

Breaking Barriers: Making Hands-On Science Learning Accessible for Students with Visual Impairment at Middle Stage

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Abstract

In the inclusive classrooms of today, children of mixed abilities sit together. Generally science teaching is done through visual instructions, due to which, it is difficult for visually impaired students to understand concepts of science. In order to understand science better, they need to be given hands on as sighted students. In this paper, it is suggested that the classroom environment needs to be adapted to cater the needs of such students. These students learn by using senses such as touch, hear and smell. The activities usually given in the textbooks of science have to be modified for these children; not only for their safety but also to make them understand the concepts by doing, so that they can pursue a career in science.

Key Words: Visually Impaired, Science Activities, Inclusive Classroom, Classroom Adaptations, Middle Level

One of the fundamental principles “full equity and inclusion as the cornerstone of all educational decisions to ensure that all students are able to thrive in the education system.”

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Introduction and Review of Literature

Inclusion model of schooling is where children irrespective of their abilities or skills need to learn together. Inclusion discards the use of special classroom to separate children with disabilities from children without disabilities. Inclusive education promotes the same curriculum for all the children of that stage. It also encourages that children learn at their own pace and in their own way. This is only possible if our teachers have patience, optimism and generosity to bring out the best from her students. She has to make every student feel important and appreciate their work. Stofflett, 1998 pointed out that the traditional classroom often looks like a one-person show with largely uninvolved learners. Traditional classes are usually dominated by direct and unilateral instruction. The traditional approach followers assume that there is a fixed body of knowledge that the student must come to know. Students are expected to follow the information they are given without questioning the instructor. Even in the activities based subjects, although activities are done in a group but do

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not encourage discussion or exploration of the concepts involved. This tends to overlook the critical thinking and unifying concepts essential to true science literacy and appreciation (Yore, 2001). If learners are provided the opportunity to think and solve the problems on their own then the learning becomes long lasting.

In the school system usually textbooks are considered to be one of the important resources for teaching-learning process. These are produced in large number and can have a large outreach. Textbooks are especially relevant to improve learning outcomes in low income countries with large classroom size. Usually textbooks are the only available resource with the students and are considered as a most powerful tool of the education system. The textbooks are being used by both special and non-special students.

In India, the National Council of Educational Research and Training (NCERT) is a leading body for school education. It is an autonomous body constituted by the Government of India. The main functions of this organisation are: curriculum development; research; teacher training; extension activities; evaluation and consultancy. The National Curriculum Framework-2005 (NCF-2005) developed by NCERT, recommends the pedagogy of science with the focus on hands-on experiences and inquiry based processes (NCERT, 2005a). The feeder paper of NCF, Focus Group Position Paper on Teaching of Science (NCERT, 2005b) discusses about process validity that leads to generation and validation of scientific knowledge, nurture the natural curiosity and creativity of a child. It also advocates that inclusion needs to be implemented in all schools and throughout Indian education system. The participation of all children needs to be ensured in all spheres of their life in and outside the schools. Schools need to become centres that prepare children for life and ensure that all children, especially the differently abled children from marginalized sections, and children in difficult circumstances get the maximum benefit of education. In nut shell, inclusive education refers to an education system that accommodates all children regardless of their physical, intellectual, social, emotional, linguistic or other conditions. For the development of social skills and better social interaction of the students, inclusive education is the need of education system.

National Education Policy also recommends that in all stages of school education, experiential learning will be adopted, including hands-on learning (NEP, 2020).

NCERT develops textbooks in almost all the subjects for classes I to XII. These textbooks are for special and non-special students. In science textbooks emphasis is on learning by doing. It has been observed that the use of traditional methods of teaching science results in the rote learning and lack of understanding of concepts (Koul, A.2014; Koul, A. & Wazalwar, A.K.2014).

