

QUEST FOR TEACHING EXPERIMENTAL SKILLS

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ABSTRACT

In Andhra Pradesh, India, chemical experimenting in under graduate college labs by students is neglected because most of the intermediate (10+1 and 10+2) students concentrate on writing competitive exams like EAMCET (Engineering and Medical Common Entrance Test), IIT JEE (Indian Institute of Technology Joint Entrance Test), AIEEE (All India Engineering Entrance Examination), AFMS (Armed Forces Medical Services), AIMS (All India Institute of Medical Science). The students spend most of their time in preparing for competitive exams, practicing bits, and writing many model exams.

Even Parents, staff, and management are also motivated and allow the students towards preparation for competitive exams because of the increase in number of engineering seats and demand of medical seats. Ultimately, the quality and quantity of students who join the B.Sc. (Bachelor of Science) has been decreasing day by day. Even after joining the B.Sc., the students are motivated towards immediate white collared job oriented courses like M.C.A (Master of Computer Applications) and M.B.A (Master Business Administration) and spending their time for preparing for competitive exams for those courses. Only a few students are interested to join Post graduation in chemistry and try to learn experimental skills in chemistry laboratory. However, the motivated students towards undergraduate chemistry will be demotivated towards it due to lack of fundamentals in chemistry (in 10+2 level), which are essential for better job market. Ultimately, the students are in confusion and neglect learning the skills in doing experiments in chemistry lab.

The present paper focuses on the thorough quest of one such teacher who strives for his own professional development. He has developed his own method of guiding the students for their improvement of skills in doing experiments in lab. The teacher explored solutions to his problems or problems of students by sorting out the critical incidents from his own laboratory experiences, documented through regular journal writing. The teacher cum researcher guided the students to overcome the difficulties in

- Determination of melting point
- Determination of Boiling Point
- Test for Extra elements
- Ignition Test for Aliphatic/Aromatic/Carbohydrate/Amide and
- Test for Functional groups

Keywords: Quest, Professional development, Organic Practical class, Laboratory Experiences, Experimental Skills.

INTRODUCTION

The received knowledge gained either from books/materials/learning experiences may help them in forming the core of their intuition but it is only the regular reflection on experiential knowledge, which helps in chemistry teachers' professional development. As teaching is a knowledge-based multidimensional activity, the creation of teaching knowledge is a process in which "ideas are sown, germinated, thinned, pruned and displayed" (Hegarty, 2000, p.454), and in which teachers need to reflect on the received knowledge in light of classroom experience.

THE GOAL OF THIS PAPER

This paper attempts to explore the benefits and difficulties of undertaking in undergraduate lab study, based upon chemistry teachers' personal experience, as a move towards chemistry teachers' professional development. The narration would be in first person singular 'I' as the writer himself expresses his reflections through diary writing. The hierarchy of the teacher's experiences penned through the pages of his diary shows the significance of diaries in teachers' professional development.

Setting

This study took place at an Autonomous Degree (undergraduate) college in Vijayawada. The classes are considerably big, consisting of sixty students or more, each of different linguistic and social backgrounds. The duration of each practical class is one hundred and fifty minutes.

The teacher had about twenty-seven years of experience at various levels, teaching chemistry for B.Sc.(undergraduate) students. His task is not merely teaching chemistry instead, he has the responsibility to train the students in lab skills in a way to prepare them for the job market and for students' higher education.

A Personal Journey

The teacher's teaching experience in the very first class led him into a gloom of 'dissatisfaction'. He started sorting out a method that could make him realize the problems and find the solutions based on his own teaching experiences. This search made him realize the necessity to pen down all his classroom experiences, not only his point of view but also the students' responses and reactions to his teaching. The moment he started to write, he could find it very difficult to recollect all the events and moods by reliving the class. However, the thoroughness in evaluation facilitated by the diary writing kept his fascination alive in spite of the difficulty involved in the process.

He started writing each entry spending ten to fifteen minutes after each class. Initially it took more time as he had to fight the inertia of writing.

As time went on it has become a habit. The main aim in writing these diary entries is to find out the problems from each class and think about the possible solutions for them after reflection, try them again in class, thus work for his professional development.

The professional development of a teacher makes his teaching effective which in turn makes the learning among students effective, thus bringing about desired change in teaching-learning process. Each entry is a candid description of what exactly had happened in each class.

FINDINGS FROM THE STUDY

The words like well-prepared, dissatisfied, disciplined, informative, students-passive, etc., which found their room in his first entry made him, realize the gap between his intuition about the class and the actual classroom situation.

