List of Abstracts

10th Annual Research Meet

May 25-29, 2020

HBCSE Webinar

Visit us at:

https://arm.hbcse.in/

Homi Bhabha Centre for Science Education

Tata Institute of Fundamental Research

Mumbai, India

List of Presentations (Webinar)

List of Posters Presentations

Day 1: 25th May, 2020

List of Webinar Presentations

Observation and Experiment: Debates in Science

Sarita Devi

Department of Education, University of Delhi

sarita.851084@gmail.com

Science is a kind of knowledge which has such authority in all the domains of our life, whether it is health, education, market and even religion. This high status of science is because of the 'Scientific Method' which makes the knowledge reliable and objective. What is this scientific method which defines the objective nature of science has always been a question of philosophical inquiry. This paper focuses on the two vital aspects of this Scientific Method namely, Observation and Experiment. Here the purpose of the paper is to discuss the debates on the role of observation and experiment in the generation of knowledge in Science. Observation and experiment form the base for scientific knowledge as it provides the content of analysis in the area of science. Observation is a way to form the perception about any phenomenon through senses. This arises the debate whether the observation of any phenomenon is a private and passive affair or it is public and active. Similarly, experiment used to verify certain facts which are based on some kind of observation. Experiments give rise to debates of its dependency on judgement of theory and advancing technology. This paper concludes that experiment and observation are two important aspects of scientific methods to claim objectivity. Both observation and experiment are objective but there is scope of fallibility and revision with respect to change in theories and advancement of technology.

Understanding the significance of History and Philosophy of Science in teaching and learning Science through the lens of History of Atomism.

Maithily K.

Grassroots Research and Advocacy Movement

mit233akshaya@gmail.com

Since the dawn of life, the hunt for methodologies in the search of truth has formulated mankind. The attempt to internalize Nature of Science as a body of knowledge, a systematic study and a process by itself has travelled hand in hand with the evolution of civilization. At a larger scale, the comprehensive expression of these processes is compiled to articulate Science to be both objective as well as subjective at contexts.

The project has both scientific and ethical goals. The scientific goals underscore the significance of the Nature and Perspectives of Science as the underlying factor in teaching and learning Science. 'Atomism' is the living fossil that exemplarily explains this characteristic of Science as a way of living. The study of atoms embraced the fine line of demarcation between Philosophy and Science thereby justifying the basis of The Universe. Acquisition of this knowledge reflected several folds of changes in the regional and religious belief system, answering vast number of traditional practices thus making Science a dynamic process. The study will be equipped with analysis of Science textbooks of grade 6th to 8th for the topics of 'Atom' trying to understand the scope of Nature of Science across this spiral curriculum. A Semi-Structured Interview with the teachers practicing Science across these classes regarding their practice of methodologies in teaching Science will underline the ethical goal of the study. The study will be carried out in 5 schools of each cluster comprising rural, urban and semi-urban contexts of Karnataka.

History and Philosophy of Science as the preliminary foundation encourages appreciation towards learning Science thus transiting the study of Science as a subject to way of living, connecting theory to practice.

The CEO of the Cell: How Centralized Thinking and Dominance Hierarchy Pervade in the Discourse on Living Cell

Charudatta Navare

Homi Bhabha Centre for Science Education, TIFR, Mumbai, India

charudatta@hbcse.tifr.res.in

This paper looks at the way the ideology of social dominance hierarchy influences the discourse on biological cells. Through the use of various visual and verbal metaphors, the cell is portrayed as a centralized system, with the nucleus as the leader or the control center. Although metaphors, like models, are nothing more than working hypotheses, often used metaphors become jargon of the field, and become an ideological lens that shapes the way we see and investigate. I dissect the visual representations as well as metaphors to note the tendency of postulating centralized systems and attempt to trace the appeal of such centralized narratives. I problematize these centralized narratives by borrowing from complex systems research (Resnick, 1996). Alternative narratives are explored wherein DNA is input data for the biochemical computing network of the cell (Altman and Koppel, 1990) instead of the program, or simply a book of ingredients instead of being a recipe or instruction manual. I argue for a decentralized view of the cell, one without a single stable locus of control within the cell. Finally, I discuss the two-way interaction of scientific narratives with the social discourse and analyze the ways in which scientific narratives can be used to justify and reinforce social dominance hierarchy.

Day 2: 26th May, 2020

Agency building and early research exposure: A study in an Indian undergraduate science education program

Deepika Bansal*, Deepa Chari**, Savita Ladage***

Homi Bhabha Centre for Science Education, TIFR, Mumbai, India

deebans.88@gmail.com[*], deepa@hbcse.tifr.res.in** , savital@hbcse.tifr.res.in ***

Undergraduate research provides students with opportunities to positively perceive their association with a discipline through agentic experiences, and thereby fostering the disciplinary identity building. This study explores students' experiences of participating in a 10-day long 'Exposure cum Enrichment Camp in Chemistry' organized by the National Initiative for Undergraduate Science (NIUS). The camp is attended by approximately 50 students every year who come from different parts of the country. They participate in extended laboratory sessions which necessitate reflection on their lab projects with a focus on experimental procedures and features of data. Additionally, they are provided guidance on core topics in chemistry. Semi structured interviews were conducted with 15 students to understand how students express their own identification and agential relationship with the subject. In this paper, we discuss their overall perceptions of participation in the camp including their self-reported accounts of emergence of agentic personalities during this camp.

