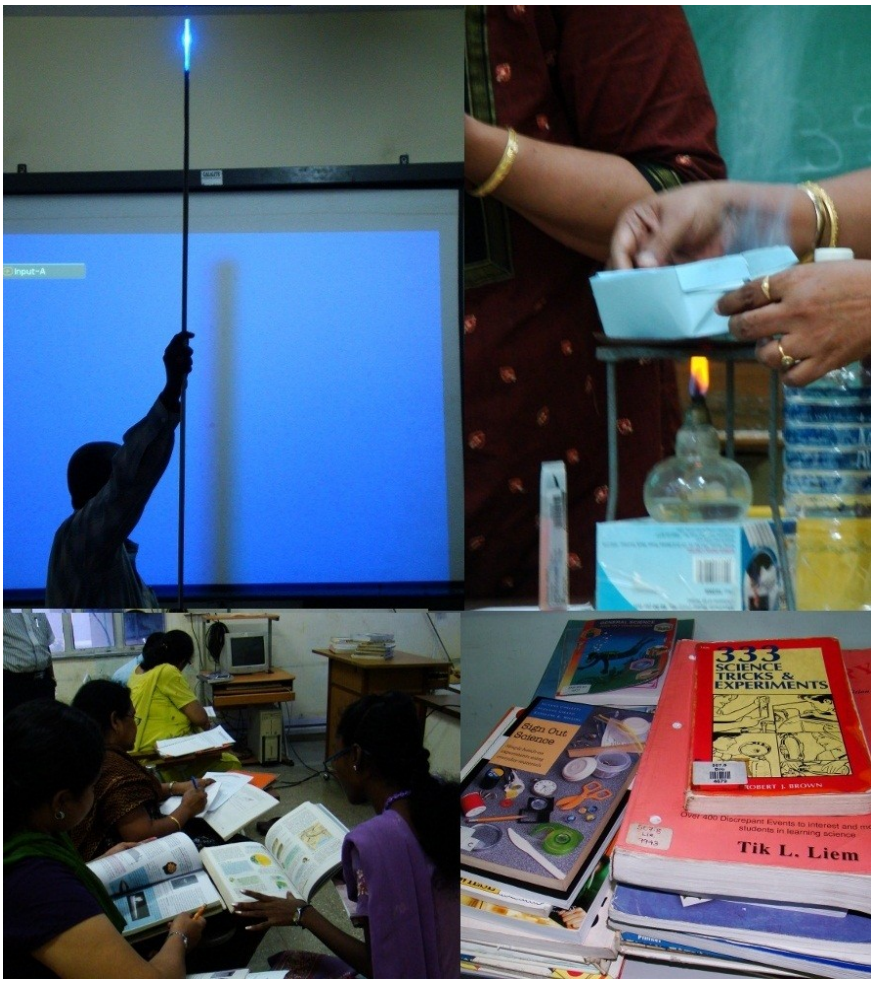
Towards Science Education for Diversity:

A Teacher Researcher Collaborative Workshop

(4 to 6 December, 2011)



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Workshop Background

Currently, the Homi Bhabha Centre for Science Education is working on a research study titled Science Education for Diversity (SED), funded by the European Commission, FP7, which is being conducted across six countries, namely UK, India, Lebanon, Malaysia, the Netherlands, and Turkey. The aim is to understand the dynamic and complex relationships between cultural diversity, gender and science education which affect the take up of science in students' further education and career.

The project is divided into 6 work packages and currently WP5 is in progress. The WP5 consists if a framework where initially questionnaires were administered to the teachers. This was followed by classroom observations of their science classes. An intervention, in the form of a workshop was planned where the research team will work in close collaboration with the teachers to develop lesson plans which address diversity in the classrooms.

Thus, a workshop- *Towards Science Education for Diversity: A Teacher Researcher Collaborative Workshop',* was organized for primary and secondary school teachers in the first week of December 2011 (4^{th} to 6^{th} December). The aim of this workshop was to sensitize teachers to the issues that arise in classroom due to diversity. Also, professional development of science teachers can be enriched when it is informed by research pertaining to aspects like socio-cultural diversity, linguistic and religious diversity and gender issues.

