ENLIVENING THE TEACHING AND LEARNING OF CHEMISTRY

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Abstract: A teacher of Chemistry in a residential school found that most of her students expressed disinterest in the subject, citing it as 'a difficult subject' with too much to remember. This is an account of the action research that she undertook to draw them into learning the subject with interest and enjoyment. The researcher began with a survey of 500 teachers' and students' views on what makes any subject interesting, why Chemistry is deemed to be 'tough' and what students look for in a teacher/interesting class. This led to a deeper understanding of the causes of disinterest and typical expectations of students from a teacher, which then gave way to the design and implementation of various strategies to make Chemistry meaningful. By the end of the cycle of Action Research, not only did the students begin to enjoy learning Chemistry, but there were also much learning for the teacher.

BACKGROUND

Considerable work has been carried out in exploring difficulties commonly experienced by learners of Chemistry. Reid (2007) connected these learning difficulties to the way the human mind processes new information. Reid used a new learning model to bring home the need to take note of how much the working memory is being loaded. Sirhan's (2007) overview of research carried out over the past few decades on learning difficulties [experienced by school as well as university students of Chemistry] also has suggestions for enhancing interest and motivation in learners of Chemistry. Humerick's (2002) Action Research Study (an approach that was adopted in the current work too) has emphasised inquiry and collaborative learning. Avargil et al (2012) have delineated four understanding levels of chemistry, and have advocated context-based chemistry as a way of spiking interest levels.

It was against this backdrop that I undertook to conduct Action Research (AR). I have generally found that most students have a mental block towards Chemistry as they deem it to be the 'toughest subject', 'difficult to understand', and 'taking a great deal of time to learn'. So I tentatively expressed the issue thus: "lack of interest in students for chemistry, due to fear of subject."

Identification of the AR problem: My facilitator led me through a process of thinking about it more deeply, after which my Action Research problem changed as below:

"To motivate my students with a love for chemistry so that they begin to learn on their own."

My facilitator then led me through a process of analysing this problem.

Analysis of the AR Problem: Now the first question that arose in mind was: "Why do most of the students fear Chemistry but not the other subjects?" My facilitator asked me when and how I began to love Chemistry. I then threw my mind back to my student days. I remembered that when I was in the XI and XII grades, I, too had found the subject difficult. After graduating from Grade XII, I was coerced by my family to take up chemistry as one of

the subjects in my undergraduate program. I remember feeling scared of chemistry at that time.

In the first year of my B Sc program, I met my chemistry teacher - Kumar Sir. He taught chemistry in an interesting way by using different strategies and linking the subject with real life examples. I realised that it was the motivation sparked off by my teacher that had created such a deep interest in me, resulting in my enhanced self-confidence and belief in my own abilities to learn chemistry. So I needed no convincing that a teacher plays a vital role in a student's learning and his/her impact on a student is enormous. Now I was eager to find out why students of today did not like my (now favourite subject) Chemistry. I began interviewing teachers and students, using questionnaires that I had designed.

Reframed AR Problem: I began to realise that motivating my students with a love for chemistry - so that they *begin to learn on their own* - was a rather tall order. So, with the help of my facilitator, I began a process of breaking down my larger goal into smaller, reachable milestones thus:

"To eliminate the fear from students' minds towards chemistry and inculcate an interest in the subject." In order to analyse the reframed problem, I conducted interviews of approximately 500 people (students as well as teachers), to understand various causes of fear in students towards chemistry. I prepared two different questionnaires for students and teachers. These are given below:

QUESTIONNAIRE FOR STUDENTS:

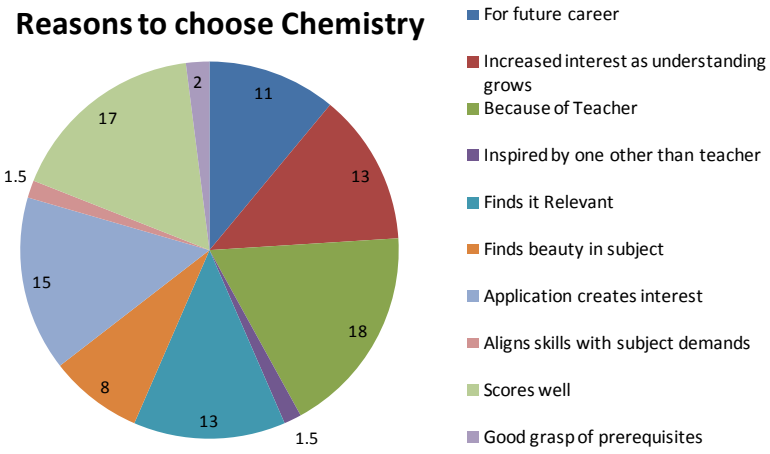
1) Which subject do you like most? Why?
2) Which subject do you dislike/find difficult? Why?
3) When do you feel comfortable/uncomfortable with a teacher?
4) What are your reasons for dropping/choosing Chemistry after tenth Grade X?
5) List some difficulties that you face while learning Chemistry.
6) What are the ways in which Chemistry could become an attractive option for you?
7) Recall a lesson where your mind was fully absorbed in the class. What held your attention?

