



Capacity Building Programme for Chemistry Teachers

(UG level)

February 20 – 25, 2025

Report

Homi Bhabha Centre for Science Education
Tata Institute of Fundamental Research
Mumbai – 400 088, Maharashtra
<https://www.hbcse.tifr.res.in/>

A capacity building programme for teachers, teaching chemistry at UG level, was held at Homi Bhabha Centre for Science Education (HBCSE) from February 20 – 25, 2025. This programme was organized as part of a collaboration between HBCSE and Maharashtra State Faculty Development Academy (MSFDA). The duration of the programme was six days and 31 chemistry teachers teaching at UG level in different districts of Maharashtra participated in the programme.

This camp consisted of multiple components focused on different content areas of chemistry and also related to chemistry education. The teacher participants were engaged with laboratory sessions which included planning/ designing aspects as well as pedagogical reflections, problem solving in domains of organic, inorganic and physical chemistry, and introduction to chemistry education research literature. The activities were carried out by the participants in pairs in workshop mode.

The detailed timetable of the camp along with name of resource persons who engaged the participants is given in annexure. An overview of the sessions conducted on each day of the camp and the key aspects of these sessions is presented below.

Day 1

The camp kicked off with introduction of HBCSE members and participants followed by introduction to HBCSE and its activities in brief. They were orientated about the campus, especially the effective practices related to waste and its disposal that are practiced at HBCSE. Also, briefing about the upcoming sessions planned for the 6-day camp, and discussions about the teachers' expectations from the camp was done.

Teachers engaged with problem solving related to molecular structures. Few examples of simple molecules (e.g., H_2O , NO_2 , NO_2^+ , NO_2^- , O_3 , N_2H_4 , N_2H_4^+ , etc.) were taken for discussion regarding drawing of their Lewis dot representations. This was followed by using VSEPR theory to draw the structures and determine the geometry and shapes of the molecules by inferring from the strength of bond-pair-bond pair/bond pair-lone pair/lone pair-lone pair interactions and the resulting bond angles in the molecules. Finally, the bulk property (macroscopic) such as acidity/basicity of the molecules were discussed which in turn is dependent on the structures (microscopic) of the molecules.

The problem solving session in organic chemistry focused on the questions related to some of the fundamental concepts, such as resonance structures, hybridization, functional groups, optical activity, and acid-base properties. Multiple conceptual questions were posed about individual molecules to reinforce these concepts before tackling an Olympiad-level question. Some simple reaction mechanisms and the roles of reagents were also discussed in detail. Finally, a problem from the 33rd International Chemistry Olympiad (IChO) was presented for discussion. Teachers were asked to work in groups to solve the problem and then share their final answers with the moderator. The most interactive part of the session involved solving the structure of a molecule using the provided NMR data.

Day 2

The teachers were introduced to MSFDA and their different initiatives and collaborative works across Maharashtra which were focused on teachers.

In the lab session, teachers were given a task of derivatization of an organic compound (aniline), its purification, and analysis. Additionally, they were directed towards handling of hazardous chemicals and understanding the safety aspects in a chemistry lab. The teachers performed the experiment in the lab at microscale. The task conducted with a *pre-lab – lab – post-lab* approach.

As part of the post lab session, teachers were asked to reflect on the designing process of pre-lab and post-lab questions, and the relevance/importance of these kind of questions for understanding the experiment. The primary purpose of this discussion was to sensitize the teachers about asking relevant questions as part of pre/post labs. They were assigned with two selected experiments (one organic and another analytical) from university lab manual. They were asked to frame 3 – 4 pre-lab and post-lab questions each for any one of the experiments. These questions were to be discussed and reflected upon on the last day of the camp, giving the teachers sufficient time to think and frame good questions.

Day 3

The teachers were introduced to Chemistry Education literature from peer reviewed journal. They were given a research paper to read. During the discussion sessions, pointers were provided to the pairs that will be useful in critical reading and reflecting on the content presented in the paper. The papers selected were related to students' reasoning about models related to acids/bases and introducing component of experimental design and restructuring the conventional UG chemistry labs.

In the second half of the day, teachers engaged with problem solving in area of chemical kinetics. Teacher were presented with conceptual problems related to order of reaction, rate of reaction, graphical representations of different variables, temperature dependence of rate constant etc.

Day 4

Teachers participated in a hands-on session of Electrochemistry in the lab where they constructed standard hydrogen and calomel electrodes. Using these electrodes, they measured the potential of each half-cell in a Daniell cell. They explored the function of the salt bridge, the origin of voltage, and the concentration dependence of the Nernst equation using the Daniell cell. They were demonstrated the inevitable voltage drop that occurs when drawing current from such a cell and the related causes.

Day 5

Teachers were engaged with an experiment that involved identification of unknown samples. As a part of this experiment, initially they performed a Thin Layer Chromatography (TLC) of organic acid-base indicators. The pH ranges of the indicators were determined by running TLCs in eluents of various pH (acidic, neutral, and basic). The same was followed by qualitative analysis of supplied unknown solutions of inorganic acids, bases, or salts. The color change observed for each indicator was then used to identify the supplied colorless unknown solutions. The approach for the experiment was equivalent to solving a puzzle, where planning and logical inference based on observations were the key tools for identifications of solutions.

