Annual Interaction Meet 2023

Homi Bhabha Centre for Science Education
Tata Insitute for Fundamental Research

Book of Abstracts

AIM 2023 Organising Committee
Anikel Sule, Sathish C G, Saurabhee Huli & Shweta Naik

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Concept Note AIM 2023

The HBCSE Annual Meet is imagined to be an internal gathering to share our research, development and pedagogical activities. It is an extended version of the earlier run activity – Annual Research Meet. The aim is to promote the exchange of diverse research ideas, foster collaborations, and inspire novel perspectives among all of us. It is an opportunity for faculty members, research scholars, post-doctoral fellows, and scientific and academic project staff to present their research and developmental work pertaining to the various programs hosted at the Centre.

A broad spectrum of the work was showcased during this meet. Here, we list categories of abstract. Bilingual abstracts were invited; however, we received all abstracts in English. Some contributions are beyond these categories.

- Science and Mathematics Education Research categories include
    - Recently completed research - describing preliminary findings.
    - Ongoing projects - describing the data collection process and interesting experiences from the field.
    - Projects which are about to start - describing the process of situating the research in the Indian educational context and its theoretical framework
- Developmental Work categories include
    - Development of learning units and similar materials from other projects
    - Novel olympiad questions
    - New instruments developed at HBCSE
    - E-materials
    - Innovative pedagogical approaches within existing programs
- New ideas in STEM Communication / Outreach
- Commentary on Science Education Policy / Advocacy
- New research/analysis related to history/philosophy of science (STEM)

We received a total of 39 submissions. Each of these submissions received feedback from 2 members of HBCSE. Participants chose different modes of presentations - Talk sessions (24), Poster sessions (9), and Hands-on Demo Sessions (8). Abstracts of up to 300 words describing highlights of the respective works were submitted. Each abstract was reviewed by two individuals. All the reviewers were from HBCSE. Members of the organising committee AIM-2023 acted as the second reviewer. Several participants chose to revise their abstracts based on the feedback received. Most sections of HBCSE submitted one or more reports of their work. We encouraged presentation by HBCSE members only, even though some projects had collaborators from outside. HBCSE members from all sections participated - Academic project staff / short-term visitors/student interns, etc. AIM-2023 was announced on 7th August 2023; papers were received till 20th September 2023. After sending the abstract for review and receiving feedback, it was sent to all the members by 6th October 2023.

This activity aims to grow as an education community; therefore, we look forward to everyone's contributions and participation in AIM-2023.

Anikel Sule, Sathish C G, Saurabhee Huli and Shweta Naik

Acknowledgements

The Annual Interaction Meet is an extended version of the Annual Research Meet. The extension was made considering the different nature of work that members of HBCSE engage with. As an organising committee, we found this extension meaningful and worked towards the idea's fruition.

We thank Prof Arnab Bhattacharya, Centre Director, for this idea and all the required support for AIM-2023.

We thank Prof Savita Ladage for encouraging this idea, helping us formulate the panel discussion and being overall supportive of the functioning of the committee work.

We thank all the members of HBCSE who participated, chaired and attended the AIM-2023. The AIM is by us, about us and for us.

We thank all the reviewers listed at the end of this document for helping us in the feedback process.

Several departments, such as Administration, Technical, Housekeeping and Canteen, often tirelessly work behind the curtains; we are grateful for their help and support. We also thank the directors, deans and PRO office for their continuous support and services.

Anikel Sule, Sathish C G, Saurabhee Huli and Shweta Naik

Schedule of Annual Interaction Meet (AIM) 2023

Day 1: 25th October 2023			
Time	Work Title	Authors (as submitted by the corresponding author/s, Presenter/s underlined)	Session Chair (Type, Venue)
09:30 – 09:45	Inauguration	Centre Director and Organising Comittee	
09:45 – 11:00	A Mathematical Theory of Quantity can Bring Meaning and Coherence to School Arithmetic	K. Subramaniam	Saurabhee Huli (Plenary Talk, NIUS G4)
Tea Break (11 am to 11:25 am) – Outside NIUS G4			
11:30 – 11:50	Touchy Pinchy Integers: A Multitouch Technology for Operation of Integers	Priyadharshni Elangaivendan, Ashwin Ramaswamy, Melwina Albuquerque & Sanjay Chandrasekharan	Joseph Salve (Talk Session, NIUS G4)
11:50 – 12:10	Baseline Survey in Astronomy	Aniket Sule, Moupiya Maji, Akshat Singhal, & Pritesh Ranadive	
12:10 – 12:30	Evolution of Vigyan Pratibha (Vp) Learning Units – An Interplay of Ideas, Feedback, and Observations	(alphabetical) Aaloka Kanhere, Amish Parmar, Ankush Gupta, Deepa Chari, Nilkantha Gholap, Prasad Desai, Ram Kumar Kumawat, Sarita Kamat, Sreeja M. & Zeenath Mustafa	
12:30 –12:50	A Smartphone Based Optics Experiment	Hemansh Shah, Mamatha Maddur & Praveen Pathak	
Lunch Break (12:50 pm to 1:55 pm) – MB Canteen			
14:00 – 14:30	Demonstration of An Education Game on Waste Management	Adithi Muralidhar, Amruta Jategoankar & Anisha Malhotra-Dalvi	Pranshi Upadhyay (Hands-on Demo Session, NIUS G4)
14:30 – 15:00	Audience Response System (Clickers)	Chetan Mandloi & Shirish Pathare	
15:00 – 15:30	Functional Group/S in Aroma Related Molecules and their Identification Through Qualitative Test/s	Sidique Mohamad Ahmad & Laksmy Ravishankar	
Tea Break (3:30 pm to 3:55 pm) – Outside NIUS G4			
16:00 – 16:20	Exploring and Comparing the Difficulties Among Undergraduate and Postgraduate Students' Understanding of Experimentation Using Primary Scientific Literature.	Meena Kharatmal & Arnab Bhattacharya	Sulochana R (Talk Session, NIUS G4)
16:20 – 16:40	Students' Perception of Nature Of Mathematics	Omkar Devlekar, Shweta Naik & Pooja Lokhande	
16:40 – 17:00	Solvent-Free Cannizzaro Reaction	Vishal Dhavle, Rajeshwari Athavale, Bala Subramaniyan, Savita Ladage & Ankush Gupta	
17:00 – 17:20	Vigyan Pratibha School Visits - A Tapestry of Anectodes	(alphabetical) Aaloka Kanhere, Amish Parmar, Ankush Gupta, Deepa Chari, Nilkantha Gholap, Prasad Desai, Ram Kumar Kumawat, Sarita Kamat, Sreeja M. & Zeenath Mustafa	

