Enhancing Learning in UG Chemistry Laboratories: An Exploration of a Few Alternative Pedagogical Approaches in Indian Context

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This work focuses on some of the alternative pedagogical approaches aimed to enhance the teaching-learning process in the undergraduate chemistry laboratory, specifically in the state colleges affiliated to the university system in India. Some of the approaches explored here are (a) Pre-lab and post-lab components; (b) use of mini-projects mode and (c) presenting opportunities to design an experimental procedure for a given specific experimental goal and then implement the same. The different approaches have been tried during various teachers' and students' camps as part of the National Initiative on Undergraduate Science (NIUS) programme in chemistry.

Keywords: Undergraduate, Laboratory, Alternative Pedagogy, Chemistry, Experiment

Introduction

In chemistry laboratory components (that is, lab courses and projects) of undergraduate curricula, especially in state colleges affiliated to university systems, students often follow predefined procedures in a rather rigid manner. Such educational experiences lack engagement and limit opportunities for deeper cognitive processes such as decision making, problem solving, and reflective thinking. As part of the National Initiative on Undergraduate Science (NIUS) programme in chemistry, we have been trying to explore some of the alternative pedagogical approaches that can be incorporated to enhance the teaching-learning process in the UG chemistry laboratory curricula.

Some of the approaches that are explored by us are: (a) Pre-lab and post-lab components; (b) use of mini-projects mode and (c) presenting opportunities to design an experimental procedure for a given specific experimental goal and then implement the same.

Methodology

In the Pre-lab – Lab – Post-lab framework, we design pre-lab questions to bring students' attention to the broader context of the experiments, to prepare them for observing the relevant changes in the reaction system during the lab work and enhancing their insights about the procedure and procedural steps. Often students are expected to make careful observations of the system. During the lab, students conduct experiments, where they follow procedural protocols. During the post-lab, students analyse and reflect on the data, and draw conclusions, through guided questions designed to promote critical thinking about the experiments.

The mini-project approach consists of multiple tasks/components that may involve different concepts related to one central theme. These sub-parts of mini-project are investigatory in nature and are structured as open-ended tasks. Students can reflect on the procedure. These tasks are linked to one another and often they provide opportunities to explore the domain where students take more ownership to the lab work. Mini-projects within the laboratory course framework can help in developing deeper engagement of students with the content and allow students to explore scientific questions in a more independent and creative manner. Such an approach can help students to build a broader understanding of the domain under investigation.

Designing of an experiment is an under-emphasised pedagogical method of learning in chemistry laboratory settings, especially in Indian context. Allowing students to design their experiments with certain given constraints, helps them to develop critical scientific skills such as hypothesis formulation, variable manipulation, and decision-making, moving beyond the simple acquisition of correct results. By prioritising experimental design, as per the chemistry education studies, learners' focus is shifted to developing critical thinking and innovation rather than following instructions mechanically. Such an engagement also empowers students to take ownership of their learning and prepares them for real-world scientific challenges.

Another strategy which we have tried in all these approaches is prompting different student groups to try slight variations in experimental procedure and then collating classroom data at the end, on blackboard or on a digital platform. This presentation of the whole class results with variations in procedures further enhances understanding of the experiment and their results. In all these approaches, the teacher has an important role as a facilitator in guiding the students minimally and yet bringing them to meaningful peer discussions. Such a process encourages peer collaborations in the learning process.

Findings

These approaches have been tried with undergraduate students during NIUS chemistry camps. The students are asked to present their experimental work and the learnings from the experiments in the form of a hand-made poster/ oral presentation. Based on students' written responses in the experimental worksheets and their group presentations, we can infer that these approaches have facilitated students' understanding of chemistry concepts and helped them connect the concepts to experimental procedures. We also conduct NIUS teacher camps both at HBCSE and outside HBCSE in regular colleges set up where we have primarily conducted discussions about pre-lab – lab – post-lab approach with the teacher community. The feedback from teachers is encouraging.

Conclusion

The current work elaborates all the above tried approaches through experimental examples along with students' feedback. The poster will present details about such camps along with the feedback of teachers. Our exploratory work indicates that these alternative approaches are feasible and can be adapted in UG colleges' chemistry labs in Indian context, especially when colleges are getting academic autonomy.

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