UNIT- 2

EXPLORING LEARNERS

Syllabus : Uniqueness in learner – Motivating learners to bring their previous knowledge into Classroom- Involving Learners in teaching-learning Process – Encouraging learners to raise and ask questions, collect materials from local resources.

Introduction:

We have come to an understanding that well-developed learning objectives should be flexible according to teaching-learning situation and the need of the learner. You will appreciate that each learner is different from the other in terms of intellectual, emotional and social needs. Their motivational levels of learning physical science are also different. They are not same with respect to their knowledge, experiences, interests and the abilities. These differences can be seen even in one individual over a period of time. All these variations contribute in the way they learn and the knowledge they acquire.

Furthermore, we observe that learners construct their knowledge of science by interacting with the learning materials available in their environment in their own way. Knowing and creating the learning environment through various activities and investigations helps you in the process of teaching and learning. It helps the learners to relate their learning with their everyday life experiences. In order to maximize their learning and facilitate them to utilize their wide range of potentials in a variety of teaching-learning situations, it is necessary to explore your learners.

Dictionary meaning of exploration is to investigate systematically. In the context of teaching-learning situations and processes, exploring the learners implies knowing your learners and their learning situations. The questions arise - Why should you know your learners? What should you know about them? How can you know about them? Let us first look at the answers of these questions through a broad framework.

Firstly, you should know your learners because each learner is unique. Secondly, you should know about their previous and naive ideas of scientific concepts, their learning needs and the variety of ways they learn physical science. You have to find how they are constructing their knowledge and the extent of their learning. All these help you to plan your teaching- learning

experiences and processes. Thirdly, you can know about the learners by creating conducive learning situations.

Learners should be involved actively in the teaching-learning process by motivating them to bring their previous and naive ideas of the concepts in physical science, appreciating dialogue among peer group, getting them engaged in discussion and arguments, and facilitating them to mediate and negotiate learning.

You should encourage them to collect learning materials from local resources for various activities, experiments and projects. For all these purposes, you need to provide them opportunity to raise and ask questions and express wonders on science and you have to cultivate the habit of listening to the learners. In this chapter we shall discuss about them in detail.

UNIQUENESS IN LEARNER

We have discussed above that every learner is different from the other. Hence the teacher should ask,

"Why should I know?

- Individual differences among the learners when I have to teach the 'same content' to all of them in my class?"
- We can get the answer by recalling our own experiences. Recall some of the teaching-learning situations of school days, where the teacher had taught the 'entire class' the 'same content' in the 'same way'.
- What was the result? Did all the learners learn the 'same thing' at the 'same level'?
- Did they get the 'same marks or grades' when examined by the teacher? If not, then, why?
- Did you ever feel like sharing your experiences with the teacher and classmates during teaching-learning process?

You will find learners in your class with a wide range of educational experiences that you should consider in planning teaching-learning experiences. Some have read a number of books; some have worked on many projects at the previous stages of learning, while some have travelled to various places.

Different learners interact with different people and they observe and interpret their environment differently. All these factors contribute to the difference in their experiences. They construct their knowledge differently by relating it to their previous experiences.

Therefore taking into account the heterogeneity of the class as well as uniqueness of the learner and paying attention to the existing ideas of the learners brings enrichment in teaching-learning experiences. At the same time, this makes the learners feel valued and motivates them to get actively involved in the learning process.

MOTIVATING LEARNERS TO BRING THEIR PREVIOUS KNOWLEDGE INTO CLASS ROOM

- Learners' experiences and observations of real-life situations and their previous knowledge should be used in teaching-learning of science.
- They should be motivated to participate actively in the teaching-learning process for construction of their knowledge.
- Emphasis should be given on their involvement by facilitating them to experiment, form hypothesis, modify, discuss, infer, justify, defend, argue, analyse, solve, put question, relate, organise, use, apply, critically examine, explain, and interpretate.
- Teacher should nurture a learning environment where learners can get motivated to share their previous experiences and knowledge without fear and take initiative to participate.
- You would find classroom with such an environment a very lively place in the pursuit of quality learning that helps learners to develop a sense of inquiry and scientific attitude.

