RE-IMAGINING SCIENCE EDUCATION DURING COVID-19 PANDEMIC: ROLE OF TEACHERS, STUDENTS AND PARENTS

Ankit Saraf
Indian Institute of Management
Ahmedabad (IIM-A)
Email: ankitsaraf@iima.ac.in

Surbhi Nagpal
School of Education
TISS Mumbai
Email: surbhi.nagpal2015@tiss.edu

The COVID-19 pandemic necessitates educators and teachers to think about novel teaching-learning methods, which enable deeper understanding and active involvement of students in their learning process. Given the nature of science, it is essential to design and create learning experiences that promote inquiry-based learning at home, nurture curiosity, and encourage learners to develop scientific understanding through reflection. There is a fear that virtual learning environments, both synchronous or asynchronous, can open doors for a more passive, lecture-based science pedagogy due to the unavailability of resources and support at home for most children in India. This paper re-envisions and outlines the roles that different stakeholders can play in creating a nurturing environment for science education at home through a short activity plan. This disquisition argues that virtual learning environments offer a broad scope for inquiry-based, investigative, and interactive science learning through systematic and equitable collaboration between teachers, students, and parents.

Keywords: Virtual teaching, digital technology, parental involvement in science education, learning activity, COVID-19.

Introduction

The COVID-19 pandemic has forced school closures for extended periods throughout India. As students move into the new academic year while being based out of their homes, teachers and parents explore newer ways of supporting students' science learning. School-based and home-based environments are inherently different and shape different aspects of students' learning. Learning goals and lessons cannot simply be transposed from schools to homes, as parents/families cannot act as teachers, and students do not experience the same environment at home in terms of access to peers, materials, routines and norms, and other educators/professionals. Thus, science learning experiences need to be designed, keeping unique aspects of home-based environments in mind such that these experiences lead to complementary and meaningful science learning. These experiences need to support students' social, emotional, and mental health and allow for an exploration of the real-world and context-specific relevant science. This paper aims to layout various ways, through a short activity plan, via which different stakeholders can support students' science learning during and after the pandemic.

The National Curriculum Framework (2005) and the National Focus Group on Teaching of Science (2006) present the goals for student science learning regardless of learning location. These documents also elaborate on the key features of science lessons and activities and how different learning

environments enable student learning in different ways. The effectiveness of any learning experience depends on its ability to achieve culturally relevant learning goals and whether the different approaches employed to achieve these goals are contextually sensible. This is true for learning experiences designed both for classrooms and homes and for both online and offline modes. Learning goals typically neglected in the classrooms can be achieved in home-based learning environments. For instance, learning experiences that help students and their families address problems and phenomena around them may be valuable for the entire community.

Home-based learning is most successful when teachers, students, and families work together in complementary and collaborative ways. Science lessons and activities that allow students' interactions with family and community members promote a deeper understanding of science as they are situated in meaningful and flexible learning contexts. Apart from gaining from the unique expertise of the community members, such experiences provide exposure to authentic problems and contextual phenomena for students to think, explore and engage with. When students engage with relevant issues in meaningful ways, they develop an interest in the topic at hand and pursue it playfully. However, for home-based science learning to be successful, teachers, students, and parents/families need to play an active role in operationalising such learning experiences. The next section of the paper elaborates on teachers', students' and families' role in supporting meaningful home-based science learning of students.

Role of Teachers, Students and Parents

Teachers

Teachers play the most crucial role in the design and implementation of equitable, coherent, and meaningful science learning experiences that ensure students learn beyond the physical boundaries of the classroom. Therefore, it is important that teachers move away from the lecture-method and the excessive focus on content coverage and instead, create, select, and adapt instructional materials, lessons and experiences for home-based environments such that they are relevant and engaging for all students.

As instructional and pedagogical experts and teachers know best about their students, their progress and how they can be appropriately supported to achieve the desired learning objectives and goals. However, as students are based out of homes for extended periods, teachers should not waste valuable instructional time on lessons with minimal relevance to students' context and the problems and phenomena that their families and communities face. Rather, teachers should design and plan learning experiences through experiments, projects and investigations that can be carried out relatively easily through locally available materials, for which they can take the help of their parents and families if required.

Though students may come from similar contexts, they may have starkly different home environments, and hence, it is important that teachers design lessons, experiments and projects that students

can pursue flexibly, asynchronously and in different home environments. While it may initially seem difficult, teachers also need to provide students with opportunities to connect their science learning with their interests by providing them with choices for projects and assignments such that they can make sense of the lessons and the concept(s). This needs to be done keeping in mind the curriculum progression, coherence and leveraging the affordances that modern technology has to offer. Given that the pandemic situation is rapidly changing and unfolds as time progresses, it is imperative that students are invited to contribute and direct their learning through the mutual design of instructional experiences. Last but not the least, teachers need to provide appropriate and regular feedback to the students and establish mechanisms that guide and enhance students' scientific thinking.