Workshop Details

The total number of participating teachers for this workshop were seven and they were from Atomic Energy Central School-3 (Anushaktinagar), Atomic Energy Central School- 6 (Anushaktinagar) and Amulakh Amichand Vidyalaya (Wadala). The number of participants were kept less mainly to increase the amount of interactions and one-on-one discussions between the research team and the teachers. The duration of the 3-day workshop was from 10:30am to 4:00pm. The teachers involved in this workshop had experience ranging from a few years to over two decades. The HBCSE team was led by Dr. Sugra Chunawala and Dr. Chitra Natarajan. The other members of HBCSE involved in the workshop were Dr. Pooja Birwatkar, Bandana Thakur, Damayanti Karade, Geeta Battin and Adithi Muralidhar.

Photo 1: Dr. Pooja Birwatkar's session on *Approaches to address diversity*

Workshop Sessions

At the beginning, an ice-breaking session was initiated where all the participants and members of the HBCSE team gave a brief introduction about themselves. After the participants and HBCSE members became familiarized with each other, the next session began wherein structured interviews were carried out with the participating teachers. Each of the interviews which were one on one were conducted simultaneously and independently. The interview sessions lasted from 45 minutes to an hour. This was followed by a presentation that Dr. Sugra Chunawala gave which briefed the participants about various aspects of diversity in the Indian context. She also introduced the 'SED' project and its aims to them. The entire session was interactive where teachers shared their personal experiences with respect to facing diversity issues in their class.

Dr. Sugra Chunawala explained about India's vast geography and the divisions that exist here in terms of caste, regions, languages, religions, socio-economic classes, habitation and gender. It was bought to notice that the Indian society is stratified on socio-economic lines on the basis of castes, where historically castes involve occupational specialisation and are interdependent with there being some correlation between caste hierarchy and economic prosperity. India which also a linguistically diverse country has over 100 non-scheduled languages listed in the Constitution. Four of the world's religions have originated in India, namely Hinduism, Jainism, Buddhism, and Sikhism. Islam and Christianity are two of the other major religions followed widely while Zoroastrianism and Judaism have existed in India since ancient times. According to the 2001 Census, the sex ratio in India is 933, that is there are only 933 females per thousand males. The ratio is better in the rural areas (946) and worse (900) in urban areas (GOI, 2001). The provisional report of the 2011 Census reports that the national sex-ratio has dropped further to 914, which is an all time low since Independence in 1947. In India, poverty, social inequalities and gender relations intersect in different ways in different regions (Ramachandran, 2009). Thus using these markers of diversity (Ethnicity, Language, Religion, Habitat and Gender), classroom situations were discussed with the participants and they were given ideas to tackle and address diversity.

The next session was taken over by Dr. Chitra Natarajan. She emphasised the myths of science, and importance of history of science and Nature of Science. Before the session started, she had the teachers fill out a questionnaire based on 'myths of science'. It included questions like- *Science is a system of beliefs*, *Scientists are totally objective in their work*, *Men are better in scientific thinking*

than women etc. Once the teachers filled the questionnaire giving true or false for the statements they believed in, a discussion on the same was started. Responses of the teachers were discussed and analysed.

To emphasis on *Nature of Science*, an activity was carried out which involved a box consisting of four distinct threads (marked by coloured beads) coming out from it. The aim of this activity was to identify the nature of linkage between the threads. The teachers could handle the boxes independently, shake, pull the strings, experiment with it, but were not allowed to open the sealed boxes. They pulled one of the strings and observed the movements of the other 3 strings and hypothesised the links between the strings. The participants came up with five different hypothesises. The idea behind this was to make the teachers aware that science meant tentativeness, being observant, experimenting and methodical. This session ended with the groups coming to their tentative conclusion and they presented the same giving reasons for their conclusion.

