
HOMI BHABHA CENTRE FOR SCIENCE EDUCATION (TIFR)

Teacher Professional Development
Module Development on Science Through Investigation
2,3,4 March 2015
KV-ZIET, Mumbai

Workshop Report**Introduction**

Teacher Education is one of the core areas at the HBCSE. As part of the Teacher Professional Development program, the Centre conducts workshops for teachers [1]. The workshop for KV-ZIET is one among the other category of events planned by HBCSE. The KV-ZIET approached HBCSE to conduct workshops on science teaching for principals and school teachers. From the list of academic areas mentioned in the KV-ZIET proposal, the theme on “Innovations in Education” was selected for the workshop for the in-service science teachers at the middle school level. Based on the theme, HBCSE prepared a concept note that mentioned the details of the objectives, framework for the module, tentative schedule, etc. which was sent to KV-ZIET. Later a preliminary preparation note was prepared, to be sent to the participants before the workshop. The concept note and preliminary note are available on the teacher education website [2]. The workshop comprised of about 25 participants. It was held on 2,3,4 March 2015 at the KV-ZIET Mumbai.

Objectives of the workshop

- The workshop was aimed towards developing modules on teaching and learning science through investigation at the middle school level.
- The module development and the activities were based on the inquiry based science learning approach.
- The module were developed primarily by the principals and senior teachers of the KVS in collaboration with the resource persons of HBCSE.

Learning Objectives of the Workshop

- Teaching hands-on science activities using the inquiry based science learning

approach

- Teaching and learning of scientific skills
- Conducting an inquiry based science investigation using a suitable model of inquiry learning
- Developing worksheets, handouts for teachers and students simultaneously
- Assessment of the activity

Science Through Investigation

- In the teacher education programs, one of the main focus areas has been on science through investigation [3].
- Scientific investigation is about using a systematic approach for learning science. The rationale for learning science through investigation is to develop scientific literacy among students. Science through investigation involves active learning, vis-a-vis doing science by following a recipe (heuristics). The approach is constructivist and students express their ideas about scientific processes and test them by performing investigations. This approach may indicate misconceptions that students have and provide a possibility that there may be a modifications of the misconceptions during the process.
- The aim is to develop scientific skills such as formulating hypothesis, designing experiments, conducting observations, analyzing data, drawing conclusions and presenting the results.

Preliminary planning by the principals and senior teachers

- List the science activities from middle school textbook, grades VI-VIII, which are important for students' understanding of the concepts.
- List students' prior knowledge, their questions, difficulties, misconceptions regarding those activities
- Possible methods for teaching these activities through investigations

Format of the workshop

- The entire workshop was in collaborative mode with groups of 3-4 members (principals and senior teachers) in each group. HBCSE resource persons facilitated the module preparation in terms of preliminary level materials,

handouts, worksheets.

- Each group listed questions that they would like to investigate. The questions were from the middle school level textbook or even from daily life situation.
- Further, activities were designed to investigate their question. While doing so, the group worked on preparing the module comprising of handouts, worksheets simultaneously.

Schedule of the workshop

Time	Day 1	Day 2	Day 3
09:00 – 09:30	Introduction	Feedback sharing and discussion	Feedback sharing and discussion
09:30 – 11:00	Talk – Nature of Science	Talk – Assessment	Talk – Inquiry Based Science
11:00 – 11:30	Tea break	Tea break	Tea break
11:30 – 13:00	Framing of investigatory questions, browsing textbooks, forming groups, using of models of inquiry based science learning	Conducting the hands-on activity with worksheet	Reflection on the activity and preparing the resource material, module
13:00 – 14:00	Lunch	Lunch	Lunch
14:00 – 15:30	Designing of the activity, requirement of materials, choosing the model	Conducting the hands-on activity with worksheet	Sharing and discussing about the module among peers
15:30 – 16:00	Tea break	Tea break	Tea break
16:00 – 17:30	Preparing worksheets related to investigatory question based on the model selected	Reflection on the activity and preparing the resource material, module	Summary and planning of follow-up workshop

Day 1: Talk and science through investigation sessions:

- Talk on – Nature of Science
- Science through Investigation sessions:
 - Generating questions
 - Planning and designing of the activities
 - Beginning to create worksheets for the activities

Talk – Nature of Science:

The talk focused on the nature of science in teaching and learning. Each participants also worked on several activities that helped the participants to connect to the nature of science. The details of the talk [4] are available on website.

Science through investigation session:

The scope of the session was explained to the participants. They were asked to think and generate questions for investigation. To enable this, worksheet-1 was provided as below:

Worksheet-1 for Preliminary Activity

1. Observe the nature around you. Look at the sky, trees, soil, leaves, living beings. Does anything raise your curiosity. Frame a question. (You may frame at least 4-5 questions).