Providing situations of observations can arouse curiosity among learners and generate questions in their minds. For example, you can start the lesson on *Combustion* or *Flame* by burning a candle and a spirit lamp (taking necessary precautions) and ask the learners to observe the two flames and give their observations.

Student's attention can be drawn towards:

- size of the flame;
- brightness of the flame; and
- colour of the flame, etc.

To relate the concept of combustion with the experiences of the learners in the classroom you can also help them to compare other flames they might have seen, such as the following:

- Flame of the burner in the kitchen.
- Flame of the burner used by the blacksmith.
- Flame of burning wood/paper/cow dung cakes, etc.
- Flame of things burnt at bonfire.

Here you are bringing the experiences and the previous knowledge of the learners about the flame in the classroom. When the learners are able to relate the classroom learning experiences to their observations and experiences outside the world, it works as a motivating factor for them to participate in the learning process.

Before starting the lesson you should ensure that the learners are ready to learn. You need to know that learning takes place in a variety of ways- through reading, asking, listening, writing, making and doing things, experimenting, discussing, thinking and reflecting, and expressing oneself through speech. They may perform these activities individually or with others. You can motivate the learners to share their existing knowledge and ideas by providing such opportunities to them.

Encourage learners to share their experiences, clear their doubts and share their existing ideas with the class. There is a lot of science in their experiences. Those experiences and ideas can be used as a stepping stone to learning scientific concepts.

When learners are encouraged to share and seek out knowledge from sources other than the textbook, in their own experiences, in the experiences of their peers, homes and surroundings, outside the school, in the laboratory and library, they realise that knowledge can be sought out, authenticated and constructed.

We have discussed above that learners in a classroom have different experiential background. Based on their experiences of natural world they form some ideas/notions/beliefs of a concept or process. These ideas are alternative framework (alternative conceptions) that may be right or wrong. If wrong, they should be removed from cognitive framework of the learners. These are *misconceptions*. If learners' previous ideas do not match with the scientific explanations and are partially correct, these are *naive concepts*.

Recognising the evolving nature of cognitive development of the learners, they should be facilitated to construct new ideas over their naive ideas. When we talk of naive ideas we recognize that knowledge is always being constructed. We need to view the learners as constructing knowledge all the time. This is true not only regarding science or any discipline, but equally regarding values, skills and attitudes.

Learners' mental representation of ideas are continually adopted, reformed and revisited in the process of construction of their knowledge. Teaching-learning of science helps them to develop their ideas in particular ways.

Active involvement of learners in intellectual stimulation with new and other's ideas, in social interactions with teachers and peers and their physical interaction with phenomena and materials, can bring conceptual changes in them. Let us now discuss how naive ideas of the earners can help you to explore them.

INVOLVING LEARNERS IN TEACHING-LEARNING PROCESS

Involving learners in teaching-learning process provides a feeling of ownership in their learning. Traditionally, it has been the responsibility of the teacher to do all the planning for teaching learning but presently, it is considered as a shared activity between the teacher and the learners about content, activities, approaches and assessment.

Keeping themes in mind, you can interact with learners to decide what they would like to know about a particular theme. With their help you can identify the 'content' for the lesson. You can add and supplement to the 'content' selected by them.

The approach of transaction can also be negotiated with learners. Learners can suggest, discuss, share information and experiences, perform experiments, go for excursion or do other activities for learning and developing deeper understanding about the concept to be learned. You can use a variety of activities, strategies and approaches to involve the learners at various junctures of learning.

Appreciating dialogue among peers

You should appreciate dialogue among peers in the teaching-learning process. Dialogue involves one to one interactions in the classroom among the learners. Dialogue provides space to

learners to reflect on their own ideas on scientific concept. It may lead to a discussion intended to produce an argumentation. Dialogue may be structured or unstructured.