Students

Students need to be actively engaged in the learning experiences rather than trying to memorise and retain information. They should explore problems and phenomena that interest them and matter to their communities. Instead of learning solely and further isolating themselves, students need to engage with their peers regularly to advance their own and others' learning. By working both independently and collaboratively on different assignments and projects, multiple possibilities and perspectives emerge. Moreover, students need to actively reflect on their own learning — what they are learning and how they are learning it. Such reflection on experiments and activities helps one consolidate their learning and gives rise to new questions. As discussed, students need to play an active role in contributing and directing their own learning through the mutual design of instructional experiences with their teachers and peers. Lastly, it is crucial that students regularly document, via pictures, text, videos or audios, what they have done, learnt, or are thinking about. This documentation can then be shared with peers, teachers and family members to receive comments and feedback, which enriches learning.

Parents and Families

The first and foremost role of parents and families is to support students' emotional and mental health needs. Then, based on their experiences, parents should discuss with their children the problems and phenomena that exist in their communities and are context-specific. Despite the challenges families and communities face due to the circumstances exacerbated by the COVID-19 pandemic and the resulting lockdown, parents/families need to act as co-learners with their children and provide the partnership that students expect from adults. Parents can offer valuable insights by sharing their expertise and varied perspectives on these problems and phenomena that affect their lives. While it is difficult for parents to mimic school-based lessons and learning experiences at home, they can act as thought-partners with teachers and supplement the science lessons with the community and home-based learning experiences that connect with and develop students' interests.

Parents and family members can play multiple roles in enhancing students' learning of science. They can encourage students by providing positive feedback and support on their work. They can act as sounding boards

and provide constructive feedback on a project or investigation/experiment that students have been involved in. They can also help children to find and source locally-available resources and materials required for conducting experiments. Moreover, they can act as co-learners and collaboratively work with students on investigations, helping them to reflect and visualise their learning from the task at hand. Parents and families can talk to their children and discuss their interests and pursue them in the current scenario. They can work with the teachers helping them design lessons and activities based on this understanding of students' interests.

Additionally, parents can help students' science learning by organising peer-group learning sessions by collaborating with other parents and families. Furthermore, parents and families can help their children contextualise certain concepts and topics by providing practical examples from varied situations or their own experiences. They can communicate and discuss their knowledge and understanding of a topic or idea with students, helping them figure out the phenomena from different perspectives. Lastly, given their socio-economic standing, parents and families can provide students with follow-up learning opportunities that build upon their existing knowledge, interests and curiosities.

The next section discusses a virtual activity plan on the pressure exerted by fluids for Class VIII students. This session has been designed for both asynchronous and synchronous modes and demonstrates the role of teachers, students, parents and families. The activity plan is designed to involve different stakeholders in the process of students' learning science and how in their different capacities, they can ensure that students get an opportunity to engage in scientific enquiry through hands-on experimentation via these virtual sessions. The session also provides students time and space for formulating their own understanding and idea about the concept through reflections on the work they engage in.

Activity Plan

Objective of the lesson

By the end of the session, students will be able to:

1. observe and report that liquids exert pressure,
2. demonstrate that water comes out at different speeds from the openings punctured in a bottle at different heights,
3. demonstrate that pressure does not depend on the shape of the container but the height at which the hole is punctured, and
4. analyse why liquid gushes out at different speeds from the openings in the bottle at different heights.

Assessment Task

1. Observations and Reporting
   - Review the observations and reflection shared by the students
2. Check for Understanding
   - Can liquids exert pressure? Give reasons for your answer.
   - Have you seen water towers and

overhead water tanks? Why do you think water towers are located at a greater height from the ground? Discuss with your friends, family and classmates and write a short explanation for the same.

Sequence of Activity

(a) Asynchronous Session

In an asynchronous session, students engage with recorded lesson videos sent by the teacher. Let us now look at the role of each stakeholder in the given activity plan.

