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MAKING LEARNING OF CHEMISTRY MORE MEANINGFUL: INSIGHTS FROM CHEMICAL EDUCATION

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Abstract

One of the most neglected areas In the Indian chemistry syllabi is the role of laboratory activities/courses in understanding chemistry principles. Even at undergraduate level where substantial time, efforts and money is spent on the laboratory courses, the objectives of laboratory courses in chemistry are seldom stated or discussed, particularly in the regular university chemistry curricula. In this paper author like suggest, some set of experiments which can be introduce in the chemistry UG curriculum at appropriate stages. While performing these experiments student will have an opportunity to correlate theory with practical. All these experiments are expected to perform using microscale experiments that are using Barrel pipets, cavity plate and very common chemicals.

***Keyword**: Microscale experiments, laboratory activities, chemistry curriculum, Chemical Education*

Laboratory work is essential in Science and a widely studied topic in chemistry education. Laboratory is a diverse learning environment and therefore a challenging space to teach and learn.

Laboratory experiments are an integral part of teaching and learning chemistry at the undergraduate (UG) level and substantial weight age and time is given to it in any UG curriculum. The objectives of experiments in chemistry laboratories are never stated and explained clearly. Due to the cook-book or recipe style nature of these chemistry experiments, students perform them blindly without abstracting the basic principles behind the experiments. They fail to understand the purpose of their investigation and the sequence of tasks they need to perform the experiment. Studies have shown that students often perform the experiments to follow instructions or to just arrive at the right answer. As a result, experiments at the chemistry laboratory have become routine and monotonous.

After spending considerable time in chemistry laboratories, often chemistry students are weak with respect to skills and fail to abstract the basic principles behind the given experiments. At advanced level of their study, they often fail to design small independent activities in laboratory and/or reflect upon the data generated during the experiments independently. Thus, there is crying need to introduce changes in the current laboratory courses that can make chemistry laboratory a meaningful place for learning.

Whenever chemistry syllabi are revised at undergraduate level, the changes in laboratory content are often cosmetic. The suggested activities are not often standardized rigorously for variables involves, particularly for safety aspect. Along with objectives and standardization, the assessment of experimental tasks is yet another important area that needs discussions.

It is important and essential to set some objectives for the chemistry laboratory at the UG level and modify the nature of experiments. In our opinion, some of the following suggestions should be considered.

1. Expose students to basic experimental techniques and skills and help them to understand it.
2. Make students aware about risk and safety aspects in laboratories.
3. Help them develop core competencies such as (a) background reading and planning of experiment (including time management), (b) execution of experiments, (c) data analysis and evaluation and (d) report writing and communication through presentations.

Often with the prescribed syllabus, emphasis is on completing the stipulated number of experiments in the given time.

In fact, in our opinion, objectives 1 and 2 mentioned above are also not completely achieved as use of new glassware/ plastic ware, correct way of performing operations and safety aspects are not discussed with students. Report writing is also not given much importance. Analysis of the data obtained by the entire class and drawing inferences from them are lacking most of the times. Often, students are provided with solutions and thus, they are never involved in writing appropriate balanced equations and finding out the molar equivalence of the reactants. A consequence of this is that they fail to understand stoichiometry of the reactions. As a result, laboratory work is not taken seriously by students. The question we are asking is whether changes can be implemented in the existing UG chemistry laboratory curriculum so that some of the objectives stated above can be achieved.

We like to suggest, some set of experiments which can be introduce in the chemistry UG curriculum at appropriate stages, where student will have an opportunity to correlate

theory with practical. All these experiments are expected to perform using microscale experiments that are using Barrel pipets, cavity plate and very common chemicals. Savitribai Phule Pune University has already adopted the micro scale experiments in its chemistry curriculum of UG as well as PG level.

1) **Inorganic Qualitative Analysis:**

You have been given seven Barrel pipets that contain solutions of Pb^{+2}, Cu^{+2}, Fe^{+3},Ni^{+2}, Zn^{+2}, Mg^{+2},Ca^{+2} and NH_4^+ though not necessarily in this order. Using the reagents like 1M H_2SO_4, 6 M NaOH, 1M NH_4Cl + 6M NH_4 (aq), 5 % KI (aq), 3 % Na-DMG (aq solution) ,cavity plate and three micro test tubes.(5ml capacity)

Devise and carry out an experiment to correctly determine the contents of each Barrel pipets.

2) **Understanding of Co-ordination Compound:**

You have been given several test tubes and, barrel Pipets, a concentrated ammonia solution, access to distilled water, and four numbered vials containing iron (III) chloride hexahydrate, cobalt (II) sulfate heptahydrate, copper (II) chloride dihydrate, and potassium oxalate monohydrate, though not necessarily in this order.

Devise and carry out an experiment to produce at least FIVE new different complex compounds, using your understanding of coordination compound geometry and qualitative evidence in your results.

3) Identification of Unknown Metal Carbonate

Given a sample of an unknown metal carbonate, M*x*CO_3, and 3.0M hydrochloric acid, HCl(aq), a balloon, and some laboratory equipment, devise and carry out an experiment by combining these two substances to determine the volume of the gas produced *and* the unknown metal. The possible metals are Ba, Ca, Li, or Na.

Room Temp. = 25^{o}C, Standard Pressure = 1 atm

4) **Understanding of acidity and basicity of the given compound**

You have been given six numbered pipets containing 0.50M solutions of the sodium salts Na_2CO_3, $NaHCO_3$, $NaHSO_3$, NaH_2PO_4, Na_2HPO_4, Na_3PO_4 not necessarily in this order, a 50-mL beaker containing 0.40M HCl, and a pipet containing methyl orange indicator. Devise and carry out an experiment to determine to contents of each pipet, providing both *qualitative* and *quantitative* data to justify your conclusions.

We are aware that there are various constraining factors, but what we are emphasizing is an alternative approach under the given circumstances. The experiment to be performed can be given/announced in advance so that students can read about the same and familiarize themselves with the experiment. Each laboratory session can be split into initial discussion of experiment, actual performance of experiment and post-facto discussion. The initial discussion can focus on students' understanding and/or queries regarding the experiment, whereas the post facto discussion can be regarding problems faced and analysis of the results/data obtained. Such changes if introduced at least for a few laboratory sessions at the beginning of the first year will help build confidence among the students and also enhance their participation.

Such an approach will help create more learning opportunities in conventional laboratories. The entire exercise is meaningful even though it needs reduction in the total number of experiments in the syllabus. Such initiatives are steps towards a positive direction where students are prepared for future careers either in academics or industry.

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