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2. Discuss and think of a way to investigate your question. Focus on any one question.

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3. Design your investigation:

- Formulate some hypotheses to answer your question.

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- State any prior knowledge and experiences that you may have about the topic.

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4. Make a list of things, materials that you may need for the investigation. The materials could be simple, commonly and easily available things.

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Using this worksheet, the participants generated several questions as individuals and among groups. Seven groups were formed each comprising of 3-4 members. In the first part, the participants discussed points 1, & 2.

The following is a list of all the questions from the groups:

Group I

1. Why leaves of all the plants are not equally green in colour?
2. The movement of the branches is always in the downward direction during the blowing of the wind?
3. The flapping of the birds' feather to balance in the air is the same for all birds.
4. Why we feel happy when we are with nature?
5. Why the sky is blue?
6. Why we do not see stars and moon during the day time?
7. Why different plants bear different coloured flowers?
8. Why the leaves are of different shapes?
9. Why squirrel moves faster than a garden lizard?
10. How does heat transfer in liquids and solid and absorption of heat depending on specific heat?

Group II

1. Where is the ant hole?
2. How pigeons communicate with each other?
3. How many types of insects live in the soil?
4. How deep insects are living in the soil?
5. Why clouds are shaded in white and grey?
6. How far are clouds from us?
7. How deep the roots of different plants are?
8. How old is a tree?
9. How pebbles are formed?
10. Why do different plants have got leaves of different shapes and sizes?
11. Why some clouds appear white while some black?
12. Why is the bark of trees brown?
13. What keep birds (kites) flying when they do not flap their wings while flying?
14. Why do we see land covered with grass/weeds in most of the places?
15. Why do some leaves have parallel veins and some a network of veins?
16. How can you clarify the plants around you depending on their age?
17. Which organisms do you see in the soil?
18. What are the uses of plants that you see around?

19. Why some leaves are brightly coloured?
20. What ingredients do you observe in the soil?
21. Comparing cleaning capacity of different detergents on various stains.

Group III

1. How will you prove that O₂ is given out during photosynthesis?
2. What is the effect of detergent on release of oxygen on aquatic plants?
3. Why sky appears blue? Sunset and sunrise time red., How can we carry out the investigation experimentally?
4. How do you differentiate different type of flu like bird flu, swine flu, chikungunia. What are the symptoms of different types of flu?
5. Why different types of plants have different types of leaves?
6. Why few leaves show different colours?
7. Why we can breathe fresh air in open space?
8. Why rooms are fitted with AC?
9. Why do we feel that as if we can touch the clouds?
10. Why do we feel thirstier in summer?
11. How do we know that sky is blue, leaves are green?
12. Why do leaves of different plants different shapes?
13. Why do height of different plants different?
14. Why do sky appear blue during day time?
15. Soil of different places has different textures. Why?
16. Length of string of simple pendulum. When changed, no pf oscillations are also changed. Why?

Group IV

1. Why building cracks more during rainy season?
2. Why do ants move continuously?
3. Why the eagles fly high up and sparrows down, Ostrich does not fly?
4. Why stones have different colour?
5. Ashoka tree grows straight whereas other trees don't. They do not bear flower, fruit, and seeds?
6. Urban people suffer more from malarial diseases than rural people in spite of all scientific facilities?
7. Why is India becoming capital of swine flu?
8. How will you test the presence of different ingredients like carbohydrate, protein, fat in different foods and plan your diet?

Group V

1. How do plants with different colors other than green perform photosynthesis?
2. Why do some plants have entire leaf and some have dissected leaves though they are of same size?
3. How do animals communicate?

4. Why do flowers have different colors?
5. Do plants have ability to feel pain?
6. Why leaves of different plants are have different sizes?
7. Why are small sized birds not able to glide at great heights?
8. Why are some plants weak and how do they creep on ground?
9. It is said that humans are but communicators? Are plants and animals not communicating? How?
10. Does colored leaves(yellow/purple) also have chlorophyll? If yes, why they don't appear green?
11. How do birds fly in spite of gravitational force?
12. Why some objects are conductors and others are insulators?
13. How unfertilized eggs of honeybee develop into male bees?
14. How plants know the direction of sunlight?
15. Why is there repulsion between like charges and attraction between unlike charges?

Group VI

1. Is money plant a parasite? Leaves grow larger when they grow on a tree.
2. Ants move in a line following a leader. Why?
3. Why are storage tanks mostly black?
4. Some plants have different coloured leaves when kept indoors and outdoors. Why?
5. Why is thirst more in a diabetic person?
6. How do indoor plants prepare food?
7. Why do potted plants die, if watered too much, though rainy season plants are not dying due to too much water?
8. How do plants with coloured leaves prepare food?
9. How are clouds formed?
10. Why does a pigeon spread tail feathers while flying?
11. Why are squirrels so agile?
12. Why do leaves become yellow?