Day 2: 26th October 2023			
Time	Work Title	Authors (as submitted by the corresponding author/s, Presenter underlined)	Session Chair (Session Type, Venue)
09:30 – 09:50	Examining Teachers' Mathematical Learning Opportunities in Practice-based Tasks	Shweta Shripad Naik	Nishtha (Talk Session, NIUS G4)
09:50 – 10:10	Lively Linkages: Leveraging Middle-School Science & Design	Disha D'britto, Anisha Malhotra-Dalvi, Adithi Muralidhar & Arnab Bhattacharya	
10:10 – 10:30	A Comprehensive Approach to Teaching Astronomical Coordinate Systems	Pritesh Ranadive, Sai Shetye & Aniket Sule	
10:30 – 10:50	Conjuction of Planets	Aniket Sule	
Tea Break (11 am to 11:25 am)			
11:30 – 11:50	Creating Mathematical Olympiad Problems	Prithwijit De	Hrishabh Singh (Talk Session, NIUS G4)
11:50 – 12:10	Online Laboratory	Shirish Pathare, Bhagyashri Latad & Saurabhee Huli	
12:10 – 12:30	Mathematics Textbooks on Uncertainty	ArulGanesh S S	
12:30 –12:50	Archives for HBCSE	Bhavya Ramakrishnan	
Lunch Break (12:50 pm to 1:55 pm)			
14:00 – 15:30	Poster Session	*List appended	NIUS G2
Tea Break (3:30 pm to 3:55 pm)			
16:00 – 16:30	Using Invertebrates to Visualize Biological Concepts	Dnyaneshwari Joshi, Bhakti Mangaokar, Uzma Shaikh & Anuttama Kulkarni	Harsha Malhotra (Hands-on Demo Session, NIUS G4)
16:30 – 17:00	Small Changes that can Make a Big Impact on the Classroom Environment: Our Experiences	Vinod Sonawane, Sonali Kathle, Narendra D Deshmukh & K T Hambir	
17:00 – 17:30	A Nonintuitive Demonstration On Faraday's Law	Saurabhee Huli, Shirish Pathare & Anwesh Mazumdar	

Day3: 27th October 2023			
Time	Work Title	Authors (as submitted by the corresponding author/s, Presenter underlined)	Session Chair (Session Type, Venue)
09:45 – 11:00	Experiences from Large-Scale Knowledge Interventions in Illumine: What We can Learn for STEM Education?	Durga Prasad Karnam	Vishrut Patel (Plenary Talk, NIUS G4)
Tea Break (11 am to 11:25 am)			
11:30 – 11:50	Revisiting Werner's Experiments to Understand Coordination Compounds	Sathish C G, Savita Ladage	Rafikh Shaikh (Talk Session, NIUS G4)
11:50 – 12:10	Geometric Transformations: A Review of Middle School NCERT Math Textbooks	Saurabh Thakur & Deepa Chari	
12:10 – 12:30	Anandi: Anticipation and Planning for Distance Learning	Team Anandi (Presenters: Uzma Shaikh & Prajakta Zarekar)	
12:30 –12:50	Assessing School Science Teachers' Understanding through Hand-on Activities on Heat: An Experience of Collaborative Learning Approach	Sonali Kathle, Narendra D Deshmukh	
Lunch Break (12:50 pm to 1:55 pm)			
14:00 – 15:30	Needs and Challenges in School STEM Education	Ankush Gupta, Nishtha, Aniket Sule	Shweta Naik (Panel Discussion, NIUS-G4)
Hi-Tea MB Canteen			

*List of Posters	
26th October 2023, NIUS-G2, 2 pm to 3:30 pm	
Title of the Poster	**Author/s Names**
Nuclear Physics Laboratory Course	Paresh K Joshi
Testing for the Taster Gene: A Classroom Activity in Genetics & Molecular Biology	Anupama Ronad, Vikrant Ghanekar, Uzma Shaikh, Bhakti Mangaonkar & Dnyaneshwari Joshi
Diversity In Soil!....	(alphabetical) Asmita Redij & Sreeja M
Observation of Live Paramecium: A Simple Teaching Tool to Study Physiology at School Level.	Vikrant Ghanekar, Anupama Ronad, Bhakti Mangaonkar, Dnyaneshwari Joshi & Uzma Shaikh
Preliminary Observations on Knowledge of Vaccination and Vaccine-preventable Diseases in High School Students in M(E) Ward Mumbai	Anupama Das, Sandhya Koushika, Gauravi Mishra & Arnab Bhattacharya
Leaflets of Chemical Compounds	Savita Ladage, Ankush Gupta, Indrani Das Sen, Trupti P. Londhe, Mursaleen Shaikh, Shreyank Mandavkar, Hanza George & Krupa Subramanian
STEAMBoat: Learnings from 2 Years of Online Outreach Sessions	(alphabetical) Adithi Muralidhar, Amish Parmar, Arnab Bhattacharya, Disha Dbritto, Manoj Nair, Ravi Sinha, Sathish C G, Sugra Chunawala & Suravi Kalita
Asking Questions in Mathematics	Prithwijit De
Students' Ways of Expression in Science Classrooms	(alphabetical) Aaloka Kanhere, Amish Parmar, Ankush Gupta, Deepa Chari, Nilkantha Gholap, Prasad Desai, Ram Kumar Kumawat, Sarita Kamat, Sreeja M. & Zeenath Mustafa
Designing Experimental Module for Analysis of Metal Ions Present in Hard Water for Undergraduate Chemistry Laboratory Education/course	Indrani Das-Sen

Plenary Talks

A Mathematical Theory of Quantity can Bring Meaning and Coherence to School Arithmetic
K. Subramaniam
Day 1: 25th October 2023, 9:45 am to 11 am

Abstract: One of the primary aims of mathematics curriculum reform in many countries and educational systems is to foster sense-making or meaningful learning of mathematics. Cognitive studies of mathematical learning in the domain of arithmetic have shown that children make sense of numbers and operations on them by interpreting them as quantities. However, quantities are typically not seen as mathematical objects, and quantitative reasoning is frequently interpreted as distinct from mathematical reasoning. I argue in this talk that quantities are mathematical and that their mathematical structure can be specified through precisely stated theories. Several mathematicians in the previous century presented such mathematical theories of quantity with a view to supporting a more meaningful approach to teaching and learning. These theories interpret numbers as operators on quantities and show that numbers themselves possess the mathematical structure of quantity. However, the theories that are available at present are not sufficiently detailed and do not take into account accumulated research on mathematical learning, to function as a reference for the structuring of the school arithmetic curriculum. Drawing on the available mathematical theories of quantity, as well as on cognitive studies of arithmetic learning, I will sketch what a mathematical theory of quantity that can support arithmetic learning should look like. Adopting a quantity perspective to arithmetic not only brings meaning and coherence to school arithmetic, but also shows that much of what has been called "early" algebraic thinking by researchers can be interpreted as reasoning about quantities.

Experiences from Large-Scale Knowledge Interventions in Illumine: What We can Learn for STEM education?
Durga Prasad Karnam
Day 3: 27th October 2023, 9:45 am to 11 am

Abstract: I have been working with Illumine Knowledge Resources, an organization identifying itself as a lab working on "human change at scale" for almost 2.5 years. At the core of its philosophy is the idea of infinite potential in every human, and its efforts are towards awakening those human possibilities. Illumine works on this human change in diverse groups ranging from public and private sector organizations to universities and schools.

Since I joined, we have been working on various large-scale knowledge interventions under GoI's Mission Karmayogi, to make the government's workforce more citizen-centric and awaken a sense of service in them by triggering a transformation in their mental models towards work. We worked with the Indian Railways, India Post, UT Police, and Delhi Police. We are currently working to enable the Village Level Entrepreneurs of CSC (Common Service Centers across the country), the entire administration in two districts in Maharashtra, and the entire workforce under Haryana State Government, among others.

In this talk, while providing a quick glimpse into these interventions and my role in them, I will try to touch upon a) the dynamics of bringing such large-scale change, b) the levers of operationalisation (from research, pedagogy, technology, deployment), c) the approach of shifting a big mass even by a small amount, d) some lessons, limitations and implications while reflecting on STEM Education. In the process, we could collectively identify the synergies and differences in the approaches towards charting new avenues of change.