If proper resources are not available, then teachers are bound to choose traditional way of teaching. The important feature of activity based teaching is that it is learner centric. It also allows the learner to study according to his / her own ability and skills. Studies have shown that activity based teaching is more effective for the development of higher order skills among students (Khan, M., et al., 2012). It has also been observed that students with disabilities benefit from learning science through the activity-oriented approach (Mastropieri, M. A., & Scruggs, T. E. 1994).

Literature shows that most science teachers have little or no direct experience in teaching disabled students (Stefanich & Norman, 1996). It has also been reported that special education teachers often lack science content and science pedagogy knowledge (McCarthy, 2005). It should be remembered that students with low vision or visually impaired have same range of cognitive level as other students of their class (Kumar,

Ramasamy & Stefanich, 2001), but most of the time during teaching-learning of science the focus is on sighted children. Stefanich and Norman, 1996 reported that visually impaired students could become chemists and Parry, Braizer and Fischbach, 1997 reported that these students can deal with physics course if provided with appropriate student support and faculty. The students with low vision experience difficulty in learning science through traditional methods (Koul, A 2015). In this paper focus is on how visually impaired students can learn science by doing activities as sighted children.

Methodology

Science activities can be performed by visually impaired student like any sighted student. In this paper various science activities have been highlighted which can be adapted for visually impaired students (NCERT, 2006). The facilitator should encourage group activities within and also outside the classroom. All the mentioned materials in the activities will be provided by the facilitator in a tray to make visually impaired students work comfortably.

It is advised that the facilitator may encourage the student to collect the tray and keep it on his/her working table. Facilitator may provide Braille slate to these students in advance to record the observations (Figure 1).



Figure 1: Using Braille slate for recording observations

How to adapt activities for visually impaired students

Some examples are given below:

Example 1:

Observe and understand how seeds germinate

Material required: Dry seeds of green gram or chickpeas (say 20 seeds), piece of cloth, water and steel/plastic container. All the material will be provided in a tray.

Motivate visually impaired students to follow the following steps:

Steps to be followed:

- Collect the tray containing materials from the facilitator and place it on your working table.
- Take some dry chickpeas and feel them by touching (Figure 2). For example: their texture, shape, hardness etc. and note down your observations.



Figure 2: Dry chickpeas

- Take a bowl and spread muslin cloth in the bowl in such a way that it covers the entire inner surface of the bowl.
- Pour water in the bowl and put these chickpeas in it. Touch and feel that seeds are completely dipped in water. Leave it undisturbed overnight.
- Next day, observe the soaked seeds. Check the texture, hardness, size and shape of the seeds, and note down the changes, if any.
- Lift the muslin cloth containing seeds and place it carefully in another bowl.
- Wrap the seeds in muslin cloth and keep them undisturbed for 2 to 5 days. Keep the muslin cloth moist by sprinkling water at regular intervals.
- After 3 to 5 days, feel these chickpeas again by touching (e.g., their texture, shape, hardness etc.) and note down your observations again.
- Can you feel any change in them?
- You may have felt a small structure grown out of the seeds (Figure 3). If yes, your seeds have germinated. If not, keep them aside for one more day.
- Compare your observations before and after germination of seeds.



Figure 3: Germination of chickpeas

Example 2:

Observe the germination of seed into a plant

Material required: Dry seeds of green gram or chickpeas, piece of cloth, water, container, used plastic bottle, soil, tactile ruler. All the material will be provided in a tray.

Encourage visually impaired students to follow the following steps:

Steps to be followed:

- Collect the tray containing materials from the facilitator and place it on your working table.
- Prepare the sprouts as shown in the Example 1.
- Take a used plastic bottle and cut it into two halves (caution: facilitator or partner may help in cutting the bottle). The lower half of the bottle is your container. Make a small hole at its base (Figure 4).



Figure 4: Used plastic bottle cut into two halves

- Place the soil in the lower half of the plastic bottle and moisten the soil by putting water in it.