Group VII

1. From where the small plants and plantlets come from?
2. How did they develop?
3. How does water percolate in the soil?
4. Why does shade of plant cool and sunlight hot and warm?
5. Why different plants have different shape of leaves and leaf patterns?
6. Why water seeps in soil?
7. Why leaves have green colour?
8. Why leaves have different shapes?
9. Why some plants have small height?
10. How seeds get dispersed?
 - a. Growing weeds along with main plants
 - b. Dispersed seeds
 - c. Rate of percolate - in different soil
 - d. How the colour of leaves changes?

11. Which is denser - water or ice?
12. Why ice floats on water?
13. How do marine organism survive below the frozen surface of water?
14. The people at polar regions make houses of ice. Why it is warm inside the ice house?
15. Does the size of particles in soil effect the water percolation?

Based on the groups questions, a common discussion was held, to discuss which of the question can be selected on the basis of scientific investigation. Those questions that were fact-based were weeded out. From the questions, each group selected their investigatory question.

Now, using the worksheet-1, the participants discussed on points 3, & 4. On the selected question, each group worked on making predictions, designing activities, listing the materials required, connecting the question with the school textbook, etc. As part of our sessions on science through investigation in workshops, each group was assigned a mentor/facilitator from the resource persons of HBCSE.

The following table lists the selected questions, names of participants and mentors, and the reference to class and chapters that the question is connected:

Groups	Investigatory Questions	Members [Mentors]	Class	Chapter
G - 1	Investigation of rate of absorption of heat by different materials in solids, liquids and also study the different mode of transfer of heat	Archana, Veena, Kalpana, Reddy [Vinod Sonawane]	Std. VII	Ch. 4: Heat
G - 2	To compare the cleansing action of detergents on greasy and non-greasy stains on a piece of cotton cloth	Neelima, Meghna, Naina [Meena Kharatmal]	Std. X	Ch. 4: Carbon and carbon compounds
G - 3	To compare and calculate the rate of transpiration in five different plants with	Arlene, Rita, Sandhya, Veronica [Narendra]	Std. VI Std. VII Std. IX Std. X	Ch. 7: Plants Ch. 1: Nutrition Ch. 6: Tissues Ch. 6: Life

	same size of leaves	Deshmukh]		processes
G - 4	To find the nutrients present in different food materials	Snehal, Manjula, Anita [Meena Kharatmal]	Std. VI	Ch. 1: Food: Where does it come from? Ch. 2: Components of food
G - 5	Black colored objects do not reflect light	Dipti, Asha, Tripat [Vinod Sonawane]	Std. VI Std. VII	Ch. 11: Light Ch. 6: Heat & Light
G - 6	How do plants with colored leaves prepare food	Sugandhi, Rama, Mercy [Narendra Deshmukh]	Std. VII	Ch. 1: Nutrients in plants
G - 7	Does the size of particles in soil affect the water percolation and how	Sinha, Bisht, More, Dhaktode, Lakmaram, [Riyazuddin Shaikh]	Std. VII	Ch. 9: Soil

Towards the later part of the day-1, a session on generating worksheets was conducted. To enable this some driving points were provided in the form of worksheet-2 as below:

Worksheet-2: Driving points for generating worksheets for the investigatory questions

- *List your investigation/question.*
- *State what is the prediction related to the investigatory question.*
- *State any prior knowledge/experience that you may have related to your investigatory question.*
- *List some sub-questions for your investigatory question.*
- *List the kinds of questions students may have in relation to your investigatory question.*
- *Draw a diagram/ chart/ concept map for brainstorming your ideas.*
- *Design an experiment that help find a solution to your investigatory question.*
- *List the variables that you would be testing during the experiment.*
- *Record and list the observations in the form of a table.*

- *Analyze the findings.*
- *Draw some conclusion(s).*
- *State whether the conclusion(s) are similar or different from your earlier prediction, justify.*
- *Think of any more ways to find a solution to your question.*
- *Can you think of any culture-specific beliefs or practices relevant to your question.*
- *Share and present your work.*
- *Let us see and discuss some templates for the worksheets.*

Day 2: Talk and science through investigation sessions:

- Talk on – Assessment
- Science through Investigation sessions:
 - Generating worksheets for the investigation
 - Preparing module for the investigatory question
 - Preparing posters on the investigatory question

Talk – Assessment:

The talk provided a glimpse of some methods that can be used by the teachers in the classroom for assessment. One of the ways was asking questions. The session also had some activities incorporated. The details of the talk [5] are available on the website.

Science through investigation session:

The participants continued with generating worksheets for their investigatory questions using the driving points provided in worksheet-2. Some of the samples of teachers' worksheets [6] are available on the website.