Day 6

The assignment given on Day 2 (designing of pre-lab and post-lab questions) was discussed in two separate groups: one group consisted of pairs that worked on experiment in area of organic chemistry

and the other consisted of pairs that worked on experiment in analytical chemistry. Each pair presented their questions and received feedback from other pairs /facilitators. The pair was given freedom to modify their questions after the feedback and they were given time for the same.

Additionally, teachers were introduced to the HBCSE Chemistry Education Research website, where they were informed about the online resources available to support their teaching-learning processes.

The session ended with a discussion, feedback, and closing remarks.

All participants were provided with two book* for future use in their institutions:

- Shaikh, G., Ravishankar, L., & Ladage, S. (Eds.) (2024). *Exploring Laboratory Experiments in Chemistry* (1st ed.). Himalaya Publishing House.
- Carneiro, G., et al. (2024). *Organic Chemistry: Guided Inquiry Approach* (1st ed.). Narosa Publishing House.

Teachers also fabricated the calomel electrode as part of the electrochemistry lab and took the same with them so that it can be used for electrochemistry experiments in their own labs.

* Both the above books are result of collaboration work done with some motivated chemistry teachers (primarily from Mumbai, Pune and Calcutta) from colleges affiliated to university system and members of chemistry education group at HBCSE. HBCSE hopes that these books will motivate some of the participants of the HBCSE-MSFDA to use the same in their own classroom. We also hope that in near future, they may start such activities at their local levels. We thank support from MSFDA towards the distributions of these books to teacher participants.

ANNEXURE

MSFDA-HBCSE Programme for UG Science Teachers [Chemistry] (February 20-25, 2025)
Schedule

Time	Day 1 * (Thursday, February 20)	Day 2 ** (Friday, February 21)	Day 3 (Saturday, February 22)	Day 4 (Sunday, February 23)	Day 5 (Monday, February 24)	Day 6 (Tuesday, February 25)
9.30 - 11.00	Introduction (9:30 – 10:00)	About MSFDA SV (9:00 – 10:00)	Exploring CER Literature (SAL, ND)	Electrochemistry Pre-lab (KK)	Identification of Unknown solutions (AN, RK, VD)	Discussion on Pre-lab/ Post-lab Assignments (GSh, LR, SAL, RVJ)
	Problem solving in Molecular Structures (IDS) (10:00 – 11:15)	Benzoylation of Primary Amines Pre-Lab (GSh, DY) (10:00 – 11:00)				
Tea break						
11.30 - 1.00	Problem solving in Molecular Structures (IDS)	Benzoylation of Primary Amines Lab (GSh, DY)	Exploring CER Literature (SAL, ND)	Electrochemistry Lab (KK)	Identification of Unknown solutions (AN, RK, VD)	Discussion on Pre-lab/ Post-lab Assignments (GSh, LR, SAL, RVJ)
Lunch break						
2.00- 3.30	Problem Solving Organic (LR)	Benzoylation of Primary Amines Lab (GSh, DY)	Problem Solving Physical (RVJ)	Electrochemistry Lab (KK)	Identification of Unknown solutions (AN, RK, VD)	Chem Edu Web Resources (VD) (2:00 – 3:00)
Tea break						
4.00 - 5.30	Problem Solving Organic (LR)	Benzoylation of Primary Amines Post-lab (GSh, DY) (3:30 – 4:30)	Problem Solving Physical (RVJ)	Electrochemistry Post-lab (KK)	Identification of Unknown solutions (AN, RK, VD)	Feedback and Closing (3:00 – 4:00)
		Understanding Designs of Pre-lab/ Post-lab (AG) (4:30 – 5:30)				

* Reporting time for the participants is 9:15 AM.

** Day 2 will start at 9:00 AM

Resource persons:

Non-HBCSE: Gulshanara Shaikh (GSh), Lakshmy Ravishankar (LR), Neeraja Dashaputre (ND), Radha V. Jayaram (RVJ), Sujatha Varadarajan (SV)

HBCSE: Anju Nair (AN), Ankush Gupta (AG), Dinesh Yadav (DY), Indrani Das-Sen (IDS), Krishnendu Kundu (KK), Mohamad Ahmad Sidique (MAS), Rajasree Kundu (RK), Savita Ladage (SAL), Vishal Dhavle (VD)

For participants:

Welcome to HBCSE! The following points will be helpful during your arrival and stay on campus:

- 1. The security personnel at the main gate will guide you regarding your accommodation.*
- 2. Breakfast and dinner will be served at the NIUS canteen ground floor, while lunch will be served at the NIUS canteen, first floor.*
- 3. The sessions will happen in lecture room G1 located in the Olympiad facility.*
- 4. The chemistry labs are located in the Olympiad facility building (OB) second floor.*
- 5. The library and publication sections are on the ground floor of the main building. The library contains extensive collections of books related to science education and remains open until 7 PM. Additionally, you can purchase HBCSE publications, which are on display in the publication section and available in the library.*
- 6. HBCSE has a strict Waste Management policy in place. We urge you to cooperate with our staff in making this institute a “Zero Waste” centre.*

Photo gallery