Integrating Psycho-Social Needs of Refugee Girl Children in Educational Spaces: A Case Study of Rohingya Girls Settled in Hyderabad

Debanjali Saha

Tata Institute of Social Sciences, Hyderabad (2016-2018)

debanjalione@gmail.com

Under international law of Universal Declaration of Human Rights (1948) and Convention on the Rights of Children (1989), refugee children have theoretical rights to basic needs such as food, shelter, health care facilities and education. However, in ground reality, such laws are unenforceable in nature. In a situation of forced displacement, the women and girl children of the

persecuted community are affected the most since through the violation of the bodily integrity of the female members of a community, the culture and ethnicity of the community is attacked. Protecting the immediate basic needs with a vision of long-term development for this doubly marginalized population thus becomes important in a host country. With respect to refugee girl children, educational spaces are sanctities which provide them with safety and security. However, this is not the case for Rohingya refugees in India. Undertaken in the suburbs of Hyderabad in refugee camps with the assistance of Save the Children, this study focuses on the analysis of the right to education of the Rohingya refugee girl child and her psycho-social needs in order to access and sustain at educational spaces. The study is qualitative in nature, pertaining to the feminist methodology of the interpretive paradigm with a thematic analysis of the data collected. This study showcases that access to educational spaces often involves sexual harassment, humiliation inflicted by teachers and peers within classrooms. Furthermore, there exist difficulties in learning a new language and integrating with the cultural norms of the host society. Within classrooms, teachers' perceptions towards and interactions with these students can either encourage or discourage their participation. This study found out the high aspiration levels of refugee girl students and refugee parents are highly involved in their daughters' education in order to secure a safe future. However, the obstacle which resonated with all refugee parents is the inability to achieve educational certificates in the absence of proper identification cards. This acts as the primary reason for prevalence of early child marriage within the community. Through this study, emphasis has been made to create spaces where refugee girl students can voice their problems, exercise agency in their life choices and carve out a better future for herself and her family. To achieve this, counselling services, language trainers and support from Urban Local Bodies (ULBs) are required to cater to their immediate needs.

Keywords: Rohingya refugee girl students, teachers' perceptions, educational spaces, gender-based discrimination, psycho-social needs, counselling services, access to education

Narratives of women's experiences in science popularization careers

*Mayuri Pawar * and Deepa Chari ***

*Homi Bhabha Centre for Science Education, TIFR, Mumbai, India**

mayurip@hbcse.tifr.res.in* and deepa@hbcse.tifr.res.in**

Science popularization aims at connecting to a generic and diverse audience with the intention of growing scientific knowledge in the reached communities. In science popularization, resources persons play a key role in maintaining good standards of science and technology dissemination. Careers in science popularization can satisfy many enthusiastic science graduates' career-interests as well as their urge to contribute to science advancement. In spite of this, women representation in science popularization careers is low. The study captures experiences of women working in the science popularization field. A narrative inquiry methodology was applied to collect contributing authors' first-hand experiences. In addition, interviews were conducted with 5 more participants, and the participants' narratives were developed. The authors collectively analyze these narratives to understand how participants identified the possible benefits of working in this area. Further, they emphasize some of the challenges described by the participants in their career trajectory and how they dealt with it. Some challenges involved poor infrastructure at the camp sites or travel facilities, and negative attitudes of colleagues about women leadership, etc. A few experiences depicted how women themselves had to opt-out from opportunities in science popularization due to some of the above-mentioned conditions.

Day 3: 27th May, 2020

Teacher Interactions with a Vigyan Pratibha Learning Unit

Chaitanya Ursekar

Homi Bhabha Centre for Science Education, TIFR, Mumbai, India

chaitanya@hbcse.tifr.res.in

The Vigyan Pratibha programme at HBCSE seeks to nurture students' interest in science and mathematics. The programme revolves around modular, activity-based instructional plans, called learning units (LUs). Teachers from participating central government schools are familiarized with the LUs at workshops at HBCSE, after which they voluntarily conduct them with their students. It is also expected that this may lead to teachers' professional development through the experience of transacting new teaching-learning materials. However, the literature suggests that teachers' use of teaching-learning materials is not a straightforward matter. Teachers may face challenges in effectively using new teaching-learning materials that may affect learning outcomes (Davis, Janssen & Van Driel, 2016).