- Remove a little soil from the surface and place a sprouted seed and cover it with the soil. Similarly, place a few more seeds in the bottle at a little distant from each other.
- Leave it undisturbed for few days. Keep the soil moist always.
- Keep touching the surface of the soil gently every day. After a few days, you can feel some soft material protruding out of the soil.
- Measure its length once a day for a week by using the Braille ruler and document it.

This is how these sprouted seeds will grow into small plants.

Example 3:

Classify materials as hard and soft

Material required: Stone, key, pencil, a piece of brick, sponge, cotton, fresh leaf and candle. All these objects will be provided in a tray.

Caution: The facilitator will make sure that the materials provided to the students will not have any sharp edges.

Steps to be followed:

- Collect the tray containing objects from the facilitator and place it on your working table.
- Take out the objects one by one from the tray and feel it by touching.
- Place the objects on the table and press them hard with your hand and also try to scratch them one by one.
- After pressing feel the change in the objects, if any. The objects which could be pressed and scratched easily are to be placed on left hand side. These are soft materials (Figure 5).
- The objects which are hard to press and cannot be scratched easily are to be placed on right hand side. These are called hard materials (Figure 6).



Figure 5: Easy- to- press object



Figure 6: Hard- to- press object

The facilitator will disclose the name of the soft materials such as sponge, cotton, fresh leaf and candle and hard materials such as stone, key, pencil, a piece of brick once the students are through with the activity.

By performing this activity visually impaired students can classify materials as hard and soft. During group activity facilitator can encourage these students to feel and explore hard and soft materials from their surroundings like sighted students, but make sure that they can explore surroundings always in the presence of their facilitator or partner.

Example 4:

Classify materials as soluble and insoluble in water

Material required: 1gram each of sand, salt, chalk powder, sugar, sawdust will be provided in separate pouches, water in a container, plastic/ steel bowls, spoon, lid of used plastic bottles. All these materials will be provided in a tray.

Caution: The facilitator will make sure that no material will be tasted in this activity.

Steps to be followed:

- Collect the tray containing materials from the facilitator and place it on the table.
- Take plastic/ steel bowl and pour water in it. Use the lid of a plastic bottle to pour water in the bowl. Put water five times in the bowl with the help of plastic lid (Figure 7).



Figure 7: Pouring water using the plastic lid of a bottle

- Pick up one pouch containing material and put it in the bowl containing water.
- Swirl your hand inside the bowl. Try to feel the material present in the bowl (Figure 8). Wash your hands thoroughly.



Figure 8: Material present in water

- Now stir it by using a spoon at least for two minutes i.e. count from 1-60 twice.
- Feel what happened to the material added to water by swirling your hand in the bowl again. You may or may not feel the material. If you do not feel the material, this means material has completely dissolved in the water (Figure 9). If you feel the presence of the material this means material has not dissolved in the water even after stirring (Figure 10).



Figure 9: Material disappeared after stirring

- Repeat the above steps similarly with other materials also.
- Wash hands thoroughly after completing the activity.



Figure 10: Material present in water even after stirring

Materials which will dissolve completely in water such as salt, sugar are called soluble substances and the materials which will not dissolve in water such as sand, chalk powder, saw dust are called insoluble substances. By performing this activity visually impaired students can classify materials as soluble and insoluble in water. The facilitator should disclose the names of the materials once students have classified them as soluble and insoluble materials in water.

Example 5:

Classify materials as sink or float in water

Material required: Small stone / pebble, leaf, key, coin, plastic/ steel bowl, water. All these materials will be provided in a tray.

Caution: Facilitator will make sure that no such material will be given to the students which have sharp edges.

Steps to be followed:

- Collect the tray containing materials from the facilitator and place it on the table.
- Take plastic/ steel bowl and fill it with water. You can swirl your hand inside the bowl and make sure that bowl contains only water.
- Take any object and place it on the surface of water containing in the bowl and wait for one minute i.e. count from 1 to 60.
- Touch the surface of water. If you feel the object still on the surface of water, this means the object floats in the water (Figure 11).
- If you do not feel object on the surface of water, then put your hand at the base of the bowl and find if the object has sunk to the bottom of the bowl (Figure 12).