Structured Dialogue: It may be used by the teacher and the learners as a means of orienting the dialoguing discourse towards understanding the problems under consideration.

Unstructured dialogue: It may also be used as a form of discussion which may not have a desired end.

Dialogue is an important classroom tool which can be used to focus on a problem and has the potential to inculcate interest among learners and encourage them to open up for discussion and argumentation. It helps to reinforce learning by helping learners to construct collectively deeper understanding of concept and to know how the same learning experiences are perceived differently by different learners.

Encouraging dialogue among peers also develops bonding among them that provides a foundation to collaborative learning, negotiating ideas and other life skills. When students are engaged in conversation about their observation, hypothesis, ideas and thinking on a particular activity, experiment, project or scientific concepts, they get an opportunity to know one another's perspectives on the concerned issue make connections with their prior learning and get the key points. They co-construct the meaning and learn how to express their opinions.

However, guidance of the teacher is necessary to help them remain focused on the issue. In the process of dialogue the teacher empowers the learners through conversation and questions to build their own understanding and to learn to think analytically.

Teacher can ask her own question in response of student's questions rather than simply providing readymade answers to them to keep the dialogue rolling on. It can encourage learners to get an insight for interconnectivity of various concepts.

Learners can examine and analyse the concepts from multiple points of view from the social interactions in the classroom. The teacher should facilitate the learner to listen to her classmates attentively without interruption and to use sensitivity to take her turn to express her ideas.

Obviously, knowledge is being constructed by learners through social interactions in the class and this knowledge is shared among the learners. It is important that teacher should remain

vigilant, so that dialogue does not lead to wrong conclusion. She should intervene at critical juncture to guide the conversation, so that it leads to scientifically consistent explanations.

Lev Vygotsky (1896–1934) believed that, "Children undergo quite profound changes in their understanding by engaging in joint activity and conversation with other people." He emphasised that learning is a complex activity. Learners learn a lot when they interact with their environment. Environment refers not only to school and physical and social surroundings, but also to their peers, the teachers and parents.

Therefore, meaning is constructed not only through processes operating on 'individuals', such as the stimulation of senses or the mediation of prior knowledge, but also through processes of social communication. Learners should be encouraged to learn from each other, be it dialogues, small group activities, cooperative or collaborative learning.

This is essential for holistic development of the learner. The process of dialogue can be followed by generating discussion in the class by emphasising on argumentation in science, highlighting the importance of learning from social interaction in the classroom and the role of learners in negotiating and mediating learning in physical science.

Generating discussion

Discussion is an important process of learning and understanding our environment. It is a way of putting our point of view and supporting it through convincing information, arguments and evidences. Discussion is required to acquire scientific and technological knowledge and to understand the physical and social environment around us. Therefore, teaching-learning of science should encourage the learners to generate discussions and question about the world around them.

Many a times the term discussion is used for any type of oral interaction. For example, when a teacher says, "let us discuss on the *conservation of momentum"* and asks a few questions to the class about the content without providing the learners the space for raising and asking questions, performing activities, doing investigations, solving problems, interacting with peers and surroundings- it is not discussion and has little learning value.

Generating and conducting discussion for active participation of the learner require the following:

- Selecting suitable concept or topic which interests learners. Learners maybe involved in this.
- Creating situations like activity, experiment, project, video clip, learners' report, field trip, etc. It can provide a common platform to the learners for class discussion.
- Ensuring participation of all learners. When you plan discussion based on the activity or experiment, arrangement of materials and apparatus should be such that each learner may obtain, perform and return the materials herself with a minimum disturbance to the classmates.
- Encouraging the learners to put their questions as well as to response to other's questions or viewpoints with suitable reasoning and argument. Probing questions asked by the teacher seeking explanations and reasoning can foster critical and creative thinking in learners.
- Acknowledging and praising learners for their responses, adding and supporting their ideas, identifying knowledge gaps without criticising them can help them to sustain their interest and keep the discussion rolling on.
- Summarising, reviewing and evaluating the ideas with the help of learners at the end of the discussion.