In the context of this larger problem, I characterize a teacher's enactment of a Vigyan Pratibha LU called "Is there protein in those grains?". My data includes a pre-enactment interview with the teacher, observations of enactment, and a post-enactment reflective interview with the teacher. I analyze this data using the curriculum strategy framework put forth by Sherin and Drake (2009). The framework suggests three kinds of teacher-curriculum material interactions – reading, evaluation, and adaptation. I highlight instances of these three in the teacher's use of the learning unit. In particular I describe the challenges faced by the teacher as a result of adaptations (both intended and unintended) that were made to the unit. I also identify provide an account of the teacher's reflections on and learning from having enacted the unit. Lastly, as a designer of the learning unit, I also highlight opportunities for student learning that emerge due to the teacher's modifications.

References:

Davis, EA, Janssen, FJJM, & Van Driel, JH. (2016). Teachers and science curriculum materials: Where we are and where we need to go. Studies in Science Education, 52(2), 127–160.

Sherin, MG, & Drake, C. (2009). Curriculum strategy framework: Investigating patterns in teachers' use of a reform-based elementary mathematics curriculum. Journal of Curriculum Studies, 41(4), 467–500.

Undergraduate Biology Students Illustration of Experimental Design of Simple Model Systems

Meena Kharatmal[1], Mayur Gaikwad[2], Aashutosh Mule[3]
[1]Homi Bhabha Centre for Science Education
[2]Elphinstone College
[3]Centre for Excellence in Basic Sciences
meena@hbcse.tifr.res.in [1]; mayur2604@gmail.com [2]; aashutosh.mule@gmail.com [3]

Experimental competencies such as asking questions, designing experiments, observing, disseminating results, forms a crucial part of learning for biology students. The objective of this preliminary study is to explore undergraduate students' formulating of experimental design of simple model systems during experimentation. Students worked in groups on three assays of fruit fly, earthworm, snail. We sought their illustration of experimental design through written and drawn responses. Further, they were specifically asked to list the parameters such as control, treatment, independent and dependent variables in their experiments. It is observed that students have illustrated experimental design quite well, though there were confusions about assigning variables explicitly. The study highlights that although students are performing experiments, there is a disconnect with the research methodology context at the undergraduate level. This preliminary study discusses aspects of experimentation along with implications.

Keywords. Experimentation, experimental design, variables, scientific method, model organisms, undergraduate biology

Using the TSPCK framework to improve the content knowledge of pre-service teachers

Narendra D. Deshmukh

Homi Bhabha Centre for Science Education, TIFR, Mumbai, India

ndd@hbcse.tifr.res.in

Research has shown that when the teaching of pre-service teachers (PSTs) is conceptualized and implemented using the construct of Topic Specific Pedagogical Content Knowledge (TSPCK) as a framework, a better understanding of how to teach those topics is developed in them (Mavhunga & Rollnick, 2013). Not much is however known or documented on the impact of the same framework on teachers' content knowledge. This was the motivation for this study. The study was guided by the two research questions:

a) What is the level and quality of pre-service teachers' knowledge of the cardiovascular system and respiration? and,

b) How does the pre-service teachers' content knowledge change (if at all) after doing an biological science course that is informed by the TSPCK framework?

In this study both qualitative and quantitative approaches used to understand pre-service teachers' knowledge of the cardiovascular system and respiration before and after the physiology course. For the data collection- Concept Based Objective Tests (CBOTs), interviews, Concept map, assignments, presentations, and Content representations instruments were used. The preliminary results show that the participants have satisfactory Concept Knowledge (CK). However, their CK shows gaps of understanding of certain aspects. Investigating participants' prior knowledge helped us as teacher educators to focus on different components of TSPCK such as curricular saliency and what is easy or difficult to teach and learn.

In this presentation, apart from pre-service teachers' misconceptions, I will discuss the role of misconception study in TSPCK and its necessity in teaching and learning for meaningful understanding.

Keywords: Topic Specific Pedagogical Content Knowledge, Pre-service teachers, Misconceptions, Circulatory and respiratory processes.

Exploring small-group learning in a PBL undergraduate chemistry laboratory

Sujatha Varadarajan

Homi Bhabha Centre for Science Education, TIFR, Mumbai, India

sujsvarada@gmail.com

We designed and implemented a PBL task on indigo dyeing wastewater treatment. PBL advocates self-directed and collaborative learning wherein students work in small groups to find a solution to the given problem. In our present work, we tried to understand - a) learning in a small-group, and b) students' perceptions about small-group learning.

To understand the learning in a small group, we closely monitored the interactions of three students of one small-group. The data collected for this purpose included field-observation, feed-back questionnaire, and the semi-structured interview. Further, we tried to understand the students' perception of the small-group learning through a questionnaire. We implemented the PBL task in a college in Pune, and a group of 20 students participated in the study.

