Extending Community of Practice (CoP) beyond Institutes to inculcate scientific habits in society

Jaikishan Advani[1), Shraddha Ghumre[2)
[1)Kishore Bharati, [2)Homi Bhabha Centre for Science Education,TIFR

Introduction:
The Indian education system still faces severe problems in inculcating scientific habits in students. With competition-driven culture education is focused on rote-learning and on securing higher marks or grades, while learning and developing scientific attitude are left on the periphery or completely neglected (Sharma, Akhter & Mir, 2020). Developing scientific attitude is an integral part of education, and goals of learning should be promoting it as a learning outcome for larger society (Kaushal, 2018). Several studies show the role of group engagement with science practices in developing scientific thinking (Kuhn, 2017). Role of questioning, argumentation, dialogue, criticisms, etc are essential components in developing scientific attitude along with engagement with material interactions (Marshall, Smart & Alston, 2017). Community of practice (CoP) has been proven a powerful way in which learning, experimentation and interactions can be enhanced by developing social communities (Lave & Wenger, 1991). The challenge which the current education system faces is lack of focus on developing social communities which can involve students as well as broader society into the practice of science.

In this study we have created a CoP named Collaboratively Understanding Biology Education (CUBE), to engage students in scientific practice. The students involved are mainly undergraduate students who are practitioners of science through a project-based learning approach. Amidst the Covid-19 pandemic a model was adopted to practice science beyond the boundaries of institutions. The CUBE community practiced science by creating labs at their homes called Home Labs. Home Labs involve performing science activities, experiments in home conditions and with resources available at home or our surroundings. Web-based online interactive video conferencing platform was adopted called as Chatshaala, where everyday students of the CoP from different parts of the country joined to discuss the work they did, observations they made and understand science through it by engaging in scientific communications. Students also used social media platforms to engage in scientific discussions on a daily basis. We analyze what kind of scientific habits were developed within CoP in a socio-cultural setting constructed using new media? How scientific attitude can be built by connecting science with daily life and realized experiences of CoP outside classrooms? Through this study we demonstrate what kind of socio-cultural and technical environment is necessary for developing and extending scientific habits in society.

Method:

We use interaction analysis methodology to analyze the discourses in the context of scientific practice undertaken by students at their Home Labs (Tang & Leifer, 1991). The transcripts of discourses in text and verbal forms are analysed in order to decipher which scientific habits are emerging from the interactions among students. Scientific habits are generally categorized as ones which surround scientific investigations to develop an empirical and critical mind (Butler, 2020). We in collaboration with science education experts from Homi Bhabha Centre for Science Education, TIFR, Mumbai have developed an elaborate list of essential scientific habits which is used for analysis. The episodes of interactions in text form are selected from social media discussion forums and verbal and written communications on whiteboard are analysed using video transcripts of online Chatshaala and marked for scientific habits.

Research Study:

In this study we extracted transcripts of student interactions from instant social media and online Chatshaala platforms which took place after performing experiments by CoP on trapping fruit flies from their surroundings at the Home Labs and questions emerging from those experiments. The transcripts are marked for scientific habits emerging from each communicated segment of interaction in the student community. The sample transcript is given in the table below;

Student no	Sample Transcript	Scientific Habits	Description
S1	We observed that if we place, say, fresh tomatoes and ripe tomatoes, flies will be more attracted towards riped ones than the fresh. So, yes , flies are more attracted towards ripe ones. But there is also a reason.	Experimenter Keen observer	S1 has done an experiment and made specific observations
S3	So which are the odour compounds present in the tomato since u already have done it @S1	Enquirer Evidence Seeker	S3 is inquiring about the details and seeking evidence from S1
S4	"I observed that the flies preferably gathered on the mango slice in a plate and avoided my bottle next to it which had the ripened banana bait" When this experiment was done, there must have been many variables in this! We don't know whether how many slices of mango, banana (was a whole banana kept or just the peel?) were kept. At what distance from each other? There is a possibility that the smell of the mango must have been more, overpowered the banana due to which more flies were seen on the mango bait. Another variable here is that the mango slice was kept in an open plate with a larger surface area whereas the banana (whole or peel, no idea) was kept in a bottle. Logically thinking, where will the smell be more?	Keen Observer Experimenter Reasoner Engager	S4 is providing his observations on another experiment, and enquiring about factors in design of the experiment. S4 is also providing possible reasons behind the observations, and engaging with others by opening the discussion with questions.
S6	Yes, i agree with u @S4. Why not we check on the compounds that give this aroma to the flies that get attracted to it? So that we can conclude what is the secret of this flies for their attraction to strong odours?	Evidence Seeker Inquisitor Engager	S6 is being inquisitive and seeking details from S1 to come to a conclusion.
S1	Fruitfly are attracted to fermenting process, and to alcoholic smell for mating and egg laying. Fermentation is more active in ripe fruits rather than fresh.	Explainer	S1 is providing information and explaining it it to provide an idea