Such situations can encourage learners to consider multiple views, reflect on their own and other's views using their thinking and existing ideas. Though it is not possible to anticipate all questions of the learners in the class, framing few questions or identifying some points on the concerned concept or topic beforehand helps the teacher to remain focused on the issue during discussion. You can initiate a discussion by giving a 'statement' or 'posing a problem' or putting a question in situation where you expect varied experiences and understanding to exist among the learners.

Generating discussion is one of the powerful ways to lead the learners into inquiry and learning to learn. Discussion may be generated in order to predict, explain and interpret the result of activities and experiments, solve problems and plan future teaching-learning activities. A good discussion allows free exchange of ideas amongst all learners and the teacher in the class.

Learners get opportunities to listen, support criticise, argument and evaluate other's ideas. Learners put forward their point of views and experiences. These help in the development of open-

mindedness and ability to suspend judgment until convinced by arguments presented by others. Let us now see how learners can be involved in argumentation in teaching-learning of science.

Argumentation in science

Argumentation is the process of doing argument. Argument is a form of discussion that needs to be planned through suitable learning experiences. It plays a vital role in science education. It helps building of explanations, models and theories in science and promotes learning.

Argumentation in science provides the learners an opportunity to generate, collect and use evidences to make sense of the concepts being studied. Learners critically evaluate each other's claim and evidences.

- It provides opportunity to the teachers to explore ideas of the learner in a social set up by engaging her in justifying, defending, collecting evidences, doing experiments and activities, critically evaluating evidences.
- It develops communication skills of learner. Learner learns to use scientific vocabulary and scientific concepts to support her arguments.
- It discourages learner to accept science as a mere collection of facts and accepting passively the provided explanation of natural world as right or wrong.
- It helps the teacher to know about thinking and learning process of the learner.

Generally, the most frequent type of questions that is used by teachers in science classroom demanding fixed responses, do not encourage students to share their ideas or enter into interactive discourse. It is observed that there is a direct relation between open-ended questions and increased involvement of learners in argumentation.

When learners are given opportunities to voice reasoning to their knowledge claims and throwing them to be evaluated by the peers and the teacher, they learn about constructing as well as evaluating arguments and making sense of their own knowledge. Learners then view themselves as the constructor of knowledge and teacher as a *facilitator of learning* rather than a *knowledge dispenser*.

Role of teacher in promoting argumentation

Just giving learners scientific or controversial scientific issues to discuss will not ensure argumentation and valid learning. Following considerations can be made in teaching-learning of science:

- Provide an open-ended situation to the learners to initiate argument.
- Use arguing prompts to motivate learners to participate in the argument. Some of the arguing prompts can be:

  – How can you explain the observation?

  – Why do you think that way?

  – What do you think about the reason for your answer?

  – Can you think of another argument for/against your view?

  – How do you know what you know?

  – What is the evidence of your knowledge?

- Ensure homogenous participation of learners in argumentation.
- Intervene in the argumentation when the objectives of learning are not being achieved directly or indirectly or the argument becomes unharmonious or unhealthy.
- Provide positive feedback to the learners.
- Help the learners to summarise the major ideas evolved in argumentation at the end.
- Suggest further follow-up activities to ponder over the argument further.

This is a sample of argument that makes students participate in interactive learning. You can see how students are giving reasoning and justifications. Teacher can initiate and sustain argumentation for learning science by discussing on common observations. Space should be given for reasoning, evidences, justification, open ended questions, experiments and investigations, analysis and interpretation of data.

Thus, argumentation includes coordination of evidence and theory to support or refute a task related with knowledge. Argumentation in science can be supported by the observations based on

activities and experiments, discussion based on mathematical formulations and using sentences with scientific vocabulary clearly and logically.