The data from our first study suggests that the disagreements between the group members and the subsequent discussion as one of the important ways of knowledge construction within the small-group. Besides, the data also indicates that the small-group interactions during the laboratory work led to students' engagement with the cognitive dimensions of evaluation and analysis of their planning and execution of the task.

The analysis of the questionnaire suggests that students recognize the contributions of group members in problem-solving during all the three phases of the implementation of the PBL task i.e. the pre-lab work, lab-work, and post-lab work. Students acknowledge the importance of heterogeneity in terms of academic skills within a small group. However, they believe the similarity of ideas that students want to explore should be the basis for the formation of groups.

The presentation would include the interpretive description of the case study of the small-group and the results from the perception study.

Day 4: 28th May, 2020

Investigating Learners' Feedback Seeking Behavior and its role in the development of Representational Competence

Narasimha Swamy

Indian Institute of Technology Bombay,

klnswamy@iitb.ac.in

Research on feedback practices in education has a history of more than a century. Across this history, feedback has been predominantly viewed as a one-way transmission of information from teacher, computer or peers to the learners. Such information was aimed at addressing learners' immediate instructional or motivational needs rather than trying to enable them to become proficient in seeking, judging and utilizing feedback from diverse community sources. Hence there is a lack of studies investigating conditions under which learners proactively seek feedback to attain the given instructional goals or when and how such feedback seeking contributes to better learning. In my study I operationalize feedback seeking behavior as a learner-initiated dialogue to accomplish the given instructional goals. I investigate learners' feedback seeking behavior during a representational task in stereochemistry. This task required learners to go beyond just verbal exchange of feedback and build complex molecular models or sketch multi perspective diagrams while seeking or providing feedback. For the purpose of analysis, I have adapted a well-established cost-value framework of feedback seeking behavior from organizational behavior research. Here I take a socio-cultural stance where dialogic interactions amongst peers, teachers and the mediating tools or conditions in the instructional environment are considered as central to the learners' feedback seeking process. So, the adaptation closely aligns with the cultural historical activity theoretical approach to Human learning. Using this framework, I examine and describe how the interaction between characteristics of instructional artefacts and rules, the learner, feedback sources and the nature of cooperation influence learners' perceptions of cost and value in seeking feedback. Preliminary findings suggest that learners' cost-value analysis influences the various aspects of feedback seeking such as the timing or amount of feedback seeking, the purpose for which feedback is sought, the choice of feedback source and also the mode of seeking and using the feedback received. Some of the

outcomes of learners' feedback seeking behavior were observed to align with that of representational competence such as gaining understanding of when and how to use models or diagram translation. Nature of my findings hold promise in potentially informing the design of instructional contexts for supporting development of both learners' proficiency in feedback seeking and their representational competence.
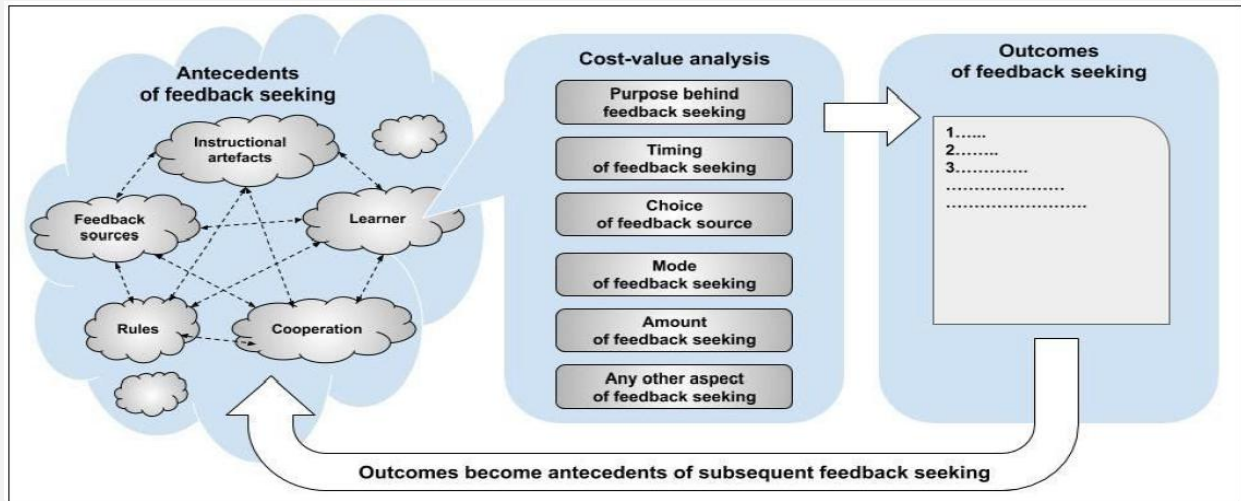
Adaptation of cost-value framework to examine learner's feedback seeking behavior.

