20 Teaching Chemistry Effectively: COULD I HELP?

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Close to two decades ago, when I stepped into a grade 12 classroom, I have to admit, it was with the enthusiasm of a newbie teacher with dreams of sharing all my 'learnt' knowledge with my students. I was well-armed with the relevant textbook, reference book and a couple of charts. I started off with what I thought was the right way to do so and lectured my way through the next 40 minutes. I stepped out feeling triumphant of having completed my 'task' of 'teaching' my students. However what I could not overlook and shrug off was the disinterested look in the eyes of the students. This went on for a while till it reached a stage when I could not go on in this manner and decided to have a chat with them.

So in one of the classes, we stepped out and gathered around a tree in the school compound. The children were baffled, amused and apprehensive too as they did not know what was in store for them. We started off by talking about what they felt about their school life till then and what plans they had for the years to come. This partly eased them and their comfort of speaking went up a bit. I was however in a rush to talk to them about their challenges in a subject like Chemistry. This was all that I had to ask and there was an outpouring of the difficulties that they faced in the subject. That is when it struck me that as a teacher, it is my responsibility to make the subject as learner-friendly as I can.

This is where my journey began and what I will be sharing now are a few experiences of my teaching days wherein I endeavoured to make Chemistry as approachable and learnable as possible. At the high school level where the focus is primarily on the Board examinations and the children are faced with the load of not just one subject but many others like Physics and Math, the children look for easy and sustainable methods of remembering data, understanding concepts and also methods that would help them to get the maximum marks. Hence, as a teacher at this level, my constant endeavour was to help them with simple techniques and I primarily operated from that domain.

Case 1

At the +2 level, organic chemistry carries a weightage of 15% of the whole syllabus and the marks in the examination. The content for this is voluminous and a total challenge for the student. They constantly battle with the challenge of remembering the numerous equations. The major part of the questions in the organic chemistry portion in examinations was based on using chemical equations to convert one compound into another. These kinds of questions are referred to as 'conversions'. For example: conversion of an alcohol to a ketone or an aldehyde to a carboxylic acid and so on. Students found it very difficult to remember the various equations in the textbook and consequently lost out in scoring marks in this portion. To solve this issue we developed what we call as 'flash cards' which each student would possess and write on. These cards are cards made of hard paper like chart paper, approximately of the post-card size.

What do students do with these flash cards?

- They write down the important chemical equations on the card. Both sides of the card are used. As far as possible, not more than two cards are used for writing the information for one category of compounds, like two cards for equations on

alcohols, two cards for equations on aldehydes and so on.

- These cards are strung together for later use.

Chemical properties of alcohols

1. Primary Alcohol to aldehyde

$$RCH_2OH \xrightarrow{CrO_3} RCHO$$

2. Primary alcohol to carboxylic acid

$$RCH_2OH \xrightarrow{\text{Alkaline } KMnO_4} RCOOH$$

How and where do the students use these cards?

- These cards are brought into use when the students need to perform organic chemical conversions.
- For example:
  - If the conversion given is ethanal to ethanoic acid.
  - The student first identifies that this is an aldehyde (ethanal) that needs to be converted to a carboxylic acid (ethanoic acid).
  - He has his set of cards with the equations written on it. He looks for the equation that converts an aldehyde to a carboxylic acid. On identifying this he writes the relevant equation and completes the conversion.
- This is one example. In a similar manner a student works on a few more such conversions.
- It's the teacher's responsibility to encourage the students to use the cards and perform the conversions.

How does the use of flash cards help?

- With constant practice of using the cards the students familiarize themselves with the varied equations and it stays like an imprint in the memory of the child.
- The cards are a condensed version of the voluminous text portion of organic chemistry and are handy to carry and use.
- The child is given the freedom to write the equations on the cards the way she finds it the most convenient for use.

The feedback that I received as a teacher when these cards were used was mainly from students who lost out on scoring in organic chemistry in the tests and examinations. Many felt that it was easier looking at a dozen small cards rather than ten pages in a textbook.

Case 2

Children who take on Chemistry at the high school level generally do take it with Math, however, there is still a lot of apprehension in solving of the numerical. Also, there is a common misconception that if the answer is wrong they would lose the credit for the whole question.