Figure 11: Object at the surface of water



Figure 12: Object at the base of the container

- Repeat the above steps with other objects also.
- Classify objects that sank and floated in the water and note your observations.
- Wash hands after completing the activity.

The facilitator should communicate the objects that sank in water are stone, key and coin and the object which floated in water is leaf.

Example 6:

Explore and find out!

- The facilitator can provide a fruit to the students and ask them to find out what will happen to the fruit when placed in water before (Figure 13) and after peeling (Figure 14). The facilitator may encourage them to find out the reason behind it while having discussion with their classmates.

In this example, the students can make out that the given fruit is orange due to its smell.



Figure 13: Orange placed in water



Figure 14: Orange placed in water after peeling

- They can also be given a task to find out that what will happen to an egg when it is placed in fresh water and when placed in salted water?

Example 6:

Identify exothermic and endothermic reactions

Exothermic reaction:

Material required: 2 gram calcium oxide (quick lime) in a pouch, plastic container, lid of plastic bottle, water. All these materials will be provided in a tray

Steps to be followed:

Caution: The facilitator will make sure that water is to be added in calcium oxide slowly.

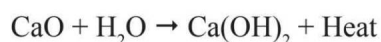
- Collect the tray containing materials from the facilitator and place it on the table.
- Take clean and dry plastic container and empty pouch of calcium oxide in it.
- Take water in a container and feel its temperature by touching. Note down your observations.
- Add this water to the container having calcium oxide carefully at least five times using plastic lid as shown in the above examples.
- Touch its outer wall again (Figure 15). Do you feel any change in the temperature? Do not put your finger or hand inside the container. Also, try to hear the sound produced, if any.



Figure 15: Touching the wall of the container having solution of calcium hydroxide

- You can record the change in temperature before and after adding water to calcium oxide.
- Wash your hands after doing the activity.

The facilitator should explain that calcium oxide reacts vigorously with water to produce slaked lime (calcium hydroxide), releasing a large amount of heat. The reactions in which heat is released along with the formation of products are called exothermic reactions.



Endothermic reaction:

Material required: 2 gram barium hydroxide in a pouch, 1 gram ammonium chloride in another pouch, plastic container, and stirrer. All the material will be provided in a tray

Steps to be followed:

- Collect the tray containing materials from the facilitator.
- Take the pouches containing barium hydroxide, ammonium chloride and feel their temperature by touching. Note down your observations.
- Take plastic container and empty the pouches of barium hydroxide and ammonium chloride one by one in it.
- Stir the mixture using stirrer/spatula at least for two minute i.e. count from 1 to 60 twice (Figure 16).



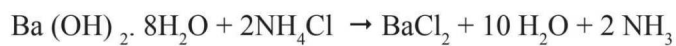
Figure 16: Mixing barium hydroxide and ammonium chloride

- Touch the wall of the container from outside and feel its temperature (Figure 17). Note down your observations before and after the reaction.
- Waft the vapours gently towards your nose and note down your observations again. Never smell the vapours directly.
- Wash your hands after doing the activity.



Figure17: Touching wall of the container having reaction mixture

The facilitator should explain that barium hydroxide reacts with ammonium chloride to produce barium chloride, water and ammonia. The reaction mixture gets cold. The reactions in which energy is absorbed are called endothermic reactions.



The examples discussed above are some exemplar activities. Most of the activities given in the textbooks can be performed by visually impaired students but of course with a few modifications.

To accommodate students with visual impairment in science classrooms, the school administration and teachers need to consider some suggestions to make science teaching joyful for visually impaired students.

Following are the suggestions for teachers and school administration to make learning feasible for visually impaired students.

- Always speak to student directly. Discuss with him/her with patience.
- The textbooks and other supplementary material should be translated in Braille. Provide tactile diagrams, which will help them for better understanding of the concepts.