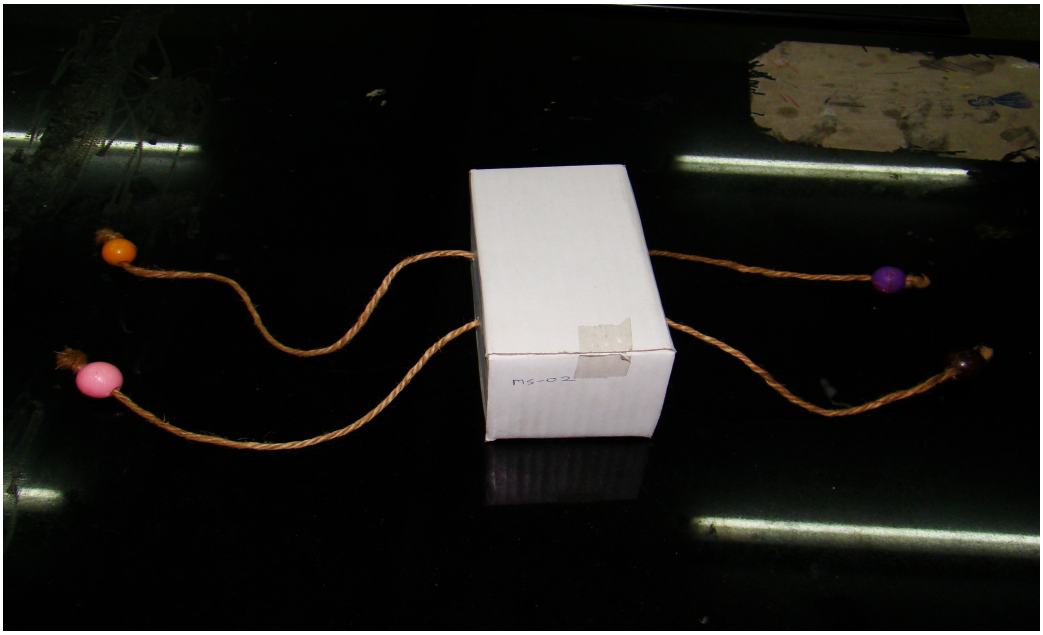

Photo 2: The mystery box that was handed over to the participating teachers to explain *'Nature of Science*'

The next session was by Dr. Pooja Birwatkar who spoke about *'Approaches to address diversity'* & '*Guided Collaborative Critical Reflection on Action as a way of implementing the SED approach'* where she touched upon aspects like dialogic teaching, argumentation. Dialogic teaching is a method of teaching which harnesses the power of talk to stimulate and extend the students' thinking

and advance their learning and understanding. It is different from the usual question-answer and listen-tell routines of traditional methods of teaching.

On Day 2, specific case studies and examples were discussed with the teachers with a help of a presentation on '*Dialogic Teaching & Argumentation'* by Adithi Muralidhar. She presented a short example on the topic "*Whether our solar system has eight or nine planets. Is Pluto a Planet?*" The presentation showcased a dialogic method adopted by the teacher in a class of inquisitive students. During the argumentation, one of the teachers mentioned about the confusion and conflict that arise in students between astrology and astronomy. Astrologers believe that there are nine planets and they forecast / make predictions on the basis of these planets. But science on the other hand says that there are eight planets in our solar system. Through this discussion it was brought out that the nature of science- *Science is always tentative.* Whatever is true today may not be so tomorrow.

The teachers were asked to reflect upon similar situations that they may have experienced in their classrooms and how they could improve the discussions they had with students. A handout on HIV-AIDS was given to the teachers which served as a case study of an 'argumentation' dialogue in progress. The debate in focus was how HIV does not spread through mosquitoes as in the case of malaria. The small script was enacted (role-play) by two of the teachers. This was followed by general discussion on the techniques of argumentation. Dr. Chunawala and Dr. Natarajan answered the questions or at times provided suggestions to the teachers on the issues raised.

The next session emphasised the importance of knowing the history of science. It was argued that history of science is integral to a teachers' main aims whilst teaching. (Monk & Osbourne, 1996). Gallagher (1992) suggests that if science teachers consider the history of science for inclusion whilst teaching, it is generally in terms of humanizing science, the purpose of which is fostering positive attitudes toward science, rather than for the purpose of understanding the nature of science.

In order to get familiarized with using history of science in classrooms, two vignettes prepared by Bandana Thakur (one on Louis Pasteur and the other on heliocentricism) were presented to the teachers who then discussed their own personal experiences of using history of science examples while they taught. The participants and research team then narrowed down on characteristics of scientist, using examples from the vignette on Louis Pasteur.