A session on understanding what is a module, how to create modules based on the activities was conducted. A sample of the module on microscope [7] was presented and discussed.

Some clarification was required on the point on whether the module is for students or teachers. It was discussed that worksheets are for students, while the modules can be developed for the teachers. The teachers continued on creating worksheets and modules.

As part of the workshop, towards the end, the participants create posters of their tasks, investigation, worksheets, modules, etc. This is followed by poster presentation by each group for discussion.

We intended to keep the format of the module flexible. However, each module would comprise of *worksheets, handouts, relevant TLMs*

- Worksheets to be used for guided inquiry during the activity
- Handouts are planned as an outcome of the activity; with information, answers to some queries, exploratory questions, etc.
- The use of *text, diagrams, charts, concept maps, photos*, etc. in the module is encouraged
- The text can be a narrative or a dialogue also

Day 3: Talk and science through investigation sessions:

- Talk on – Inquiry based science learning
- Science through Investigation sessions:
 - Preparing modules
 - Preparing posters on investigatory questions
 - Poster presentation sessions
 - Submission of worksheets, modules

Talk – Inquiry based science learning:

The talk focused on the approach and development of the Small Science Curriculum that is based on inquiry based science learning. The details of the talk [8] are available on the website. Further two relevant readings were suggested – C V Raman's talk on “Why the sky is blue?”, K P Madhu's article on “Why Ramu does not ask questions?”

Science through investigation sessions:

Since the participants required clarification on how to develop modules, a sample of a module on electricity [9] was presented and discussed. The participants also continued

preparing their group posters.

Towards the end of the workshop, each group and its members presented their investigation in the form of poster presentation. The posters [10] are available on the website.

HBCSE has developed an online platform for discussion related to teacher professional development workshops. A demonstration of using this platform [11] was conducted and the participants were registered.

Outcomes from the workshop

- Generating list of questions, selecting investigatory question, planning and designing the activity, conducting the activity and presenting the investigation
- Developing worksheets for the investigation
- Draft version of modules on the basis of investigation

It is envisaged that these modules can be tested with the hands-on activities by the teachers along with students later in their classroom. This will help in refining the module based on the actual experience. Through follow-up workshops, there can be a development of a complete module on inquiry based science learning for middle school level.

Resource Persons: Jayashree Ramadas, Sugra Chunawala, Karen Haydock, Meena Kharatmal, Narendra Deshmukh, Vinod Sonawane, Riyazuddin Shaikh

Photos of the workshop (courtesy KV-ZIET):

Day-1: 2 March 2015: https://onedrive.live.com/?cid=4DA2BE52ADA33194&id=4da2be52ada33194%2122160&authkey=%21ACjoJAjYQT_QAw8

Day-2: 3 March 2015: https://onedrive.live.com/?cid=4DA2BE52ADA33194&id=4da2be52ada33194%2122161&authkey=%21ACjoJAjYQT_QAw8

Day-3: 4 March 2015: https://onedrive.live.com/?cid=4DA2BE52ADA33194&id=4da2be52ada33194%2122168&authkey=%21ACjoJAjYQT_QAw8

Links:

- [1] HBCSE teacher education website: <http://teacher-ed.hbcse.tifr.res.in/project>
Annual program of the teacher professional development workshops:
<http://teacher-ed.hbcse.tifr.res.in/project/tpd-program>
- [2] Workshop on Module Development for KV-ZIET:
<http://teacher-ed.hbcse.tifr.res.in/workshops/workshop-on-module-development-for-kv-ziet>
- [3] Science Through Investigation approach at the TPD workshops:
<http://teacher-ed.hbcse.tifr.res.in/documents/science-through-investigation-for-teacher-professional-development>
- [4] Talk – Nature of Science: <https://tpd.hbcse.tifr.res.in/mod/resource/view.php?id=91>
- [5] Talk – Assessment: <https://tpd.hbcse.tifr.res.in/mod/resource/view.php?id=96>
- [6] Sample worksheets generated by teachers can be viewed by visiting the online platform: <https://tpd.hbcse.tifr.res.in/course/view.php?id=7>
- [7] Sample module – Microscope: <https://tpd.hbcse.tifr.res.in/mod/resource/view.php?id=76>
- [8] Talk – Inquiry based science learning:
<https://tpd.hbcse.tifr.res.in/mod/resource/view.php?id=94>
- [9] Sample module – Electricity: <https://tpd.hbcse.tifr.res.in/mod/resource/view.php?id=90>
- [10] Posters created on the investigation by the participants: https://onedrive.live.com/?cid=4DA2BE52ADA33194&id=4da2be52ada33194%2122168&authkey=%21ACjoJAjYQT_QAw8
- [11] Online platform: <https://tpd.hbcse.tifr.res.in/>

Meena Kharatmal, March 2015