Teacher	Students	Parents/Families
Part 1		
The teacher sends the first video of the session, asking the students to pause and recall the concepts covered in the last session. After a short pause, the video displays a mind map of the previous session's ideas. Students had covered the concept of 'pressure' in their last session.	Students revisit the last session's topics by looking at their notes or making a mind map. Students then proceed to look at the mind map given in the video.	Parents are encouraged to ensure that students pause, reflect, and only then look at the mind map given in the video.
Part 2		
The next section of the video sent by the teacher has a prompt for discussion. Students discuss the question: Can liquids exert pressure? Why do you think so? A short explanation of the answer can be sent by students via Google Forms. After receiving the responses, the teacher can send the next video to the learners.	Students discuss this prompt with their parents/family members/guardians/ friends and fill the Google Form.	Parents ensure that the student discusses and writes the answer. They can provide their own understanding of the topic based on their experiences. The Google Form link can be accessed on their devices for students to send their observations to the teacher.

Part 3		
At this point, the teacher shares the second video of the session, provided the response to the first activity is received. Teacher will not yet reveal the answer to the questions they have discussed. This second video consists of instructions to perform two experiments. A short note on how to supervise this experiment should be shared with the parents a week prior. **Experiment 1** Make two holes in a bottle at different heights and seal the holes with cello tape. Fill the bottle with water, remove the tape and let the water pour out. What did you observe?	Students perform the two experiments under the guidance of their parents and report their observations via the Google Form.	Parents are requested to organise and supervise the two experiments. The short note consists of a video of the two experiments, which can help them guide the process. The Google Form link can be accessed on their devices for students to send their observations.
Experiment 2 Take two or three containers. Make a hole in each container at the same height. You can use a ruler. Seal the holes with cello tape. Fill the containers with water, remove the tape and let the water flow out. What did you observe here? Anything different from Experiment 1? Teacher asks students to send their observations through Google Form.		

Part 4		
Teacher shares the next video with the learner, wherein (s)he shares observations on the experiments. In this video, (s)he asks them to reflect on the following questions and send their answers through another Google Form. -Do these experiments prove water exerts pressure? How? - In the first experiment, why did the water come out at different speeds from holes at different heights? - In the second experiment, why did the water come out at the same speed from containers of different sizes?	Students reflect on these questions. They are free to discuss them with their family or classmates before sending their answers to the teacher.	The Google Form link can be accessed on their devices for students to send their reasons and analysis of the observations.
Part 5		
After receiving students' analysis, the teacher sends the final video consolidating their analysis and explaining the concept of pressure exerted by liquids. Students read the textbook portion on the topic and complete an assessment task used by the teacher to check their understanding.	Students watch the video to understand the concept, read the textbook portion, and attempt the assessment task and send it to the teacher. (Assessment task has been described at the beginning of the activity plan)	Parents should ensure that students send in their assessment tasks.

This asynchronous session can be supplemented with a short debrief online session based on the evaluation of students' responses received on the assessment task.

(b) Synchronous Session

For a synchronous session over Zoom or any other similar platform, the teacher will conduct each part with support and help from the parents during experiments and activities. Parents' role decreases as teacher-led discussions can be conducted within the online platform via chat/breakout rooms. The teacher can help students conduct the experiment through live instructions/ demonstration while resolving queries simultaneously. The pauses for reflection in an online class can be easily achieved without Google Form submissions. Teachers can record the session and copy-paste the chat to later formatively assess the responses received by each student and plan the next session accordingly. Though the role of the parents/family members substantially

reduces in a synchronous session, it is still required to help students conduct activities and experiments using locally-available resources.

Conclusion

The nature of the activity plan discussed above is different from how a typical lesson is designed and implemented in a regular classroom. Teachers need to design virtual sessions differently to ascertain maximal student engagement. The asynchronous version above is divided into parts, and completion of activity in each part takes the students to the next level. Providing the entire video lesson at once will eliminate any scope for reflection or analysis, and students will rely on the teacher's explanation of the concept. While the activities designed require some technological prerequisites, this activity plan can be implemented in a resource-constrained environment with limited connectivity through the asynchronous mode. It makes use of locally available materials and there by not letting sophisticated or expensive equipment(s) cause a roadblock in learning the concept at hand. This activity plan also takes into account the nature of parental involvement in the session. The involvement outlined is minimal and supportive and encourages parents to engage in a scientific reflective dialogue through means of experiments designed. Such conversations can be achieved if science is connected to the students' daily life experiences and their communities. Family members and friends have an intuitive understanding of different phenomena and processes, which can help students derive scientific applications and explanations. In this activity plan, the assessment task is based on a simple concept of placing a water tower at a height or construction of a tall water tower to create adequate pressure so that water can easily reach the houses. This collaboration between teachers and parents can be strengthened by teachers taking the initiative and proactively communicating with students' families regarding their role and support. While some guidance and encouragement will be required initially to involve parents in the process, this can potentially evolve into a long-term association aimed towards creating a supportive, scientific environment for the students beyond the physical classroom.

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