Overall, it says that the class was pleasant and as the lecture was informative. Students could gain knowledge, but the reason for dissatisfaction and the overheard comment from one of the students... 'Confusing' is to be reflected upon and the appreciable solutions should be arrived at.

Teacher's Personal Experience

First Guidance on Determination of Melting Point:

The melting point of a compound is the temperature at which it changes from a solid to a liquid. Experimentally, melting point is actually recorded as the *range of temperatures* in which the first crystal starts to melt until the temperature at which the last crystal just disappears.

Instruction

Obtain a capillary melting point tube and a known compound. The known compound may need to be ground into a fine powder with a mortar and pestle. Place a small amount of the finely ground known compound in a weighing boat. Push the open end of the capillary tube into the compound to load sample into tube. Load only 1-2 mm of sample into the tube. Larger samples will heat unevenly. Hold the closed end of the capillary tube over a dropping tube; the dropping tube should be held perpendicular to the table and on top of the table. Drop the capillary tube into the dropping tube; the capillary tube will bounce on the table packing the powder into the bottom. Remove the capillary tube from the dropping tube. Place the capillary melting point tube in the Mel-Temp apparatus chamber, with the closed end pointed down. Turn power switch ON. Set the power level to obtain the desired heating rate. The sample should be observed continuously, so that the melting point of the sample is not missed. Heat slowly to acquire the most accurate results. Record the melting range, which begins when the sample first starts to melt and ends when the sample is completely melted. The teacher planned to teach and demonstrate the determination of Melting Point. After the task is over students are asked to determine melting point for Benzoic acid, Oxalic acid etc. The students did well and reported the results with some errors. The reasons are:

- not filling capillary tube properly
- Not proper packing the capillary tube with the compound
- Some students note the temperature at which solid starts converting into liquid.
- Some student's note the temperature at which solid completely converts into liquid state.
- Some students take the average of above two values.
- Some students took impure compound.
- Some students are unable to read the reading of thermometer.
- Some students heat the thistle tube continuously by keeping the Bunsen burner just below the thistle tube.

The entry goes like this:

Um! Dissatisfaction... Most of the students did not get results wanted. They were confused with the colours of nitrogen test, (different students get different colours). They were confused with test of chlorine. Most of the students feel that they got test for chlorine though the compound does not have chlorine.

When I asked them questions to sum up, even then they were silent. I felt worse when I overheard some one say... confusing.

Insights Gained

Observations of students discouraged him and the reflection on the above extract warned him that the problem is not with the class but with his lack of practical knowledge. By explaining the colours for nitrogen test and test for chlorine, the students were brought out of the cocoon of passivity, he could transform himself from a dictator to a friend and a guide and the classroom has become student centered unlike the previous one, which was teacher fronted.

After Reflection

The teacher pointed out the mistakes done by students in the lab and gave the needful suggestions. The students were directed to take long glass or plastic tube and throwing the packed capillary tube with the pure Compound from one end to other end after every filling. Students were asked to repeat the experiment with the suggested changes and thus the errors were minimized.

Teacher's Personal experience in second class

The second experience was rather pleasant as he could gain confidence that could also build in confidence among the students, supporting the view that the teacher and the students are not separate entities but they work together for healthy academic prospects.

Entry after the second experience

A glance through the second entry

Today, I am happy a bit. I found the students were enjoying the class. They were talking to me, answering me. Their expressions make me feel friendly towards them. They were trying to clear their doubts. They were talking among them, sometimes while attempting the tasks. The class today, however, it was the last period was full of activity.
Discernible Gradual Movement

From the above information, he could see the gradual movement from 'dissatisfaction, to 'satisfaction'.

Second guidance

Determination of Boiling Point

The boiling point of a liquid is the temperature at which that liquid is converted to a gaseous state. Boiling point is formally defined as the temperature at which the vapor pressure of the liquid becomes equal to the pressure at the surface of the liquid. The boiling point of a liquid can change if the pressure at the liquid's surface changes. Since pure substances have a distinct boiling point, boiling points are sometimes used to determine the purity of substances.

Instruction

Place about 1 mL of Isopropyl alcohol in a 10-12 mm diameter test tube. Using a small rubber band, attach a thermometer to the outside of the test tube. The thermometer bulb should be even with the test tube's bottom. Insert an inverted closed end capillary tube into the test tube. Half fill a 100 mL or larger beaker with warm tap water. [Note: a water bath is used if the boiling point of the material is expected to be less than the boiling point of water; otherwise, an oil bath is needed].

Place the above test tube assembly in the water bath so that the surface level of the alcohol in the test tube is beneath the surface level of the water bath.