Panel Discussion

Needs and Challenges in School STEM Education
Panelists: Aniket Sule, Ankush Gupta & Nishtha
Moderator: Shweta Naik

Summary of the panel discussion:

The panel began by raising three concerns/themes. 1. Given the nature and history of work at HBCSE and the changing scenario of the classroom settings in urban and rural areas, what could be the focus of HBCSE research and development work? 2. Given that the education policies and scenario have changed quite a bit, and yet the teacher isolation and disconnection to how students learn continues, what could HBCSE develop to bridge these? Even though the teacher communities are developed at some level, their role (or "unerstanding of pedagogic tools") is still tangential to concerns related to learning. 3. The current education scenario elicits fundamental dilemmas in the goals of education, as in to whom the education is catering and the role of content.

The goal of education itself has changed over the decades from literacy to the development of professionals, and that has increased the load of what teachers or education stakeholders need to do. Societal aspirations are centred around grade 10 examinations, which delineate citizens who will study science *vs*. those who will not study science. Demands in education are no longer about delivering facts – as in the internet era – the facts are readily available but more about facilitating reasoning.

A more considerable worry and solution to which HBCSE represents uniquely in the pan-India context is our perception towards the content and context of schooling. Even though everyone agrees that learning takes place in the context, the features of these contexts could be more precise. Whether the context should legitimise the learner's experiences in school - bridging informal to formal, or the context should have structures conducive to learning. This particular worry points to the more extensive debate on uniformity *vs*. individuality of curriculum, teaching processes and goals of education. Focus on individuality (of students as well as teachers) brings autonomy, whereas uniformity brings equal opportunity; both these are equally relevant to successful learning.

The several discussions and challenges ask us to reflect on three concerns as an education community. One, how do we bridge the gap between theory and practice of Science and Mathematics Education? The answer is working with teachers, and that is also through more extended collaboration. The prolonged interactions also make us helpful to the teacher, and we do not become one added work for them. Second, for whom do we cater? Given that most of the population requires help in learning basic science and mathematics, we make sure that, along with facilitating excellence, our research projects and problems remain close to the needs of this majority. Third, do we work on large-scale or small-scale issues? It depends on the research problem, but in either case, thorough, research-based and high-quality work is needed, and HBCSE is an institution that can handle issues of learning apolitically and neutrally.

Paper Presentation Session I
Day 1, 25th October 2023, 11:30 am to 12:50 pm

Touchy Pinchy Integers: A Multitouch Technology for Operation of Integers
Priyadharshni Elangaivendan, Ashwin Ramaswamy, Melwina Albuquerque & Sanjay Chandrasekharan

Classroom teaching experiences and existing literature suggest that early middle-school students have difficulty with operations on integers, and these lead to misconceptions. We present a touch-based system – Touchy Pinchy Integers (TPI) designed to assist early middle-school students gain a conceptual understanding of the addition and subtraction of integers through embodied interaction. This application builds on the neutralization model of integers (cancelling integers of equal and opposite signs) and existing gestures used in touch devices. By embedding touch gestures with mathematical meanings, the design allows the student to develop an alternative – and mathematically accurate – mental model of integers based on embodied interactions. This mental model reduces their dependence on the purely rule-based system to learn integer operations promoted by current static media.

Baseline Survey in Astronomy
Aniket Sule, Moupiya maji, Akshat Singhal & Pritesh Ranadive

The Office of Astronomy Education, India, has launched a baseline survey to understand the current state of astronomy education in the nation. This study explores the views of students and teachers about the content of astronomy in the school syllabus, their basic understanding, interest levels, and connections to cultural aspects. With the HBCSE Institutional Review Board's approval, we've adapted the survey into more than 10 languages. We've reached out to 30 schools, spanning diverse urban and rural regions in the country, engaging about 2000 students. The survey methodology includes two components: a set of short questions for the students and interviews for the teachers. We present an initial analysis derived from interviews with 10 teachers, focusing on their perspectives regarding the astronomy curriculum in schools located in the Mumbai-Pune area.

Evolution of Vigyan Pratibha (VP) Learning Units – an Interplay of Ideas, Feedback, and Observations
(alphabetical) Aaloka Kanhere, Amish Parmar, Ankush Gupta, Deepa Chari, Nilkantha Gholap, Prasad Desai, Ram Kumar Kumawat, Sarita Kamat, Sreeja M. & Zeenath Mustafa

VP Learning Unit (LU) is an interplay of content ideas, feedback, and observations of many stakeholders involved in the facilitation and learning processes at various junctures. Most LUs get initiated through discussions at Resource Generation Camp (RGC), with a team working further on developing the first draft. At this stage, some teacher notes are added to the unit, but they are very brief and usually just authors' estimates of the expected pedagogical interactions. RGC is followed by student trials, where these versions are strengthened by observations of LU facilitation and follow-up discussions with the observers. The main objective of these trials is to get direct feedback from the audience, like what the VP program aims to cater to and support authors in revising the

teacher notes. It is important to note that some occurrences of students' work become a part of the teacher's notes. This enhanced learning unit version is further tried at teachers' workshops.
In the teacher workshop, one of the VP members conducts the LU while a small team of observers provides post-session feedback. The interactions during the sessions and teachers' feedback contribute towards the next version, which the teachers are encouraged to conduct at their schools. The last pieces in this process of this evolution of the LUs are the observations and feedback one gets during school visits, where we see the gaps that the LU might still have.
In this presentation, we will be talking about some specific examples of this process of evolution of the LUs. The journey shows the importance of the involvement and contributions of various people and practices in making every iteration better.

A Smartphone-Based Optics Experiment
Hemansh Shah, Mamatha Maddur & Praveen Pathak

A smartphone screen display unit consists of millions of pixels and a touch-sensitive surface on top. The display unit can be used for many optical experiments. In this study, we explore the behaviour of light on a smartphone screen, divided into three parts: we start by directing a laser beam onto the screen to observe the resulting pattern. Remarkably, the pattern closely resembles the iconic "X" pattern seen in Rosalind Franklin's 1952 Photo-51 image of DNA diffraction. Next, a drop of water is carefully placed on the screen, serving as a unique lens to uncover specific properties of the screen. Finally, we investigate how light bends as it passes through the screen glass, providing further insights into our previous measurements. All three parts of the experiment independently verify certain measurements, creating a cohesive understanding of diffraction, interference, refraction, and reflection. A part of this experiment was also included as a theoretical task in the Indian National Physics Olympiad exam this year.

Hands-on Demonstration Session I
Day 1, 25th October 2023, 2 pm to 03:30 pm

Demonstration of an Education Game on Waste Management
Adithi Muralidhar, Amruta Jategoankar & Anisha Malhotra-Dalvi

The issue of waste management has been a critical problem for our country, particularly in light of increased consumerism seen more in the cities. Citizens are most often not involved in the process of waste management after disposal, and therefore there is an alienation in terms of understanding what happens to something after we throw it. This thought fed into the conceptualisation of an awareness-building game which attempts to emphasise the potential and realistic journey of a commodity after its disposal. 'Trace the Waste' is designed to sensitise children and adults about domestic waste management with the hope of engendering a personal connect to this crucial issue. We would like to present a demonstration of the final game so that audience members may play the game and experience it first-hand, followed by a brief discussion on the underlying design principles and educational goals of the game.

Audience Response System (Clickers)
Chetan Mandloi & Shirish Pathare

In classrooms, we often find that only some students participate in discussions. Many students hesitate to participate due to their fear of being judged by their peers and teachers. It is, therefore, necessary to equip students with tools which can allow them to respond without revealing their identity. Also, getting real-time anonymous responses from students is sometimes essential for gauging students' thinking patterns in the classrooms. Different platforms, popularly known as "Clickers" in the field of education research, are available for collecting responses in large classrooms. These are small handheld units with 4-6 press buttons. Students have to select their response, which gets registered in a remote unit without revealing their identity. Nowadays, there are multiple response systems which are web-based, freely available, and which can be operated using smartphones. However, these systems need a strong Wi-Fi network for their operations. This constraint motivated us to develop an in-house clicker system. In this talk, we discuss our low-cost clickers, developed in-house using ESP8266 microcontroller. These clickers are based on a custom-made printed circuit board (PCB) with 10 response buttons and a reset option. Each clicker module connects to a Wi-Fi network hosted on a router, which need not be connected to the internet. The modules are powered using a standard Li-ion battery, which can last for more than 10 hours when fully charged and can be recharged externally. The user runs a Python-based interface which polls each active module within a second. Each module has indicator LEDs to show that the module is powered on and a response has been selected. The user can post a question and get the collated anonymous response information on their screen. The clickers can be reset for their subsequent use.