Introducing argumentation in the classroom requires a shift in the role of teacher from authoritative to a dialogue approach associated with extended contributions of learners. Argumentation in classroom helps to construct knowledge, clarify concepts, remove naive concepts and make learners active partners and become self aware of their learning.

NEGOTIATING AND MEDIATING LEARNING IN PHYSICAL SCIENCE

The mediation of students helps the teacher to design relevant activities according to the need of the learners. The learners develop a sense of involvement and participation in the teaching-learning process.

Learners negotiate what they will learn, how they will learn within the given framework of the curriculum. Following are the positive points of learners' negotiation and mediation in learning process:

- Learners become active partners in learning. It generates interest in learning science.
- It raises self-esteem, critical thinking and listening skills of the learners.
- They design activities with the help of the teacher. Thus they learn by doing themselves.
- They feel responsible for their learning. The whole learning process imparts a sense of achievement and satisfaction.
- They work in collaboration with other learners and teachers, and develop various social skills.

Teacher should create a learning environment in the class that is conducive for mediating and negotiating learning in the pursuit of learners' questions rather than strict adherence to the curriculum. Learners can mediate and negotiate in a collaborative set-up that can influence their actions.

Learners can compare and contrast their ideas, attempt to integrate information from two or more sources such as observations of two similar experiments to mediate and negotiate learning and construct their knowledge.

In the context of physical science, there is little scope for compromise as indicated by the words *negotiate* and *mediate* in isolation. Learning tasks in physical science may be performed

differently, argumentations may be given differently, and however, meaning can be obtained by mediating and negotiating with peers and the teacher.

Opportunities of observations, discussion, argumentations and presentations can be given to the class as a whole. Negotiation is reached when a learner believes that her construction of knowledge and its scientific explanation are not different from her peer's even though they are likely to be different. The role of the teacher is to act as a facilitator of learning, encouraging interventions and promoting learner's autonomy.

You may argue that involving learners actively in the teaching learning provides little time for the teacher to cover the contents of the syllabus. However, this gives learners time for critical thinking. This places more responsibility of learning on the learners and they come prepared in the class. It also brings readiness for learning in them.

Active engagement of the learner needs proper planning and patience on the part of the teacher in the beginning. It saves your time and effort in the long run as it leads to deeper understanding, setting the learner on the path of meaningful learning. You would not observe more misconceptions and naive concepts in learners.

ENCOURAGING LEARNERS TO RAISE AND ASK QUESTIONS

If you take a round of the corridors of traditional schools running the classes, most of the time you will hear the voice of the teacher. Even if students are speaking, they are answering the questions that the teacher asked. Opportunities are seldom provided to students to raise and ask questions.

NCF-2005 recommends that teachers need to nurture an enabling learning environment in the class where children feel secure; there is absence of fear, and which is governed by relationship of equality and equity. Often this does not require any special effort on the part of the teacher, except to practice equality.

The classroom space should have a favourable climate where children can ask questions freely, engage in dialogue with the teacher as well as with their peers during an ongoing lesson. Unless they can share their concept-related experiences, clarify their doubts and ask questions, they will not engage with learning.

If instead of ignoring children's comments or sealing their tongues with strict rules and restricting on the language to be used, teacher encourages them to talk, they would find that the classroom is a more lively place and that teaching is not predictable and boring. It then becomes an adventure of interacting minds. Such an environment will facilitate the self-confidence and self-esteem of learners of all ages.

It will also go a long way in improving the quality of learning itself. Science involves observation, investigation and inquiry. **Asking questions is one of the most valuable skills a learner can have for learning science.** Learning process should lead to a situation where the learner gets involved in cognitive conflict.

Studies show that students find the class boring if only teacher asks questions and they are not allowed to express their ideas. In the class learners ask mostly those questions that relate what they are learning in the school with the things outside the school. In this process many questions may come up to their mind.

Strategies to encourage learners to ask questions

• Welcome and value each and every question. No question should be stamped as simple or silly question.