Unpacking Collaborative Uncertainty Management Processes of Learners in the Context of Engineering Design

Navneet Kaur

Indian Institute of Technology Bombay,

navneetkaur@iitb.ac.in

Uncertainties are part of almost every learning process. It is believed that the production of true knowledge starts from feelings of uncertainty, requiring people to express them openly. Researchers across varied disciplinary domains have argued that learners should encounter uncertainties engendering complexity, doubt or confusion to develop a deep understanding of the disciplinary content and practices. However, in order to leverage uncertainties to aid learning, it is first important to understand how learners engage in the process of managing the uncertainties that they face. This includes aspects like – how uncertainty is expressed and by whom, what factors trigger uncertainties, how learners respond to them and what are its outcomes from the

learning perspective. The focus of my research is to dig deeper into these aspects, in the context where learners collaboratively solve an open-ended engineering design problem given to them.

The target population of my work is middle school students and I have conducted two research studies with sixth and seventh grade teams until now. The analysis of the data, primarily collected from the video recordings of the teams, focused on identifying what are the different types of uncertainties that learners experience, the uncertainty management strategies used by them, and what uncertainties have the potential to productively engage learners with disciplinary practices. This preliminary analysis resulted in the process diagram showing the connections among – 1) how and by whom the uncertainty is expressed, 2) management of uncertainty by the teams, and 3) the outcomes of the uncertainty management process. We further investigated how shaping the learner's ability to 'notice' and then experience specific uncertainties can create opportunities for them to develop deep disciplinary understanding. Taking the distributed cognition perspective, we are further designing studies to understand the cognitive processes involved in the task of collaborative uncertainty management. The investigation will involve unpacking the role of the design environment which includes, the team members, mentor/facilitator, materials for building designs, tools for acquiring or sharing information and tools for providing feedback.

Exploring the Use of Stories and Narratives of Scientific Discoveries to Teach NOS to Middle School

Punam Medh

Tata Institute of Social Sciences

punammedh@gmail.com

There is also an age-old practice of conveying information through narratives, both in formal and informal science education (Glaser et al, 2009). A narrative approach allows for the true excitement of curiosity to shine through, fueling children's own curiosity and interest in the process (Engel et al, 2018). Research also posits that integrating stories about scientists and their discoveries into science content instruction can also be effectively used as highly contextual nature of science instruction, and has long been advocated in science education. (Abd-El-Khalick, 1999; Allchin, 2013; Clough, 1997, 2004, 2006, 2011; Matthews, 1994; Klassen, McMillan,

Clough, & Olson, 2007). The need for Nature of Science (NOS) education in order to enable deeper engagement of science also sits in with the curricular recommendations of NCF 2005 which states that:

We can regard good science education as one that is true to the child, true to life and true to science. The historical validity requires that science curriculum be informed by a historical perspective, enabling the learner to appreciate how the concepts of science evolve with time. It also helps the learner to view science as a social enterprise and to understand how social factors influence the development of science" (NCERT, 2005).

Given the importance of stories and their contribution to NOS, it would be interesting to find out whether and to what extent does the practice of using stories translates into the classroom, i.e. how often do teachers actually tell stories during class. If they do indeed use stories, what kind of stories do they tell? Whether these stories are planned or spontaneous? What do teachers do about the small blurbs 'Great Scientists' that appear in textbooks? The answers to this line of inquiry are foregrounded by an attempt to understand the teacher's own perception of NOS and its importance in the curriculum.

Twelve science teachers, mainly from government and low-cost private schools in urban and semi-urban locations, share their practices and perspectives on stories, story-telling and on Nature of Science.

Network Map of Cognitive Flexibility in STEM education

Archana Udayagiri

NetworkEd

archana.udayagiri@gmail.com

This literature review stitches together the perfect harmony between the laws of nature and laws of the human mind in order to have a healthy and flexible mind capable of deep learning and application of knowledge.

Jean Piaget, a developmental psychologist, coined the term 'Constructivism' meaning the human mind constructs a beautiful web of information based on what is selectively absorbed from the environment. This information web called the 'schema' is natural to all humans regardless of

culture, economic background and gender. All our interactions with the world and our meaning-making is based on our schema.

Likewise, the world around us, particularly nature operates on a set of patterns and principles. Be it hidden patterns of mathematics in nature or man-made inventions which again draw back to biomimicry, there's a unifying theme amongst all functionality we experience in the world.

This literature review brings out the essence of the Aristotle's Laws of thought as a solution to enhance our schema, design experiences and enhance curricula for children to grow cognitive flexibility in the STEM fields through observation and grow the potential of inculcating an 'innovator worldview' in children from a very young age through simple yet powerful techniques.

Day 5: 29ᵗʰ May, 2020

GIT: An introduction to version control

Soham Dighe

Homi Bhabha Centre for Science Education, TIFR, Mumbai, India

sohamdighe228@gmail.com

Collaboration is the key to success. Creating a collaborative workplace often results in a win-win situation, where everyone involved can gain from the experience through successful outcomes and the feeling of achievement.