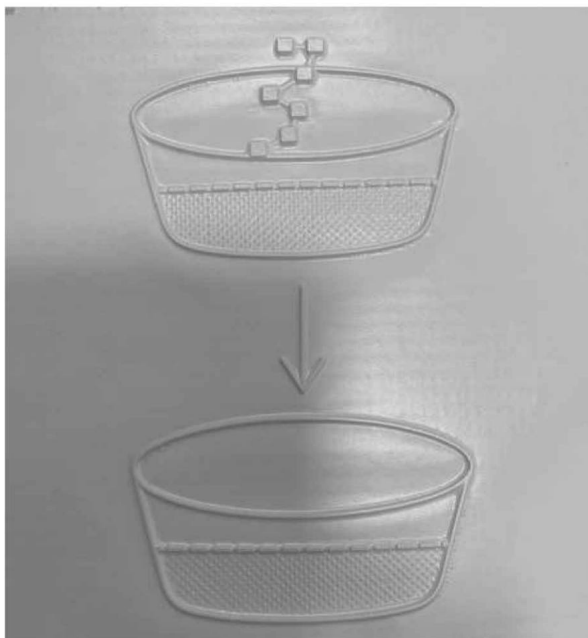


Figure 18: Tactile diagram to show solubility of material in water

- The print material should be of large font size and also while writing on the black board, write bigger font size. This will be useful for low vision students.
- Try to audiotape lectures so that these students can hear them after school hours at their own pace, if by chance could not follow the lecture in the classroom.
- If possible provide a partner who will help him / her during activities. Partner should be such who is willing to work patiently with such students.
- Use real material/objects from the surroundings, so that they can feel them by touching and smelling. Remember; never allow them to smell any chemical or gas directly. Always ask them to waft the vapours towards their nose. They will gain self- confidence by exploring surroundings but of course under the guidance of facilitator or partner.
- Always use three-dimensional (3D) models for small objects.

- While working in activity room, these students must be oriented with emergency exit, chemicals, glass apparatus, equipments, heating device, placement of sink, water taps etc. As far as possible, use unbreakable apparatus instead of glass.
- Always use Braille labels on chemicals, reagents, glassware, equipments etc.
- Encourage visually impaired to take the help of a sighted buddy or facilitator when an experiment involves burning of anything. The most common heating device which can be used at this stage is spirit lamp. For safety measures particularly for low vision the use of tripod stand and wire gauze is recommended. The use of tripod stand around the spirit lamp provides extra protection around the spirit lamp and wire gauze identifies the position of the flame because it glows brightly. Long handled match sticks should be used to keep the student's hand away from the flame. Always provide a bowl containing water in the tray while working with heating device. If student by mistake touches any hot container can dip his/her fingers in the bowl of water as a first aid.
- Provide computers and Braille measuring devices.
- Ensure that they must wash their hands after completing the activity and never taste any material unless asked for.
- Encourage them to work in group activities. Make sure that each task should be followed by discussion. Ensure that these students share their observations and experiences.
- Make sure that doors of classrooms and activity room are either fully open or fully shut. Doors should not be left half open.

Conclusion

As a researcher, we feel that it is necessary to modify the activities to make classrooms inclusive in nature. Other resource materials such as tactile charts, tactile graphs, tactile figures, 3 D models etc., may be used more to make visually impaired students understand science better. Group discussions should be encouraged while working. Every student in the class should be given chance to address his/ her own ideas. This will facilitate learning in inclusive classrooms.

It is hoped that the methodology described in this paper will motivate science teachers to adapt the activities given in science textbooks and encourage visually impaired students to learn science not only by lecture method but by hands-on. Blindness is just a physical disability and not an intellectual one. Ultimately, the message is *"One does not need to be sighted to understand and pursue a career in Science."*

"Alone we can do so little; together we can do so much"

Helen Keller

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