• Even if the question is simple or silly, it should not be tagged as such. Instead, learner should be guided to search the answer by asking some probing questions based on her previous experiences.

• Acknowledge their questions as *very good; interesting; intelligent questions; good statement; your question shows, 'you are thinking;' 'you are creative;' 'you have read a lot*;' or with similar feel.

• Only a few students should not be allowed to dominate the class. Provide equal opportunities of interaction to all. Students and teachers together may set a rule with respect to interaction. It may be *each learner of the class has to raise at least one question during teaching-learning process of one chapter/unit.*

• Familiarise them with the fact that asking a good question requires thinking and knowledge. Not only their answers, but also the quality of their questions will be assessed in the class. This would motivate them to concentrate on learning and thinking.

• In spite of having a good social and emotional climate of classroom, you may find that a few students are hesitant in asking questions. You may need to be empathetic with them.

You may say, *I understand. Even today I sometimes find difficult to ask question in meetings, but I have observed that once I start getting involved in conversation, things become normal and easy.*

• When you set up a difficult problem and do not get any response from the class, you may provide hint or draw their attention to the difficult part of the problem to encourage them to think and raise questions.

You may speak in lighter tone, *perhaps I explained it very quickly; I will discuss it again;* or, *this type of problem we have not done in the class earlier; do not give strain to your brain; take your own time; we shall discuss it tomorrow; etc.* Learners should be made to realise that learning science is not difficult, if they understand the underlying concepts.

• Instead of providing readymade answers to learners' question, the teacher should provide situation or experience so that they can get the answers themselves. You can pass on the question to different groups of learners. Let them enter into a dialogue with one another and then facilitate them to arrive at the answer.

• When you observe that the same question is raised by many learners of a class or one learner asks the same question many times, you need to reconsider the strategies of your teaching-learning. You may say, *sometimes I move from one concept to another concept very fast.*

These types of statements will help the learner to save her face and she will not feel hesitant in asking questions in future. Statements like *listen carefully to what I say; you are not attentive; I have explained it several times,* should be avoided.

Teachers should not insist that all learners in her class must give identical answers to her questions. Instead she should encourage students to ask as many questions as they can, related to the activities going on in the classroom, and also search for the answers on the basis of their own observations and experiences and information including the one they get through the media.

They should be encouraged to express themselves in their own words from their own experiences. Learners may ask questions not only during transaction of a concept but also when involved in any teaching-learning experience.

Creating the habit of listening to learners

Asking and listening are closely tied together in teaching-learning process. You can listen to students by asking questions or presenting an open-ended question or problem or conflicting situation or asking a battery of questions. Listening to students is one of the most powerful tools of teachers in order to

• know what students think about certain scientific phenomena;

• understand why students think that way;

• find if their thinking is consistent with the scientific explanation;

• gauge how logically they think;

• find how they apply their understanding of concepts in explaining a scientific phenomenon or a new situation;

• find if there is a learning gap between their thinking and existing concepts of science; and

• know how do they organise their thoughts about scientific concepts and express themselves.

While listening to your learners, be focused on what the learners say, do not agree or disagree or be judgmental. Let the ideas first flow. You may respond non-verbally occasionally. Your body language should encourage the learners and convey that you are listening.

Creating opportunity of listening to learners

• **Acknowledge the fact that each learner is unique with varied levels of interest and abilities.** Learners come from a diverse social and educational background. Each of the learners may respond differently to the same learning situation. Also each learner is capable of learning, but you need to be aware of her existing ideas to motivate her in learning.

• Take the time to observe and assess the ideas of all learners including those seemingly invisible students who seldom participate in teaching-learning process. Listen to their explanation of scientific concepts. You will be aware of the complex way of thinking that might give you an insight into choosing an appropriate approach to teaching-learning.