So as a teacher my first task was to familiarize them with the system of assessment in the final examination. They had to be made aware that the answer to a numerical carried the least mark while it was the steps that would be more important, the logic being that focus was not on the end result alone, but on how well the concept had been understood. In the following way, I went about helping the children tackle the numericals effectively and with reasonable success:

- My first suggestion to them was to complete all the descriptive questions and multiple choice questions before attempting the numericals.
- The first step of solving a numerical was to read it a minimum of three times. The reading for the first time would not strike a chord at all in how to solve it. The second and third readings would provide some idea as to what has been asked.
- The next step would be to write down all the data which is given in the numerical along with the

relevant symbol and also what has been asked to be calculated. This can be enclosed into a box (square or rectangle) – say Box 1

- The student could then (in the working column) write all the formulae which she thought could be applied here. One by one she can then eliminate and finally choose the right formulae. Once this is done the formula is then written and also put into a box – say Box 2
- The student then substitutes the values which she has identified in Box 1 in the formula written in Box 2. This substituted formula in then put into Box 3
- The student then performs the calculation and writes the answer with the relevant unit in another Box 4
- To cite an example for this, I would like to refer to a solved numerical in the NCERT Chemistry text of Class XII (Page 72, example 3.3)
- The standard electrode potential for the Daniel Cell is 1.1V. Calculate the standard Gibbs energy for the reaction:

$$Zn_{(s)} + Cu^{2+}_{(aq)} \longrightarrow Zn^{2+}_{(aq)} + Cu_{(s)}$$

On having read this the child lists the data given in

$E^0_{cell} = 1.1V$

From the ionic equation the student finds that the electron change is 2

$F = 96487\ C\ mol^{-1}$

Box 1

$\Delta_r G^0 = -nFE^0_{(cell)}$

Box 2

$\Delta_r G^0 = -2 \times 96487 C mol^{-1} \times 1.1V$

$= -21227\ J\ mol^{-1}$

Box 3

$\Delta_r G^0 = -212.27\ kJ\ mol^{-1}$

Box 4

Box 1 and the formula to be used in Box 2.

How does this process help?

- For one, it is systematic and the child does not miss out on any step and hence also no marks are lost
- Even if the child goes wrong in the calculation she is bound to be valued for the earlier steps written
- In numericals, with multiple steps this provides a logical flow to the calculation
- From an evaluator's point of view it is easier to mark such meticulous presentation

Case 3

The inorganic portion of the grade 12 chemistry syllabus is the most dreaded as it is made up of description of metallurgical processes and preparation and properties of metallic compounds. This is another part that is difficult to learn and also remember. In fact, many of my students used to skip parts of this portion as they did not want to and also did not know of a better way of learning it other than rote learning it. Moreover, the textbook listed selected properties and explained them briefly, while the reference books dealt with each property in detail. This was another aspect of the challenge as the students, mostly if not always, considered learning all the possible information from the reference books. This wasn't really necessary. With the help of my students we devised a method to tackle this issue. To take an example – in chemical properties of metallic compounds, the students had to learn the properties of compounds like potassium permanganate, potassium dichromate, sodium chloride, sodium carbonate and so on. We went about it like this:-

- The students were divided into groups with at least five members and the groups worked entirely

during class hours. None of this work was carried home.

- Each group was assigned the compounds of one particular metal.
- The group had to first make sure that each member had a copy of the textbook and a set of at least two different reference books.

How did the groups work?

- Each group would record their information in A4 sized papers and generally a student with a legible handwriting would take on this responsibility.
- The whole group would then read about the compound from the textbook. They would note down the methods of preparation and the chemical properties shown by the compound.
- After this the reference books would be used to get the maximum information about the methods of preparation and the chemical properties.
- This would be done for the compounds which were allotted to the group and written in brief in the sheet in a format like this:

Name of compound	Preparation method/ property	Chemical equation involved	Specific use of property	Type of property (oxidizing, reducing etc)

- What we focussed on here was to look at only the methods mentioned in the textbook and talk about them in detail.
- Also many of the properties which they noted were easily observable in the laboratory and therefore we would then go to the lab and carry out the experiments.
- After each group compiled their information about the compounds, this would be shared with the rest of the groups wherein the other groups would make photocopies of the information.
- With the information culled out in this manner, it was then an individual effort to map common properties across compounds, eg. compounds which showed reducing properties. Some students would create flow charts or mind maps about the comparative properties and share them with the class.

In all the three cases above I have shared the practices that I followed for almost two decades. They sustained for this long a period primarily because they appealed to the students and it made work easy for them. I got constant feedback from them and other than a few minor changes these were used. In fact, just a year back in one of the social networking sites my students had a conversation about the flash cards and how they are still reminded of them!! To me as a teacher, I learnt much more than the books I referred to and over the twenty odd years I hope that I have been of some help to my students.

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