In the modern-day world, major collaborations happen over files and documents.

There are certain collaboration problems that we face with respect to the same:

1) File duplication and the inability to access the most current document version.

2) Users are unsure of which is the final document version.

3) Important documents are accidentally written over.

4) Time is lost searching for documents which are often never found.

5) Document naming conventions are convoluted.

6) Document access permissions are confusing.

7) Client collaboration and file sharing is not clearly defined.

8) Users are unable to access boiler plate documents, forms and templates.

File Duplication stays the top most problem as users end up working on multiple versions of the same file. That's where GIT, a version control tool, comes into picture. By definition, Version control is a system that records changes to a file or set of files over time so that you can recall specific versions later. GIT is as useful to a programmer like me, as well as to a researcher. In my presentation I will be focusing on both the roles and how can we as users benefit from the same.

Acoustical Resonance in Humans through Determination of Individual Natural Frequency

Anirvan Gupta[1], Nivedita Azad[2]

[1]*Department of Physics, Smt. Devkiba Mohansinhji Chauhan College of Commerce and Science, Silvassa, U.T. of Dadra and Nagar Haveli, India*

g.anirvan@gmail.com

[2]*Department of Botany, Smt. Devkiba Mohansinhji Chauhan College of Commerce and Science, Silvassa, U.T. of Dadra and Nagar Haveli, India*

niveditaazad1984@gmail.com

In the auditory channel, humans are highly attuned to emotional signals in speech and music that arise from shifts in the frequency spectrum and intensity of sound. In this study, responses of human beings from various age groups were observed by exposing them to sinusoidal tones of frequency within human hearing range. Similar to a mechanical resonant system, the human body also has an internal cavity, which, when exposed to an external frequency equal to its natural frequency, vibrates with maximum amplitude. An attempt was made to estimate the resonant frequency of an individual. The study is expected to throw light on the acoustic environment most suited for an individual to make him realize a state of contentment when he is in an enclosure meant for worship or meditation. The study may also support people from medical background to treat a person through acoustical techniques.

Incubator: Incubating your ideas and sharing knowledge:

V. C. Sonawane

Homi Bhabha Centre for Science Education, TIFR, Mumbai, India

vcs@hbcse.tifr.res.in

Learning by 'making things 'is highly encouraged as students can take multiple decisions regarding material, size, proportions, control during experimentation. Making which engages

them with doing science. With this idea, we took up the challenge to make an incubator from scratch as a learning experience in the Integrated Laboratory.

Incubator is a device used to grow and maintain microbiological cultures or cell cultures. It basically maintains optimal temperature, humidity and proportion of CO_2 & O_2 in an enclosed area like the atmosphere. Incubators are essential for a lot of experimental work in cell biology, microbiology and molecular biology. An incubator for hatching hen or quail eggs has more demand since it has commercial value. As chicken eggs are readily available and are the biggest single cell available for us to study embryos in the laboratory, we decided to build it. Chicken egg is a eukaryotic organism whose cells, unlike prokaryotes, have a nucleus enclosed within a membrane. We decided to study it, partly to make this unit a part of Makers Lab. Idea struck us that we would design and fabricate a portable incubator. Four eggs were kept for hatching but only two hatched. During the entire 21 days, we learnt many things. In this workshop interesting facts related to incubators as hardware and the study of embryos will be discussed in brief.

Eliciting students' models of atmospheric pressure through a designed activity

Tripti Bameta [1], Arjun Singh [2], Deepa Chari [3] & Mashood K K [4]

Homi Bhabha Centre for Science Education, TIFR, Mumbai, India

tripti@hbcse.tifr.res.in [1], arjun@hbcse.tifr.res.in [2],

deepa@hbcse.tifr.res.in [3], mashood@hbcse.tifr.res.in [4]

The direction of force due to atmospheric pressure is a difficult topic for students to understand. Our study involving 35 high school students point towards the existence of two contrasting mental models of atmospheric pressure underlying their conception of the direction of force due to atmospheric pressure. These mental models, which we call the weight model and the collision model, were revealed as part of an activity to determine atmospheric pressure. Our study shows a predisposition among students to adhere to the weight model. We discuss everyday experiences and textbook presentations as two plausible sources for this predisposition. The activity and associated discussions have shown potential to facilitate student's transition from the weight model to the collision model.

Rough Concept Inventories

A. Mani

Homi Bhabha Centre for Science Education, TIFR, Mumbai, India

a.mani.cms@gmail.com , mani@hbcse.res.in

Homepage: http://www.logicamani.in

Orcid: https://orcid.org/0000-0002-0880-1035

Concept inventories are MCQ-based instruments designed to test the understanding of concepts (and possibly the reasons for failure to understand) by learners. Often, they are deemed to be rather incompatible with student centered modes of learning and evaluation. Some inventories require students to provide justifications for their answer and thereby significantly boost the quality of assessment offered. In this research the problem of adapting the subject/concept specific instruments to make room for diverse response patterns (including vague ones) is explored in some detail by the present author. It is shown that high granular operator partial algebras invented by her [1] with additional temporal and key operators are well suited for representing them. Rough concept inventories, proposed in the research, can handle vague subjective responses, improved standardization and the basic apparatus for the formal study of consequence in the contexts.