Functional Group/s in Aroma Related Molecules and their Identification through Qualitative Test/s

Sidique Mohamad Ahmad & Laksmy Ravishankar

Flavours and fragrances are significant parts of our lives, though they may be present in minute quantities. The chemicals which are responsible for these are largely organic compounds. The organic compounds with a strong and distinct smell are called ‘aroma’ compounds. The smell of the organic compounds is primarily due to the different types of functional groups present in them and their interaction with the olfactory sensors. The aim of this experiment is to identify structures of given compounds from a given set of chemical structures by performing qualitative tests. This identification is carried out by performing several tests for the functional groups in the unknown compounds and, based on it, identifying their molecular structure from the given set of structures. The chemical reagents used for functional group tests give a distinct observation (such as colour change, odour, effervescence, etc.), which are unique for certain functional groups only. The design of the experiment imitates solving a puzzle with a minimum number of chemical tests and learning to correlate experiential distinction (of smell) among compounds with the structural features of the molecules.

Paper Presentation Session II
Day 1, 25th October 2023, 4 pm to 5:30 pm

Exploring and Comparing the Difficulties among Undergraduate and Postgraduate Students' Understanding of Experimentation Using Primary Scientific Literature
Meena Kharatmal & Arnab Bhattacharya

Abstract. In this preliminary study, we explored and compared undergraduate (UG) and postgraduate (PG) students' understanding of experimental design and its parameters: sample, control, treatment, dependent variable (DV), and independent variable (IV), based on a reading of Primary Scientific Literature (PSL) of a biological assay. We noticed students' difficulties in identifying treatment and control, also in assigning of variables. Most students, 65% UG and 88% PG, demonstrated a correct understanding of experimental design. But only a few students, 35% UG and 12% PG, depicted a correct understanding of its parameters. In the assay, difficulties in identifying control were seen among 76% UG and 71% PG students, while 82% UG and 65% PG students indicated difficulties in understanding treatment. Both student cohorts seemed to have a reasonable general understanding of experimental design. However, on finer probing, they were confused about several important issues and had difficulties in understanding relevant parameters. Interchanging the DV and IV was a widespread problem among the PG cohort (53%) as compared to the UG cohort (29%). Surprisingly, in spite of their added training, postgraduate students did not show a better understanding of experimental design. This reflects a worrying disconnect between coursework on research methodology and acquiring useful scientific literacy skills. Our study demonstrates the potential of using critical discussions of primary scientific literature as a teaching intervention to effectively enhance understanding of experimentation and scientific literacy skills.

Keywords. experimentation, experimental design, variables, primary scientific literature, scientific literacy skill, research methodology, undergraduate biology education, postgraduate

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Students' Perception of the Nature of Mathematics
Omkar Devlekar, Shweta Naik & Pooja Lokhande

Several math educators and researchers have discussed one's understanding of the nature of mathematics and its connection to learning authentic mathematics (Lerman, 1990). Although the strong impact of teachers' perception of NoM on teaching and learning mathematics has been well documented in numerous studies (Beswick, 2012), minimal literature is available on students' perception of the nature of mathematics (NoM). In light of the need to know how our students perceive mathematics, we designed and conducted a survey consisting of Likert and open-ended questions. As a secondary objective was to see secondary-tertiary transition (STT) in learning and appreciating mathematics, we chose to work with grade 6th, 9th, and 12th mathematics students. The tool for the data collection was designed based on eliciting the NoMs of the researchers from the research literature and complimenting or contrasting the ones given in the NCERT textbooks. Three researchers anticipated student responses for each question and made the first revision. The second revision was made based on the criteria that emerged from the research, and edits were made to avoid repetition and maintain novelty. The third revision of the tool was made based on the actual pilot of the survey. The survey was then made bilingual for certain semi-English medium

schools. More than 150 student responses will be analyzed for mathematical perception that is wide and varied, rich in connection, lively and developing and structured deductively (Hoffman & Even, 2023).

Solvent-Free Cannizzaro Reaction
Vishal Dhavle, Rajeshwari Athavale, Bala Subramaniyan, Savita Ladage & Ankush Gupta

This experiment is designed in a manner for students to appreciate the environmental aspects of a synthesis experiment. In the current experiment, o-chlorobenzaldehyde is ground together with KOH pellets to drive the reaction forward. The reaction is carried out on a mini-scale and uses a greener route for the Cannizzaro reaction. The mechano-chemical method used here involves the use of mechanical energy during grinding to induce or accelerate the reaction. The design focuses on the green route by avoiding the use of any organic solvent, reducing the amount of energy used as well as minimizing waste generation. The module includes pre-lab questions, laboratory experiments and post-lab questions, which facilitate an understanding of the reaction conditions, mechanism as well as safety aspects of the reaction. The experimental procedure is simple and can be performed in any undergraduate chemistry laboratory.

Vigyan Pratibha School Visits - A Tapestry of Anectodes
(alphabetical) Aaloka Kanhere, Amish Parmar, Ankush Gupta, Deepa Chari, Nilkantha Gholap, Prasad Desai, Ram Kumar Kumawat, Sarita Kamat, Sreeja M. & Zeenath Mustafa

School visits are an integral part of the Vigyan Pratibha (VP) project. They provide us access to the school learning environment and inform us about how students are engaging with the VP resources, namely Learning Units (LUs). A lot of team effort goes into the organisation and execution of school visits, which are typically to observe teachers facilitating some LUs with students in their schools. These teachers have been a part of the teachers' workshop and receive orientation of some LUs. School visits provide a window to observe teachers' pedagogic practices associated with that LU. Sometimes, teachers employ alternative approaches to conduct the tasks discussed in the LU. School visits also help us to conduct trials of LUs while allowing us to interact with students closely. We notice that their curiosity is not limited to the LU task alone but often extends beyond. For instance, while conducting an LU on observing birds, some students enquired about the translation of birds' communication language to the human tongue! On the other hand, discussions with students also reveal gaps in students' understanding, leading to opportunities for revising the LUs appropriately to address those knowledge gaps.
School visits provide a realistic view of how teachers facilitate the LUs and the challenges they experience while conducting the LUs in their school settings, making us more sensitive to ground realities.
Through a tapestry of anecdotes from school visits by VP team members (in Maharashtra, Gujarat, & Goa region), we vouch for their importance in the project.

Paper Presentation Session III
Day 2, 26th October 2023, 9:30 am to 11 am

Examining Teachers' Mathematical Learning Opportunities in Practice-based Tasks
Shweta Shripad Naik

Practice-based teacher professional development (TPD) creates learning experiences highly connected to and contextualized in professional practice. Such experiences can better enable mathematics teachers to make the kinds of complex, nuanced judgments required in teaching. Practice-based TPD is popular in several countries that excel in Math teacher education, such as Japan and Finland. In the Indian context, there is a lack of documentation about what constitutes practice-based and how to enact such TPD. This presentation will elaborate on practice-based TPD through examples and episodes of enactment with teachers in the Indian context. The presentation will examine data from a practice-based TPD to illustrate how such tasks provided "opportunities" for teachers to connect and enrich mathematical ideas for teaching. Further, how such interactions with teachers lead to writing a practice-based teacher education curriculum for the first time in the Indian context will be discussed.