The next session required the teachers to work in dyads for two sample activities prepared by the HBCSE team which incorporated all techniques that were talked about during the past sessions. Finally, a real time problem was given to the teachers wherein they were asked to design an activity/ lesson plan (using the science syllabus of the school) that would take into consideration all the points and issues discussed during the previous sessions. The first phase required them to list the topics they would like to plan the lesson for. Dr. Sugra Chunawala once again briefed them on the points they had to consider whilst making the lesson plan. A topic and the activity based on it was to be chosen which would have the following features: *Relevance to real life, situational, controversial (capable of causing conflicts of ideologies), should consider the available resources, should be a topic that is considered acceptable by parents and school, should elicit high order questions among students*. The activity should be such that it should be relevant to daily life, explain the nature of science, encourage dialogic teaching and bring about argumentation. Once the teachers decided on their topic, they were given some time to work on the plan and list out the requirements that they may require to implement their activity.

Day 3 began with brainstorming within each group on how they would present and discuss their topic. The first group consisting of four teachers chose the topic: *Role of water in fire-fighting and lowering ignition temperature.* They had designed this activity for VIII standard students. The team had prepared a power-point presentation which they presented. Mid-way through the presentation, the team carried out an activity where they used a tripod and spirit lamp to burn a paper cup. Another cup with same dimensions was filled with water and kept on the stand.

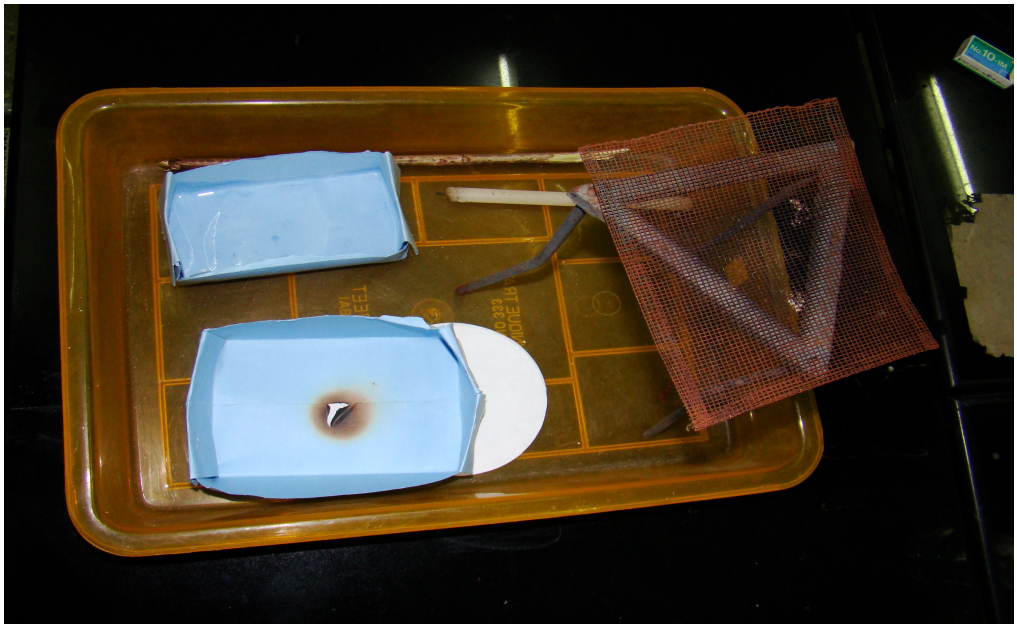

Photo 3: The experiment carried out by the first team of participating teachers

At this point, several questions came up from the other teachers. This activity provided scope for inquiry, dialogue and discussions. At this point, Dr. Chitra Natarajan acknowledged the importance of a teacher's observations. She stressed that a teacher needs to keep her/his ears open to the students' opinions and answers. Otherwise she/he might take ideas from only those students which are in consonance with teacher's personal views. The teachers presenting requested members of the audience to come and observe the paper cup filled with water placed on the spirit lamp. They asked them to deduce what could have happened and why the cup did not catch fire.

In response to a question, 'When water gets heated, it breaks down to hydrogen and oxygen, is it so?' (from audience), one of the teachers presenting argued that, if she were to light a match above the paper cup with hot water, the 'gas' should catch fire, since hydrogen is a combustible gas and oxygen is a supporter of combustion. On lighting a match, it didn't cause any fire/small explosion.