A weak summary of the proposed methodology is as follows:

1. select a number of key concepts in a subject or topic;

2. situate them relative to the concepts and granular concepts described in the model (or alternatively situate the concepts relative to a concept map in terms was constructed from and is a part of, and basic well-understood concepts);

3. formulate multiple choice questions that aim to test key aspects of applications

of the chosen concepts;

4. each question is required to have at least one correct answer and a number of distractors based on alternative conceptions;

5. require explanation from students for their choice;

6. evaluate explanations relative to model in terms of concept approximations (or alternatively evaluate explanations relative to concepts that are definitely and possibly understood).

References

1. Mani, A.: Dialectical Rough Sets, Parthood and Figures of Opposition-I. Transactions on Rough Sets XXI(LNCS 10810) (2018) 96_141

List of Poster Presentations

1. Impact of Strengthening Student Voice and Expression on students' academic results in STEM subjects

Gaurav Siddharth

Teach For India

gaurav.siddharth2018@teachforindia.org

Student voice here refers to any expression of any student anywhere about anything relating to schools, learning or the educational experience. This study enabled students to be co-designers in learning and empowered in their own development. Teaching Mathematics to a group of 75 Grade 9 students over a period of 2 years showcased the trend - where students constantly exposed to opportunities wherein their feedback, suggestion or complaint - had an impact, led to their overall development in academics faring better than their same age peers. Students in the study were provided several opportunities for a duration of 2 years - both within and outside school. In all these events and activities, students' opinions were welcomed, changes suggested by them implemented and classrooms were in turn driven by what students wanted. Students also designed classroom

structures that were more effective at meeting the classes' own goals for the academic year.

The different structures which made students voice and expression evident in decision making were specifically designed exit slips, reflection circles, student-led classes, student council, marathons, etc. The central idea was that the students are equal stakeholders around which the whole fabric of education is woven. They must be empowered to make right choices for themselves and this would be possible only when they are able to express themselves. The results of the study were - Students'

performance grew from a meagre 3% of students above 1st class to more than 42% of the students above 1st class in Mathematics (Geometry).

The classroom was also adjudged as one of the top 10 finalists in the Transformational Impact Journey (TIJ) classroom by Teach For India. The students who were earlier not able to clear grade 9 scored a whopping 100% in their weekly assessments and an average of above 60%.

2. Simulation Based Learning (SBL) in Chemistry: Student Understanding of Acids and Bases

Shanize Forte[1], Nathan Turner[2], Tanya Gupta[3], Sanjay Chandrasekharan[4] & D.P. Karnam[5]

shanize.forte@gmail.com[1], nathan.turner@sdstate.edu[2], tanya.gupta@sdstate.edu [3], sanjay@hbcse.tifr.res.in [4] & durgaprasad@hbcse.tifr.res.in [5]

Simulation-Based Learning (SBL) has been found to be promising for developing student conceptual understanding. SBL involves constructed models of the real-world phenomenon to assist students in understanding and connecting the underlying scientific concept of a phenomenon and the chemical interactions involved therein through dynamic visual representations. In this study we sought to analyze the impact of SBL in chemistry at the college level by studying how SBL impacts student conceptions and mental models. Using exploratory qualitative research methods that involved Likert surveys and semi-structured interviews, data was collected from college students for pre- and post-simulation activity. Analysis of data showed that students experiencing SBL had a positive outlook of chemistry. The semi-structured interviews revealed gaps in student understanding of acid-base chemistry and how SBL furthered student conceptual understanding. This presentation will highlight results of the impact of SBL on student understanding of acid-base chemistry.

3. Experiences Piloting Design, Technology and Innovation as a Subject in TSWREIS School with a Student-Led Model

Abhishek Dey[1], Shramanth Rajarathnam[2] & Eshwar Bandi[3]

Inqui-Lab Foundation

abhishek@inqui-lab.org [1], shramanth@inqui-lab.org [2] & eshwar@inqui-lab.org [3]

Inqui-Lab Foundation has been in the space of creativity, design, prototyping and innovation for the past 3 years. Inqui-Lab's vision is to "Nurture problem solving capacity in the next generation", where, problem solving capacity as building the following   skills   in   students: Design Thinking, Prototyping, Risk Taking, Team work Inqui-Lab designed a year-long program called "Innovation Program" which was based on design, technology and prototyping but with the idea that students can solve problems with their own creativity and innovative spirit. For the academic year 2019-20, Inqui-Lab partnered with 15 TSWREIS schools (which come under the Telangana Social Welfare Department) to pilot a student-led program. This essentially meant that selected students (2 from each class) were trained to teach other students in their classrooms. An assigned teacher from each school also accompanied the training, but with the view of only being aware of the Innovation Program, the logistical and material demands, but not to teach the program. As the pilot progressed, we documented our learnings and some critical data points in the implementation of the Program. These include the role of the teacher, the need for Inqui-Lab's direct support in the initial stages of the program, key check-ins, need for incentives for competitive spirit, success of the execution of the program in classrooms, and, experiences of the student-leaders.