Place the beaker on the wire stand and, stirring frequently to insure even heating, carefully heat the water bath with your heat source until the water bath boils and a rapid stream of bubbles continuously emerges from the capillary tube. [Note: if an oil bath is used, the oil does not boil; the stream of bubbles from the capillary tube is the sole indicator that the liquid in the pipette or test tube is boiling]. Remove the heat source and begin observing the stream of bubbles. When the last bubble emerges from the capillary tube, record the temperature. Reheat the water bath and repeat the cooling process two more times. Record the temperature reading after each trial, and average all three trials. Calculate the error between the observed boiling point and the published value of the boiling point.

After teaching and demonstration is completed, the students were asked to experiment. The students did well and reported the results with some errors. The reasons were;

- Some students note the temperature at which liquid starts converting into vapour.
- Some students noted the temperature until the liquid is completely evaporated.
- Some students note the temperature where constancy in temperature is observed.
- Some students took the average of 1 and 2.

After Reflection

The teacher made things clear to all students and asked them to repeat the experiment in the next class. Students repeated the experiment with the suggested changes and the errors were minimized.

A glance through the third entry:

Extremely satisfied... I could create team spirit among the students. They were talking to me freely trying to get their doubts cleared. Lot of work was done with out feeling tiered. I moved round the class warning them to avoid speaking... They could answer the summing up questions competently.

Third guidance

Ignition test

Ignition test gives the idea about aliphatic/aromatic/carbohydrate/amide. The compound that gives sooty flame is aromatic and the compound that does not give sooty flame is not aromatic. The compound on ignition chars is a carbohydrate. The compound that gives ammonia smell on ignition is an amide.

The students did well and reported the results with many errors. The reasons were;

- They do not know what is sooty flame?
- They do not know what is charring?
- They do not know what is ammonia smell?

After Reflection

The teacher made things clear with demonstration to all students and asked them to repeat the experiment in the next class. Students repeated the experiment with the suggested changes and the errors are minimized.

Finally he has given a list of compounds with necessary details to students and asked them to check and match with their results.

S.No	Name of the compound	Name of the functional group present in it	Result of ignition test	Nature of compound
1	Methyl alcohol	Alcohol	Non sooty flame	Aliphatic
2	Ethyl alcohol	Alcohol	Non sooty flame	Aliphatic
3	Benzyl alcohol	Alcohol	Sooty flame	Aromatic
4	Formaldehyde	Aldehyde	Non sooty flame	Aliphatic
5	Acetaldehyde	Aldehyde	Non sooty flame	Aliphatic
6	Benzaldehyde	Aldehyde	Sooty flame	Aromatic
7	Acetone	Ketone	Non sooty flame	Aliphatic
8	Formic acid	Carboxylic acid	Non sooty flame	Aliphatic
9	Acetic acid	Carboxylic acid	Non sooty flame	Aliphatic
10	Oxalic acid	Carboxylic acid	Non sooty flame	Aliphatic
11	Benzoic acid	Carboxylic acid	Sooty flame	Aromatic
12	Salicylic acid	Carboxylic acid and phenol	Sooty flame	Aromatic
13	Phenol	Phenol	Sooty flame	Aromatic
14	Alpha Naphthol	Phenol	Sooty flame	Aromatic
15	Beta Naphthol	Phenol	Sooty flame	Aromatic
16	Aniline	Amine	Sooty flame	Aromatic
17	Urea	Amide	Ammonia smell	Amide
18	Glucose	Carbohydrate	Charring	Carbohydrate
19	Fructose	Carbohydrate	Charring	Carbohydrate
20	Sucrose	Carbohydrate	Charring	Carbohydrate

The above chart is useful for all the students to assume unknown compound given to them for analysis. A glance through the fourth entry:

I am very happy to know that the students have got clear idea about performing the tests given to them. The students are well motivated in doing the experiment with utmost interest. They feel that they can do the tests well in exams too.

Fourth guidance

Testing extra elements

Preparation of lassaingne's extract

Cut a small piece of sodium metal with metallic spatula and dry it by pressing between the folds of filter paper. Put this piece of sodium metal into an ignition tube. The ignition tube is heated slowly till the sodium metal turns into shining globule. Remove it from flame and add the compound (a pinch of solid compound or 2-3 drops of liquid compound*b). First heat it gently and then strongly until it becomes red hot. Plunge it into 10 ml of distilled water contained in a china dish. And cover the china dish immediately with wire gauze to stop the flames. The same procedure is repeated by 3 more ignition tubes. The ignition tubes if not broken completely, are crushed with the help of a glass rod. Boil the contents of the china dish for about 5 minutes and filter. The filtrate is called lassaingne's extract or sodium extract. The filtrate should be colourless. Filtrate will be coloured when fusion is incomplete. So, if it is coloured, whole procedure should be repeated again.