Lively Linkages: Leveraging Middle-School Science & Design
Disha D'britto, Anisha Malhotra-Dalvi, Adithi Muralidhar & Arnab Bhattacharya

Levers are a part of the middle school science curriculum and appear as full chapters or subtopics within other chapters. There have been a few studies that have explored this topic from a teaching-learning perspective. I was particularly interested in the topic since I found students struggled with understanding this concept just as much as I struggled with coming up with a more creative lesson plan. We designed a hands-on module called 'Lively Linkages' to encourage students to discover the motion transformation provided by linking levers. In an interactive session, we initially did trials with 71 students during National Science Day 2023. Post trials, a revised and slightly advanced version of the module was then tested with around fifty middle school teachers from different disciplines and schools in Mumbai. Teachers worked in groups to create mechanically-animated compositions involving levers. Broadly, we wanted the module to provide learners with an opportunity to understand the concept of levers and their application through hands-on experimentation and also give them an opportunity to ideate, collaborate, tinker, and create novel compositions. Our presentation will give a broad overview of the module, observations from our student and teacher trials, and insights gained from it.

A Comprehensive Approach to Teaching Astronomical Coordinate Systems
Pritesh Ranadive, Sai Shetye & Aniket Sule

The challenge of teaching the astronomical coordinate system/s is ubiquitous. This is partly due to mathematical rigour and partly due to the need for extensive visualizations. At HBCSE, especially during the NIUS astronomy program, we have tried to overcome these issues by adopting a comprehensive approach by seamlessly combining traditional classroom teaching and tutorial

(problem-solving) sessions with telescope handling and a session inside a mobile planetarium. Each of these components complements each other to create a well-rounded perspective. Our talk will shed light on the design and execution of this innovative approach. We believe that it helps in enhancing students' grasp of advanced topics.

The Conjunction of Planets
Aniket Sule

I present here one Astronomy OCSC question, which stemmed from a seemingly simple query about real-life observation. In the last week of February 2023, Jupiter and Venus appeared almost next to each other in the evening sky. It was observed that on one particular day, Jupiter was above Venus, but the very next day, it was below Venus. That prompted a discussion among some astronomy enthusiasts about how one can model this situation. That eventually led to a question in Astronomy OCSC 2023. Let us look at the factors which go into accurately modelling the situation and what that tells us about the motions of planets.

Paper Presentation Session IV
Day 2, 26th October 2023, 11:30 am to 1 pm

Creating Mathematical Olympiad Problems
Prithwijit De

The broad goal of the mathematical olympiad is to promote a culture of mathematical problem-solving at the high school level in the spirit of a friendly contest. The contest problems belong to four broad topics: Algebra, Plane Geometry, Number Theory and Combinatorics. Ideally, a contest problem should not be a routine textbook problem but one that piques curiosity and tests the mathematical acumen of the contestant by posing a decent level of challenge. It should also be solvable without the use of advanced mathematical knowledge and in a reasonable amount of time. It is a real challenge for the problem proposers to ensure that these traits are indeed present in the contest problems. I will discuss a few examples from the Indian Mathematical Olympiad examinations and show how some of the mathematical topics taught in schools play an instrumental role in creating those problems.

Online Laboratory
Shirish Pathare, Bhagyashri Latad & Saurabhee Huli

During the pandemic, schools and colleges adopted the option of online laboratories. Depending on the available resources, the format of the online laboratory changed. Some colleges used simulations. Some used photographs and videos of experiments. Some colleges sent the low-cost or easy-to-transport apparatus to students along with the instruction sheet. In each of these efforts, students were asked to share their data with the faculty, and later, they carried out discussions based on their data analysis.
In all these efforts, the rules of the experimental game were clearly laid down for the students. They were informed about the measurement tools to be used. They were given instructions about the procedures to be adopted, the data to be collected and, in some cases, even the range of data to be collected. This hardly left any scope to check their knowledge of procedural understanding.
The development of our online laboratory differs exactly from this traditional instruction-driven perspective. We developed webpages with the aim to introduce different aspects of procedural understanding. We wanted to make students think about how to proceed in solving a given experimental problem. We tested our online laboratory experiments through two online camps. The first camp was with 53 student-participants of the Indian Olympiad program. The second camp was with 56 women students enrolled in post-graduate courses in physics.
In the presentation, we discuss the contents of the web pages, the aspects of designing the procedure and some of the students' responses.

Mathematics Textbooks on Uncertainty
ArulGanesh S S
In the periphery of my work on the thesis, I analyzed probability content in Keralam State Board, NCERT and Maharashtra State Board secondary school textbooks on various occasions from different perspectives. We notice that textbooks tend to start with colloquial discourses about and around uncertainty and move to 'mathematization of uncertainty' without necessarily making any qualitative distinctions between the two. Thus, for instance, the uncertainty associated with weather

and that of coin tossing seemingly become equivalent when it comes to questions of mathematizability.
Further, while the mathematization of uncertainty is premised in dynamic contexts -- mostly aimed at making decisions or inferring about future events --, textbooks tend to assume static situations and premises, thus inadvertently posing problems about proportions as problems of probability. Another point of note is the casual replacements of objects with human agents in problems about random devices and random situations. For instance, replacing black and blue beads in problems of random selection with girls and boys in social situations. While these problems can be seen as mathematically isomorphic, ideologically, they are not isomorphic. Thus potentially leading to confusion and false equivalences, especially around questions of mathematizability. I will be trying to illustrate these claims through problems and excerpts taken from textbooks, as well as different formulations of uncertainty and risk. The objective of the exercise is not to deconstruct the textbooks but to suggest that the presentation of content as well as context in probability-related chapters may need some careful attention.

Archives for HBCSE
Bhavya Ramakrishnan

The HBCSE Archive was initiated in 2022 to coincide its growth with the Centre turning 50 years in 2024. Files, old photographs and slides were recovered and sorted. Old posters, newsletters, brochures and publications were collected. All material is documented as soon as it is brought in. Documentation includes dating, numbering and concise description, both in writing and soft copy, while following conservation practices. The holdings also include VHS tapes, floppies, discs and oral histories of three ex-Directors of HBCSE. Material dating back to 1973 and several photo negatives promise to unravel a bygone era. Educational tools from the pre-digital age are almost artefacts today as the technology supporting their use has become rare.

HBCSE is a unique institute in the country. For one interested in the history of science education, on-ground reach, supporting tools and pioneering activities of the HBCSE, the archives would be an invaluable resource.

An archive offers recourse in times of doubt in the functioning of an institution or its history. E.g. the Tata archives in Pune received previously lacking support well into its conception when the archivist uncovered documents that helped overturn a court case, saving the company crores of rupees. The TIFR archives receive researchers from all over the world. These visitors sometimes have access to digital copies of archival material yet wish to view the original documents towards the final stages of their work.

Given my experience at the TIFR art and archives section, I was also asked to propose art initiatives for HBCSE. With the help of the astronomy department and technical services, I was able to curate and manage the execution of a mural on the porch ceiling of the main building. A mural painting competition was another outcome. I also curated and designed posters with photographs of biodiversity taken on campus and juxtaposed them with quotes from popular culture to brighten up the corridors where students visit.