Children are curious by nature; observing any novel situation or thing they become impulsive to ask questions. Pin drop silence in the class is not conducive to learning. Science

classroom environment should be conducive for generating curiosity and thinking, so that learners get motivated to talk over the issue, ask questions and enter into discussion and argumentation. Every question of each child should be respected.

There is no hard and fast rule by which you can generate situations for listening. If you ask formal questions, answers to which may be given by 'yes' or 'no' only, you will not get much opportunity to listen to your students. You need to pose open-ended and thought provoking questions that may help learners in interpretating information, predicting consequences, making inferences and thinking critically.

Activities that teacher can provide situations where learners can collect materials, learn and enjoy learning.

- Developing a science corner in the school.
- Opening science club in the school.
- Organising field trips.
- Arranging for bulletin board or wall magazine.
- Maintaining a scrap book.
- Taking up a project.
- Making static and working models.

Encouraging learners to collect materials from local resources

We know that children learn or construct their knowledge on the basis of the experiences they gain through observation and activities they are engaged in outside and inside the school and home. It is reiterated that with proper planning of activities involving learners, a teacher can awaken their interest in learning science. Learners get opportunities to establish link with their previous experiences and for context-based learning by getting involved actively.

You can provide many situations where learners can collect materials, learn and enjoy learning. Some of the activities are as follows.

• Developing a science corner in the school.

• Opening science club in the school.

• Organising field trips.

• Arranging for bulletin board or wall magazine.

• Maintaining a scrapbook.

• Taking up a project.

• Making static and working models.

For developing a science corner in the school, you can encourage learners to collect materials such as coloured stones, metallic wrappers, sheets and wires, spring balance, torch cells, small tumblers and bottles, droppers, syringes without needles, small bulbs used in torches, thread, balloons, sieves, beads and thread, sticks or sipper of cold drinks, ice-cream cups and spoons, straws of different radii and many other things that can be used in making models, doing an experiment or just to study.

Learners may collect different samples of soil, water, rocks, fibre, fabric, toys and materials made using magnets, stamps with pictures of scientists, etc. An exhibition of the materials collected along with proper write-ups can be organised in the school to motivate them.

Learners can also collect some materials when they go out for excursions, field trips or visits to some places. They can use the collected materials in performing activities in science club. To develop the habit of reading, learners can be encouraged to identify and collect information regarding current issues and award winners in science from various sources such as newspapers, magazines, and internet. A sense of wonder and curiosity can be generated when students see pictures given in newspapers and magazines and read about them. This can enhance their learning.

They can express their own ideas and prepare write-ups for maintaining wall magazines and bulletin boards in the school. Some learners may design cartoons or write poems, jokes and skits based on scientific concepts.

The wall magazines or bulletin boards can display theme-based information collected and displayed by learners. The themes could be from history of science, inventions, discoveries, phenomena, current issues such as global warming, floods and droughts, disaster management, volcanoes, deforestation and afforestation and many more depending on the stage and capabilities of the learners.

Learners may also search and collect learning materials for virtual experiments and activities from internet. Emphasis should be given on primary sources of data and use of manipulative materials in teaching–learning of science. Learning situations emerging from some events and their observations may also be used in teaching–learning of science as it happened in the following case.

All the above mentioned activities can generate interest in the learners, motivate them for learning and give them a chance to move out from the school boundaries and collect relevant materials and information from their surroundings.

SUMMARY

In teaching-learning of science, it is important for learners not only to be able to make sense of meanings and data to construct their knowledge, but they also need to be able to consider and critique others ideas.

Therefore, conversation, discussion, argumentation, negotiation, mediation and listening and asking play key roles in exploring the learners. Creating learning environment through various suitably designed activities, giving value to each learner and their ideas, and understanding how they are constructing their knowledge also help the teacher to explore the learners.

Eliciting learners' existing knowledge and understanding, uncovering the ideas coming to their mind and linking those ideas with suitably designed teaching-learning experiences are essential to explore learners. Active involvement of learners in all these processes are necessary to move towards achieving the aims and objectives of learning physical science.

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