TEST FOR NITROGEN

Take 1-2 ml of the Lassaingne's (sodium) extract in the test tube add freshly prepared ferrous sulphate solution into it. A dirty green precipitate of ferrous hydroxide is obtained. If no precipitate is formed, add a few drops of dilute sodium hydroxide solution to get the precipitate. Now heat this mixture gently with shaking for 1 minute and add dilute sulphuric acid into it. A Prussian blue colour confirms the presence of Nitrogen in the compound.

TEST FOR SULPHUR

Sodium Nitroprusside Test

Take 1-2 ml of the sodium extract in the test tube, add 1ml of freshly prepared sodium nitroprusside solution into it. A violet colour indicates the presence of sulphur in the compound.

TEST FOR NITROGEN AND SULPHUR PRESENT TOGETHER

Take 1-2 ml of sodium extract in the test tube and acidify it with dilute hydrochloric acid. Add 2-3 drops of ferric chloride solution. A blood red colour indicates the presence of Nitrogen and Sulphur together.

TEST FOR HALOGENS

Silver Nitrate Test

When nitrogen and/or sulphur are absent

Take 1-2 ml of sodium extract in test tube and acidify it with dilute nitric acid. Add silver nitrate solution (0.5ml). A white precipitate soluble in Ammonium hydroxide indicates the presence of chlorine. A pale yellow precipitate soluble in excess of Ammonium hydroxide solution indicates the presence of bromine. And a yellow precipitate insoluble in Ammonium hydroxide indicates the presence of iodine. The teacher asked the students to detect Nitrogen, Sulphur and Halogens. Though halogen compounds are excluded from the syllabus, he has given some chlorine and iodine compounds to students for analysis so as to train the students for post graduation.

The students did well and reported the results with many errors. The reasons were;

- They use tap water which contains chlorine- The problem is that they get chlorine test for all compounds.
- They do not ignite the ignition tube till it is red hot
- The liquid compound evaporates when they fuse and without combining with sodium.
- They do not properly grind the broken glass pieces.
- They do not properly collect filtrate.
- They do not recognize the colours
- Most of the students are confused with the Prussian blue, purple and violet colours.
- They are confused with the solubility test for chlorine, bromine and iodine.

After Reflection

The teacher made things clear with demonstration to all students and asked them to repeat the experiment in the next class. Students repeated the experiment following the suggestions and the errors were minimized. A glance through the fifth entry:

I was very happy when they were heating the ignition tube to red hot, grinding the broken glasses and recognizing the colours.

Fifth guidance

Testing functional groups

Normally the students are asked to test all functional groups whether they get positive or negative. Some times the students feel that they get positive test for one functional group and immediately go for confirmative and for special tests without completing the testing of all functional groups. Ultimately he/she will be in wrong direction and reports wrong result. They are also confused with colours, precipitates and gases evolve.

After Reflection

The teacher made things clear with demonstration to all students and asked them to do the experiment in the class. Students repeated the experiment with the suggested precautions and the errors are minimized. A glance through the sixth entry:

I was very happy that all students have done all tests whether they get positive or negative. After doing all the tests only they have come to conclusion about functional group identification

Now, Fewer Hurdles!

The reflections on the teacher's personal experiences allowed him to refine his intuition through deeper insights gained through his own experiences both good/bad. The diary/journal study provided him deeper understanding into his teaching style and took him more close to the students.

For writing diary entries, he made a close observation of every aspect of his class, which made him more sensitive towards the taught. He ultimately realized that the better way of teaching is to facilitate opportunities for the students to learn. Though writing a diary is time-consuming and laborious activity that calls for consistency and transparency, this is the best method for professional development of teacher of chemistry.

CONCLUSION

The reflective approach is an 'insider' approach or 'self-directed' approach (Richards and Farrell 2005). It seeks to offer a dynamic, reliable, and viable means by which the teacher can develop his/her professionalism. A teacher-initiated and teacher-directed professional development model, it is exploratory in nature and involves teachers observing themselves, collecting data about their own classrooms and their roles within them, using the data as a basis for self-evaluation and change and their professional growth (Richards and Lockhart 1996). Of all the strategies of reflective practice it is the journal writing which involves the documentation of thoughts and experiences is more practical and beneficial for teacher's self – analysis, as it involves recalling, re-considering and re-thinking about their own experiences. The solutions obtained or the lessons learnt by a teacher can be a reference to other teachers, if the diary is kept open to the public.

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