ideas or alternative frameworks and confusion about concepts are very important and helpful in teaching and learning science. It provides an insight into what children are thinking and what they want to know. Children are actively participating. Thus, a teacher can pitch in at their level. And everyone's constructing their own knowledge. The type of questions asked by children can also indicate the questioner's depth of thinking (Chin, 2006). The questions from children's side not only reflects their thought-process, but also gives a scope for learning through the means of scaffolding. It points out to the potential use of children's questions in learning where the teacher can gain some insight into the children's minds and provide the appropriate feedback. It becomes a potential source of learning for children as well as teachers.

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