Poster Session
Day 2, 26th October 2023, 2 pm to 3:30 pm

Nuclear Physics Laboratory Course
Paresh K Joshi

It has been observed that students of M.Sc, with Nuclear Physics as the main optional subject, do not get the opportunity to conduct any nuclear physics experiments due to various reasons. This leaves them with many conceptual deficiencies in nuclear physics. A laboratory course has been designed for 5 days, for students from different colleges, mainly Mumbai area. It involves learning how to bias detectors, collect data, analyze the data (manually in .xls sheet), and interpret the data in terms of calibration, resolution and other fitting parameters. The expected result at the end of the course is teachers/students can now handle nuclear experiments with confidence and enter the research (or application) area with the most elementary and essential knowledge of handling Nuclear laboratory experiments.

Testing for the Taster Gene: A Hands-on Activity in Genetics & Molecular Biology
Anupama Ronad, Vikrant Ghanekar, Uzma Shaikh, Bhakti Mangaonkar & Dnyaneshwari Joshi

The taste of certain food items is perceived differently by different individuals. Items such as bitter chocolate or broccoli may taste very bitter to some individuals but not so to others. This can be attributed to the presence or absence of a single nucleotide change in the taster gene in humans. Thus, in a given population, some individuals will be ‘tasters’ while some will be ‘non-tasters’. PTC is a chemical that is regularly used for the detection of the phenotype of an individual. At very low concentrations, it is very safe to use PTC loaded onto strips of filter paper for the test. Such strips are commercially available and can also be prepared in the lab. The ability to taste is a dominant trait in humans. A hands-on activity to detect the genotype of tasters and non-tasters was standardized as part of a hands-on activity given in one of the lab areas of the Orientation cum Selection Camp of the Biology Olympiad Programme. Developing challenging and interesting experimental tasks is an important part of the Biology Olympiad Programme. Here, we present the lab activity that was developed based on a published paper to test students’ hands-on skills and conceptual understanding in the area of genetics and molecular biology. By integrating the phenotype and genotype identification, the task gives a better understanding of several key concepts, tools and techniques used in genetics and molecular biology. The activity has been used in various capacities as part of teacher and student training programmes at the high school, undergraduate and postgraduate levels. Teachers especially have found that various parts of the activity can be useful for inclusion in their classroom teaching, depending on the availability of resources.

Diversity in Soil!....
(alphabetical) Asmita Redij & Sreeja M

Alluvial, black, laterite, saline….. is the typical scientific classification of soil followed in mainstream textbooks and resources. Also, there is a general understanding that the type of soil in

an area determines the type of vegetation and crops that grow in that particular area. However, if we explore, soils change significantly even over a distance of 1-2 km.

Now we have two learning modules on soil: “No Soil, No Us; Know Soil, Know Us!” a Learning Unit developed as a part of the Vigyan Pratibha project, and a learning module titled “SOIL, PLANT AND US” as a part of a project on developing Culturally Responsive Science Teaching practices in school.

As a part of Culturally Responsive Science Teaching practices, where we identify ways to situate the textbook content with students’ lived experiences of students from the Eastern part of Maharashtra (Gadchiroli district), we studied the variety of soil samples in the region and students’ connection with it. Here, we got more than 6 varieties of soil samples within the range of 15 km, having a wide variation in the texture, colour, and physical and chemical properties of soil. For people of this region, soil is an integral part of their life. As narrated by some students from Gadchiroli,
“Soil from the river side is used to wash hair and it helps to reduce dandruff and keeps hair shiny.” (Translated from Marathi). “Even humans eat soil.” (Translated from Marathi)
In this poster cum exhibit, we will be displaying a variety of soil samples collected from different regions of India. The findings from school visits will be discussed.

Observation of Live Paramecium: A Simple Teaching Tool to Study Physiology at School Level
Vikrant Ghanekar, Anupama Ronad, Bhakti Mangaonkar, Dnyaneshwari Joshi & Uzma Shaikh

Animal classification is introduced in class IX in NCERT textbooks. In most of the school setups, classroom teaching of animal classification highly depends on either pictorial representation or preserved specimens of multicellular organisms. The unicellular microscopic protists are generally represented in the form of diagrams or images in all the textbooks. The lab specimens of this group are often restricted to chemically fixed slides.
Paramecium is a single-cell protist which can sustain and grow at normal room temperature with very little maintenance and can be cultured for extended duration without any sophisticated lab conditions. Due to the unicellular structure and transparent non-pigmented body, the life processes like ingestion of food, osmoregulatory activities, and digestion are easily visible under a compound light microscope. Apart from direct observation of live and actively moving protists under the microscope, the paramecium can be used for designing simple activities which can be performed even at the school level. Here, we present the observation of ingestion and digestion processes with minimal preparations and basic laboratory setup. The activity has been conducted regularly by cell members for students and teachers in various camps at different places. Considering the easy availability of experimental requirements and the possibility of observing active life processes in live microorganisms, teachers and students find it a very attractive and effective way of teaching/learning physiology in invertebrates along with animal classification.

Preliminary Observations on Knowledge of Vaccination and Vaccine-preventable Diseases in High School Students in M(E) Ward Mumbai
Anupama Das, Sandhya Koushika, Gauravi Mishra & Arnab Bhattacharya

India has a robust universal immunization program (UIP), with early childhood immunization being the focus of most government immunization initiatives. Adolescent immunization, however, had not received the same level of attention. A wealth of research has gone into studying parental knowledge and attitudes towards early childhood vaccination. To the best of our knowledge, there hasn't been a comprehensive study in India that examined high school students' attitudes and knowledge of vaccination.
This investigation was conducted to fill this significant knowledge gap. In order to assess students' knowledge and attitudes toward COVID-19 and general vaccines, sixteen interviews were conducted at various schools in the M(E) ward of Mumbai. The interviews covered a wide range of topics, including students' knowledge of vaccination, vaccine-preventable diseases, and vaccine hesitancy. The preliminary observations are interesting, as the difference in vaccine awareness and prevalence of VPDs is markedly different in schools catering to students from different socio-economic strata. The results of the study are highly relevant and timely given the recent COVID-19 vaccine approval, initially for children aged 15 to 18 years and then later for those aged 12 to 14 years. This work has provided input for designing a questionnaire for a larger quantitative survey to be carried out across Mumbai.

Keywords: vaccines, vaccine-preventable diseases, adolescent, knowledge, attitudes

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Leaflets of Chemical Compounds
Savita Ladage, Ankush Gupta, Indrani Das Sen, Trupti P. Londhe, Mursaleen Shaikh, Shreyank Mandavkar, Hanza George & Krupa Subramanian

Reddening of yellow spots on the clothes when washed with soap, brightening of color of mehndi on hand, mind refreshing smell of soil after the first rain are some events which might have pleased your senses some or other day. You might have seen unusually bright colours or quick ripening of fruits these days, which was not the case some decades ago. Understanding some chemistry aspects behind these phenomena is always worth it. So, herewith, we will present a collection of leaflets that will introduce you to some of the captivating facts about the chemical compounds responsible for these phenomena.
Leaflets of chemical compounds have been developed by the Chemistry group at HBCSE, which allows learners to look at the fascinating chemistry of chemical compounds used in day-to-day life. Most of the compounds for these leaflets were chosen from the past Indian National Chemistry Olympiad (INChO) question papers. The motive behind the leaflets is to explore the interesting chemistry of chemicals through multiple lenses like its history, art, trade, applications and its interconnections with environment, society, culture, etc. We hope that members of HBCSE coming from diverse backgrounds will be able to connect to some of the diverse facets of chemistry through these leaflets.