It is known that students too are inquisitive and ask many questions when there are demonstrations and experiments happening in the class. The teacher should be able to encourage these students to come out with their questions and should be able to handle their doubts with simple yet thought provoking explanations.

The second group consisted of two teachers who chose the topic - Reproduction in Animals. The specific topic was: Sex determination in humans. The activity was designed for Class VIII students. The presentation started out with an enactment of a classroom situation, where a student refuses to accept that the father is responsible for the sex of the child. In order to understand this better, the presenter writes the numbers 2 on three chits and the number 3 on one chit. He then called upon 2 individuals from the audience, one man and one woman.

The presenter then handed over 2 chits to the woman, which contained the numbers 2 and 2. The man was handed two chits which had the numbers 2 and 3. The presenter then asked them to participate together to form the number 4. The woman handed her '2' card while the man also handed over the '2' card. The presenter then asked for a sum of 5 to happen. The woman again handed out the 2 card while the man handed out the 3 card, in order to make the sum 5. The presenter then co-related this activity to their topic saying that – Man has 2 and 3 (X and Y chromosome) and woman has 2 and 2 (X and X chromosome). So only the man can give different chits (chromosome). In order to get a girl (4) and in order to get boy (5); it is the father who can facilitate this by giving the 2 (X chromosome) or the 3 card (Y chromosome). Hence he determines

the sex of the child. The presentation was met with a rush of arguments and view points. Dr. Sugra Chunawala pointed out the following- I) By assigning the number 2 to female and 3 to a male, are you (the presenters) saying that a male has more chromosomes/genes? ii) Numbers give an idea of hierarchy, by denoting the girl with a 2, it seems that she is inferior to a boy who is 3, which is a higher number. Another view point expressed was iii) When one says the man 'gives' the X/ Y chromosome, it indicates that he has a choice which he does not in reality.

In response to all these points, the presenters agreed that use of numbers may lead to a wrong interpretation of men having more chromosomes or genes than a woman. They also agreed that numbers may indicate superiority. Discussion further tried to show how simple statements can be misinterpreted in many ways and thus teachers have to be very careful when they teach science and should consider the social aspects as well and make sure there is no bias when teaching science.

The final presentation was by a pair of two male teachers and the topic chosen by them was Light (Shadows). It was designed for standard VI students. The presenters began with switching off the lights in the room. A transparent plastic/ translucent sheet and plate were used, in order to see if a beam of light passes through them. Based on the observation, the presenter went on to explain the different types of materials. The presenter then placed a metal rod near and away from the LCD light (which was acting as the source of light) and asked the audience to tell him what they observed. Dr. Chitra Natarajan pointed out that the teachers have to be open to questions and should not give the answers right away to the students. They should try and raise questions to the questions asked by the students.

Dr. Pooja Birwatkar summarised the events of the three days and had a short discussion about the course of future plan. She mentioned that, this three day workshop was aimed at sensitizing and orienting teachers towards a set of principles that they could use in designing lesson plans/ educational activities to address the issues of diversity in classroom. All the participants were given a diary/notebook and were asked to keep notes on their future class and lesson plans and were also requested to keep a log on the happenings of their classroom sessions. All new ideas and views had to be included in the diary. It was suggested that teachers should treat teaching as a research activity and try to implement new ideas in the classroom and should check whether these ideas are successful or not, and analyse the reasons for the success or failure. The teachers were asked to

discuss their ideas with the researchers and other teacher participants in improving their plans. The workshop ended with the participating teachers receiving certificates and complimentary books from HBCSE.

Photo 4: Dr. Sugra Chunawala and Dr. Chitra Natarajan handing out the certificates to the teachers

Way Forward

It was intended that this workshop would aid in providing insights to teachers regarding issues related to diversity and involve them in collaborative interaction between researchers to explore these areas further more. The science classes of the participating teachers would be observed again. Responses and feedback from the students will be crucial in letting the teachers know if their new methods are working. The teachers will continue their association with the HBCSE team who will work in close collaboration with the teachers to develop many more lesson plans keeping in mind the issues of diversity. Several more interventions in the form of short workshops may be held to take this interaction further.

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