This poster will discuss some of the above critical data-points, our learnings, scope of scaling of student-led model for design and technology education and changes for expanding to more classrooms next year.

4. Exploring teachers' understanding of students' sexuality and sexual knowledge

Panchami Jose

Homi Bhabha Centre for Science Education, TIFR, Mumbai, India

panchami@hbcse.tifr.res.in

The study tries to explore various cultural beliefs about childhood sexuality held by teachers and how the cross-cutting modalities of religion, caste, sexuality, and gender of the teacher and students shape these constructs. Through teacher interviews, the study

aims to understand which sexual identities are preferred by the teachers and how the school discourse regulates the unfavoured sexual identities of the students. I have tried to look at the social context in which teachers and students are placed and understand how the social context has shaped the school discourse. Preliminary analysis of the interviews shows that many of the teachers' narratives are shaped by the macro-discourses in society. Teachers have imbibed many prejudices from the widespread anti-Muslim narratives. These beliefs and assumptions about Muslim community shape and organize other beliefs and practices within the school.

5. Micro-organisms at our Doorstep! - Exploring Students' Ideas about Micro-organisms Through A Project Based Learning Unit

Meena Kharatmal

meena@hbcse.tifr.res.in

We developed a Project Based Learning unit that facilitates hands-on activities such as collection of samples, observation of live microorganisms, describing and drawing their observations, measuring the microorganisms, in addition to using microscopes. One of the chapters in the class 8 textbook just lists about the activities to collect soil sample and observe through a microscope. The learning unit can be considered as an extension of the class 8 textbook activities, in addition that it also helps to establish links with the topics related to microbes.

During the Vigyan Pratibha teacher's workshop, we conducted the Project Based Learning unit for groups of teachers. This was followed by teachers conducting the unit with students in their respective schools at class 8 as part of the Vigyan Pratibha learning unit. In this article, we provide one such classroom. Based experience of implementation of the learning unit. The students (n=20) were provided with worksheets alongside doing the hands-on tasks/activities. Based on their responses, we discuss student's ideas about microorganisms. The learning unit has been able to highlight students understanding of the existence, source, dormancy of microorganisms.

All students think that microorganisms exist in air, water, soil, although most have mentioned air as only the primary source. Another interesting observation that has been

highlighted through this learning unit is about students' misconception about the dormant, living condition of microorganisms. Notably, even the problems in measurement and errors in estimating the size of microbes in microns, have also been highlighted. We elaborate on the objectives, learning outcomes, tasks, activity sheets of the learning unit. We also address certain challenges and suggest some recommendations for middle and high school science.

6. **"What would that cell look like?": Findings from clay-modeling activities with teachers and students**

Charudatta Navare[1], Chaitanya Ursekar[2] & Joseph Salve[3]

Homi Bhabha Centre for Science Education, TIFR, Mumbai, India

charudatta@hbcse.tifr.res.in [1,] chaitanya@hbcse.tifr.res.in [2,] joseph@hbcse.tifr.res.in [3]

The concept of a cell is a foundational concept in biology and is considered to be among the Benchmarks for Science Literacy. There is an extensive literature in biology education research on the challenges faced while understanding this concept. These challenges include an understanding of the scale, dimensionality and the relationship between structure and function. Here we address the problems of visualizing the cell (three-dimensional image of the cell) and understanding structure-function relationships in the cell. To this end, we have developed an instructional sequence which involves the use of clay modelling and guided discussions on the relationship between structure and function. Our sequence was refined over the course of 4 workshops conducted with teachers in the Eklavya Maharashtra project. We then conducted sessions with teachers from Kendriya Vidyalaya (KV), and for students in Atomic Energy Central School (AECS). We collected data in the form of notes, audio and video recordings. In this paper, we report preliminary findings from this study. We observed the persistence of the textbook image of the cell as well as the textbook terminology. We also found both teachers and students using a reference-oriented strategy to build cell models, rather than a combinatorial strategy. Finally, we also note instances of exploratory imagination (Anderson, Dupre, & Wakefield, 2019) such as the realization that endoplasmic reticulum would be membrane-enclosed sacs, or questioning whether the textbook diagram is a longitudinal section or transverse section. Based on these findings, we attempt to

characterize the affordances that physical models provide for learning, and discuss some ideas for future work.