STEAMBoat: Learnings from Two Years of Online Outreach Sessions
(alphabetical) Adithi Muralidhar, Amish Parmar, Arnab Bhattacharya, Disha Dbritto, Manoj Nair, Ravi Sinha, Sathish C G, Sugra Chunawala & Suravi Kalita

In November 2021, the Homi Bhabha Centre for Science Education launched a series of popular online outreach sessions called STEAMboat. STEAMboat was especially aimed at students and

teachers who were not able to physically attend school due to the pandemic-induced disruption but could be reached online. The idea was to reach out to the general public through an online forum via engaging sessions exploring Science, Technology, Engineering, Arts, Mathematics (STEAM) and their intersections! One of the unique features of STEAMboat was that it would have these sessions in regional languages apart from English.
Till August 2023, 22 sessions have been conducted in Marathi (8), Hindi (10), and English (4). The sessions are conducted via a Zoom meeting that is also live streamed on YouTube. Pre-recorded videos (1 Gujarati, 1 English, 2 Hindi and 1 Marathi) of some sessions in additional languages were also uploaded on YouTube. STEAMboat is a great example of HBCSE members working collaboratively towards a shared goal. We have had faculty, research scholars, postdoctoral visiting fellows, project staff, and scientific staff members conduct various sessions spanning topics in STEAM. The sessions, typically lasting 50-60 minutes, are held in a very interactive format, with questions invited from the audience over Zoom and YouTube.
Lately, we have experienced a decline in the online audience and YouTube views, which could be attributed to online fatigue given the large amount of content now available, as well as the easing of pandemic-related restrictions. We seek inputs from the larger community to re-conceptualize STEAMboat to expand its viewership and audience further.

Asking Questions in Mathematics
Prithwijit De

Asking questions is central to learning any subject, and Mathematics is no exception. Often, new mathematical problems arise by asking simple questions on the statements of an existing problem. This not only keeps the subject alive by engaging one in pursuit of solutions to these new problems but also builds the "mathematical temper" of an individual who indulges in brainstorming. The act of asking questions catalyses the growth of the mathematical temper, which is one of the main goals of mathematics education. I will address this point by drawing on the contents of the following articles.

1. A Triangular Exploration - Prithwijit De & Gerry Leversha
https://www.cambridge.org/core/journals/mathematical-gazette/article/abs/triangular-exploration/783E039E63C56863C156C0B1A07FFBAC#article

2. An Interesting Spin-off - Prithwijit De & Sutanay Bhattacharya
https://www.cambridge.org/core/journals/mathematical-gazette/article/abs/10617-an-interesting-spinoff/D128B886B256524FAB428D75895B5EBD#article

3. Dwelling on the Incircle - Prithwijit De
https://publications.azimpremjiuniversity.edu.in/4183/1/15-Prithwijit_Incircle_Final.pdf

4. The Other Way Round - Prithwijit De
https://www.ias.ac.in/article/fulltext/reso/027/06/1089-1093

Students' Ways of Expression in Science Classrooms
(alphabetical) Aaloka Kanhere, Amish Parmar, Ankush Gupta, Deepa Chari, Nilkantha Gholap, Prasad Desai, Ram Kumar Kumawat, Sarita Kamat, Sreeja M. & Zeenath Mustafa

The Vigyan Pratibha project involves the creation of science and mathematics learning modules called Learning Units (LU) and their implementation in schools by teachers. An important aspect of implementation is school trials and observation, where Vigyan Pratibha members either facilitate a particular LU with a group of school students or observe a teacher do the same. Both situations become ways of hearing and seeing how students participate in class. Especially so because the LUs are designed to create numerous opportunities to bring students' thoughts into discussion.

Based on our team's experiences in school visits, cluster camps and other initiatives, we will exemplify ways in which students express their thoughts and ideas related to science content in written or oral form. While some of these ways may include textbook material, some can also be very informal with respect to language or analogies used. Some examples will also show in what ways students challenge each other.

Using these anecdotes, we will reflect on the potential of students' responses in making the science classroom a site for conversation and discussion around the topic at hand. These, in turn, contribute to a better understanding of the topic and help the facilitators in their roles in the classroom.

Designing Experimental Module for Analysis of Metal Ions Present in Hard Water for Undergraduate Chemistry Laboratory Education/course
Indrani Das-Sen

Chemistry Education Research literature related to laboratory education states that for meaningful learning in undergraduate chemistry laboratories, it is required that students conduct experiments using an exploratory/inquiry style. Such experiments need to present opportunities to integrate/relate both theoretical concepts with the experiments and reflect on experimental procedures. In the Indian context, especially for state colleges, the lab manuals that are used for chemistry laboratory courses are written in an algorithmic manner with little scope for reflections on the experimental procedures and associated difficulties.
The chemistry group at HBCSE is involved in developing experimental modules for the undergraduate laboratories in collaboration with teachers from colleges in Mumbai and Pune. This presentation will discuss one such exploratory module related to the estimation of Ca (II) and Mg (II), metal ions that are present in hard water samples. The module involves the use of a colourimeter or visible spectrophotometer. Efforts are made to develop the module in such a manner that students are involved in-part planning of the experiment and involved in decision-making before actual conduct in the laboratory, followed by data analysis and reflection of the same. While experimenting, students also try to understand the variables involved.

Hands-on Demonstration Session II
Day 2, 26th October 2023, 4 pm to 5:30 pm

Using Invertebrates to Visualize Biological Concepts
Dnyaneshwari Joshi, Bhakti Mangaokar, Uzma Shaikh & Anuttama Kulkarni

Invertebrates like Drosophila and Hydra are relatively inexpensive to maintain. They are also good pedagogical tools used to visualize core concepts of biology, like cell biology, developmental biology, genetics, physiology, animal behaviour and reproduction. We have developed and standardized multiple experimental techniques using these systems at the biology cell-HBCSE. For the AIM-2023, we will illustrate our approach using two experimental techniques. In one of the experiments, our goal is to analyze the pH profile of the Drosophila larval gut. Here, we discuss similarities and differences in the physiology of insects vs. vertebrates and questions like whether insects could be used as a model system to study human gastrointestinal tract disorders. We can also creatively modify these experiments to increase the level of inquiry in the laboratory courses. For example, in another experiment, we image Drosophila embryos under live conditions using a compound microscope. Once the students learn live imaging of Drosophila embryos and learn to identify different stages in fly embryogenesis, they can answer inquiries about whether changing the environment (media/temperature/noise) would affect the development of fly embryos. These experiments are now extensively used in various student and teacher enrichment activities at the centre. We will experimentally demonstrate these to our colleagues from HBCSE at AIM 2023.

Small Changes that can Make a Big Impact on The Classroom Environment: Our Experiences
Vinod Sonawane, Sonali Kathle, Narendra D Deshmukh & K T Hambir

This is an attempt to conduct a Hands-on Science Activity session for teachers and students in active mode instead of the Passive mode of performing an experiment and discussing it with the participants, which takes plenty of time and never allows the participants to interact with the actual setup. In the active mode of hands-on performing experiments in the school classroom, consisting of locally available material and low cost, several concept-based experiments in "Electricity and Magnetism" were carried out. Experiments from physical sciences are tested for the achievement of the students and teachers. Class VII to X grade students were allowed to perform more than 20 experiments in a single session. Interaction with the experiment was made simple; just by pressing the switch and rearranging the things by themself, one can observe the result. The interaction group was expected to establish causal relationships and reflect on the 'how' and 'why' aspects of their experimental observations. Also, how they connect it with the concepts that are studied in their earlier classroom and with specific names of the experiments which they already performed. Groups were rotated, considering that every student would get a chance to perform all the experiments. Now, with the completion of all the experiments, we found that they all could hardly explain the science and, hence, the causal effect, keeping in view that they needed to justify the How and Why of what they learned. As the laboratory setup differs from what is done in the school, we can say that in the discussion session, both teachers and students positively expressed that the activities performed or discussed during the laboratory session contributed greatly to our latest learning. The learner-centred approach is highly demanded since there is very little or no experimentation done in the present scenario of school science.