Table 1. Illustrating student interaction segments and characterizing their scientific habits

Through interactions it was seen that the students were asking a variety of questions, providing their original observations, providing reasons for observations, explaining in detail various aspects of the phenomenon, designing and finding faults in experiments on fruit flies, and seeking evidence for possible reasons. Whiteboard from the video conferencing session showed discussions among CoP who in their Home labs were engaged in observing earthworms near their area and studying them. The inscriptions on the whiteboard show details of experiments discussed, such as, basic aspects on what earthworm feeds on, how salt affects earthworm and what it does to earthworm's body. The scientific habits such as *experimenting & designing* is reflected from experiments designed using salt and tap water. Scientific habits such as *reasoning and explaining* are reflected from names of biochemical molecules involved in digestion of food earthworm feeds on, drawing of the body wall of earthworm and effect of salt on it. Students are inquiring through experimentation about life processes of earthworm through experiments reflecting the scientific habit of being *empirical and enquirer*.

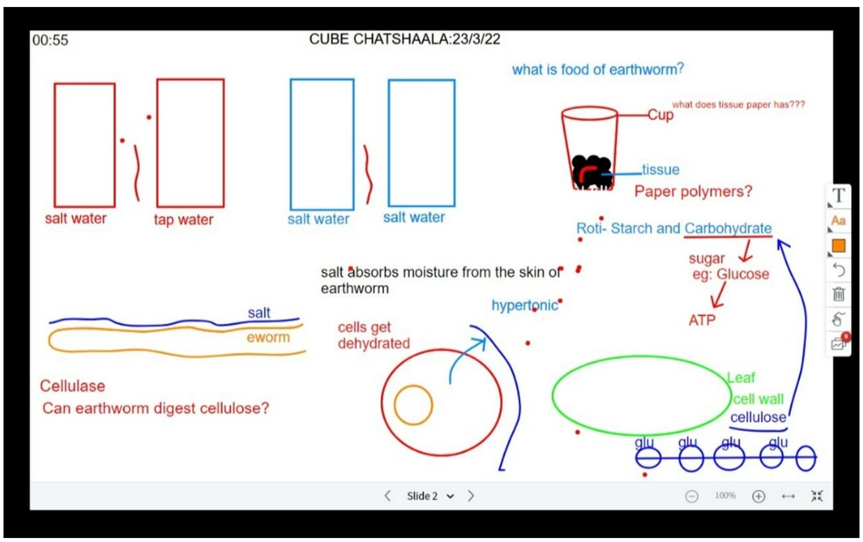

Figure 1. Whiteboard Image from Chatshaala

Figure 2 & 3. Home Labs created by students

Results and Discussion:

Developing the scientific attitude is one of the key tasks of education (National Curriculum Framework, NCERT, 2005). In this study we analysed scientific habits emerging from the discussions which took place through student practice on working on fruit flies in their Home labs, and discussing on social media platforms in urban settings. Scientific habits like observing, experimenting, being inquisitive, engaging, seeking evidence, reasoning are found to be developed among students through interaction in the community of practice. The Chatshaala whiteboard images demonstrate students' abilities of designing experiments, explaining details of phenomenon, and applying logical reasoning being developed through community interaction. The research study focuses on identifying scientific habits developed through CoP outside institutions in the home lab setting where by bringing science close to daily real life practices and realized experiences of students, providing opportunities for authentic learning experiences. It also shows how students get socialized and interact more openly in an informal community setting and freely develop habits of questioning and sharing in an environment with no traditional classroom authority figure or hierarchies. Thus, the study provides an approach and idea on the cultural environment needed to propagate scientific habits in communities. It explores strengths of CoPs to impart scientific habits and provides a model on how CoP of science can be extended beyond institutes to students' own real life and to the larger social contexts.

Conclusion:

We demonstrate how community engagement in science practices in Home lab environments can help generate qualities of scientific habits such as observing, reasoning, experimenting, seeking evidence, through collaborative interactions. These scientific habits are crucial for developing scientific attitude in students and society at large. The study shows the role of CoPs as a socio-cultural interactive environment which can act as a powerful model to propagate and enhance scientific habits in society.

Acknowledgement:
We are grateful to Prof. G.Nagarjuna in developing an elaborative list of scientific habits at https://metastudio.org/ which is used in the study. We thank Prof. M.C Arunan for their support in the work and students for their participation in Home lab activities and interactions.

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