A Nonintuitive Demonstration on Faraday's Law
Saurabhee Huli, Shirish Pathare & Anwesh Mazumdar

Students are introduced to the concepts of potential difference in Kirchoff's laws of voltage and current in high school. These ideas are used extensively in problem-solving and common laboratory experiments as well and are considered to be universally valid in any electrical setup. However, one tends to forget that the concept of the electric scalar potential is based on the condition of the electric field being conservative. We present a simple demonstration where this premise breaks down, leading to remarkably non-intuitive measurements in standard electrical devices. Being confronted with such an apparently baffling experience helps to clarify understanding of the phenomenon of electromagnetic induction and the non-conservative fields involved therein. We will present the demonstration and discuss its underlying physics. We shall also touch upon the responses of students and teachers who were shown this demo, which reveal pitfalls in the understanding of Faraday's law.

Paper Presentation Session V
Day 3, 27th October 2023, 11:30 am to 1 pm

Revisiting Werner's Experiments to Understand Coordination Compounds
Sathish C G, Savita Ladage

Conventional undergraduate (UG) chemistry lab courses in state colleges in India primarily involve students working individually, following prescribed lab manuals. These lab manuals outline the aim, procedure, data to be collected, the way it is to be presented, and anticipated conclusions. Such an approach often limits students' engagement with higher-order cognitive skills, like critical thinking and decision-making, in the experimental domain.
Considering these issues and also to foster a deeper understanding of concepts related to coordination chemistry (a core topic in the UG inorganic chemistry syllabus), inquiry-based experimental modules are being developed. One such module is related to Werner's theory of coordination compounds, a foundational theory that explains structures and bonding in coordination compounds. In this module, students revisit and recreate select experiments performed by Werner during the formulation of the theory. Incorporating historical context, the guided inquiry module provides opportunities for enhancing theoretical comprehension through experimental observations and chemical reasoning.
The module is implemented as a group activity to present opportunities for peer collaboration. The module was tried out with undergraduate students during NIUS Chemistry Camp to get first-hand experiences about their responses. Based on students' responses and feedback, the module is further standardized. The feedback from students indicates that the module is engaging and presents opportunities to reflect on experimental observation to advance the theoretical arguments. The present talk will discuss this module under development.

Keywords: Coordination chemistry, history of chemistry, undergraduate lab education, collaborative learning

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Geometric Transformations: A Review of Middle School NCERT Math Textbooks
Saurabh Thakur & Deepa Chari

Geometric transformations (reflection, rotation, translation, and dilation) are majorly discussed in 'symmetry' and 'visual patterns' topics in the middle school mathematics textbooks of NCERT (2006). We aim to examine the scope of these geometrical transformations and study how they are discussed in the textbooks to understand the associated contextual, pedagogical, and curricular issues. We list some important observations here and discuss them in detail in the presentation.

The first example is about reflection. The idea that a 'perpendicular bisector' drawn to the line joining an object and its image is the 'axis of reflection' is not emphasized when reflection is discussed. In contrast, understanding this relation is fundamental for reflectional transformation.

In another discussion on the construction of quadrilaterals, students are supposed to push a rectangle along the breadth (in two opposite directions) to form two parallelograms. The result is described as leading to a set of "altogether different parallelograms". However, the text shows

images of two laterally inverted parallelograms. We argue that such a choice of parallelograms may lead to the abstraction of the idea that reflection is not an isometry.

The exercises based on articulating the rules underlying visual patterns do not include translation motion happening between each term, and it is instead expressed as “what should come next”. We argue that more such contexts already exist in the textbooks that can be used to highlight the role of translations or sliding, which is absolutely missing at this stage.

Ideas around superposition reflectional and rotational symmetries have been used to verify results related to angles, angles in special triangles and parallelograms, and diagonal properties of various quadrilaterals. We argue that the role of the axis of rotation and the avenues for dilation in a geometrical context are scarce.

Anandi: Anticipation And Planning For Distance Learning
Team Anandi. Presenters: Prajakta Zarekar & Uzma Shaikh

Anandi is an HBCSE newsletter for students of rural areas, started in light of the COVID-19 pandemic and the subsequent closure of schools that reduced learning opportunities. The newsletter's content is designed for students in grades 8 to 10. The 8-12 page newsletter and a response leaflet have easy-to-read articles on science, mathematics and humanities. Students often fill out the response leaflet and send it back using a pre-stamped envelope attached to each newsletter. Anandi is distributed to students through their schools. The pilot of this project started in 2021 with a few sample issues being sent to select schools on an initiative by Dr Asmita Redij, a postdoctoral fellow at HBCSE. As of September 2023, each month, the newsletter is being sent to about 7000 students in about 60 schools across Maharashtra. The graphics used in Anandi are based on an 'edu-design' approach, whereby the readers can relate to the content. Often, the context is chosen as relevant and language is simplified. The newsletter is replete with colourful figures and drawings that use representative and realistic imagery familiar to the readers. Every issue is unique, and every cover page, too. The cover page is designed on the central theme of the topics highlighted in the editorial. To aid readers' engagement, the article layouts are made differently. We have used two-page spread posters, step-by-step infographics, comic-style layouts, etc. Each issue of Anandi also comes with a crisp editorial that tries to challenge or intrigue the reader. During this presentation, we will bring snapshots of articles published in Anandi and elicit the abovementioned aspects. Our focus would be to illustrate how student engagement and participation could be anticipated through deliberate planning in content, design, context and tiny directives for a distance mode material development.

Assessing School Science Teachers’ Understanding through Hand-on Activities on Heat: An Experience of Collaborative Learning Approach
Sonali Kathle, Narendra D Deshmukh

The process of science learning and sense-making helps students to think and act scientifically and critically. According to the NEP 2020, science teachers should implement various constructivist learning approaches to emphasize active learning, critical thinking, creativity, collaboration, and communication.

The purpose of this exploratory study was to assess school science teachers' understanding through hands-on activities on basic concepts of heat. Also, the effectiveness of collaborative learning approaches was investigated during the workshop. In this qualitative study, hands-on activities and a two-tier diagnostic test on basic concepts of heat were developed and standardized. The convenience sample consisted of 34 high school science and mathematics teachers from urban and rural schools run by the Government of Maharashtra. The data collected through a two-tier diagnostic test and activity sheet was analyzed manually. The analysis of the data revealed that a significant number of teachers were unable to provide explanations for sub-concepts of heat, such as thermal equilibrium, conduction, convection, and exchange of heat. This indicates their lack of knowledge about these sub-topics. School science teachers possess inadequate knowledge, which subsequently hinders their ability to effectively impart accurate knowledge to their students. This means that these teachers' misconception of heat possibly affects classroom learning and may create misconceptions among students.

Similarly, teachers must collaboratively work on activities to rebuild their knowledge. The study also shows that to promote engagement, hands-on experiments can provide a 'realistic and exciting experience of the content' and may facilitate motivation. It is also important to integrate hands-on activities focusing on heat conduction, thermal equilibrium, and convection with everyday materials in teacher training and classroom teaching. Teachers suggested they need more hands-on activities on various science concepts to implement a similar collaborative learning approach in their classrooms.

List of Reviewers

1. Adithi Muralidhar
2. Aniket Sule
3. Ankush Gupta
4. Anwesh Mazumdar
5. Deepa Chari
6. K Subramaniam
7. Mashood K K
8. Prithwijit De
9. Sanjay Chandrashekharan
10. Sarita Kamat
11. Sathish C G
12. Saurabhee Huli
13. Savita Ladage
14. Shirish Pathare
15. Shweta Naik