QUESTIONNAIRE FOR TEACHERS:

1) Describe your most worried and happiest moments as a teacher.
2) What are the elements that you look for in a student, in order to derive 100% satisfaction from your class?
3) What are your most frequently adopted teaching methods?
4) When you teach, what aspects of your subject make you comfortable/ uncomfortable?
5) What could be the reasons for students choosing/dropping a subject after tenth grade?
6) Who was your most inspiring teacher? Describe in detail what inspired you - the qualities possessed by this teacher.
7) In your opinion, apart from subject knowledge, what else should a teacher give to a student to help them grow?

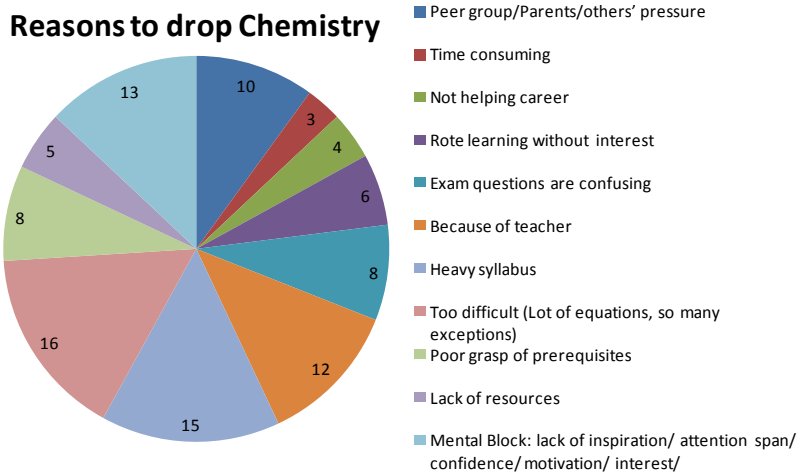
BROAD SUMMARY OF FINDINGS: From the enormous amount of data that I gathered, I prepared a pie chart as shown below. The main findings from the top four sectors of the pie chart are:

- The highest percentage (18%) of students who like Chemistry do so because of their teacher.
- The second highest percentage (17%) likes it because they score well in the subject.
- The third highest percentage (15%) of students likes it because application of their learning has created interest in them.
- And the fourth highest sectors (13%) like it either because they find it relevant, or because their interest grows as they understand it better and better.



This reaffirmed my own experience of the teacher playing a vital role in sparking interest in the student. I also began to see that students' interest can be sustained if they can see the relevance and applicability of the subject in their own lives.

There have been instances of students opting to learn Chemistry and later dropping the subject. So I then analysed the reasons why students drop the subject. From the pie chart alongside, it can be seen that:

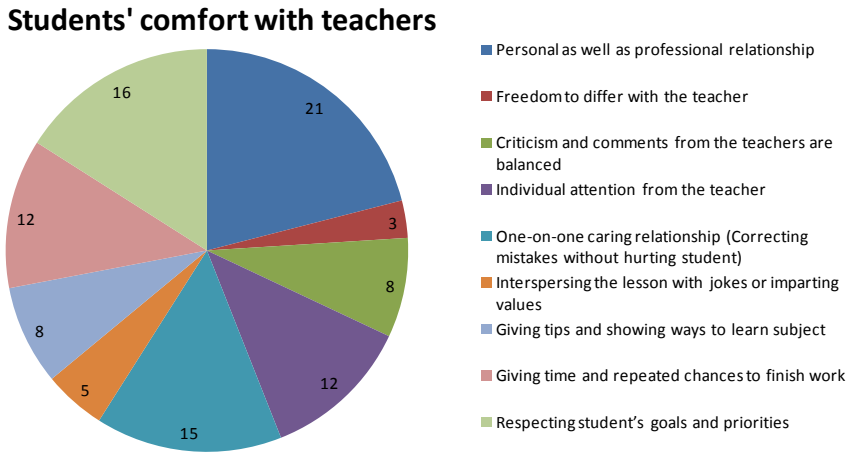


- The highest percentage (16%) of students who drop Chemistry do so because of difficulty in remembering numerous equations as well exceptions to every rule.
- The second highest percentage (15%) drops it because of heavy syllabus.
- The next highest percentage (13%) drops it because of mental block: lack of inspiration/ attention span/ confidence/ motivation/ interest.
- And the fourth highest (12%) drops it because of the teacher.

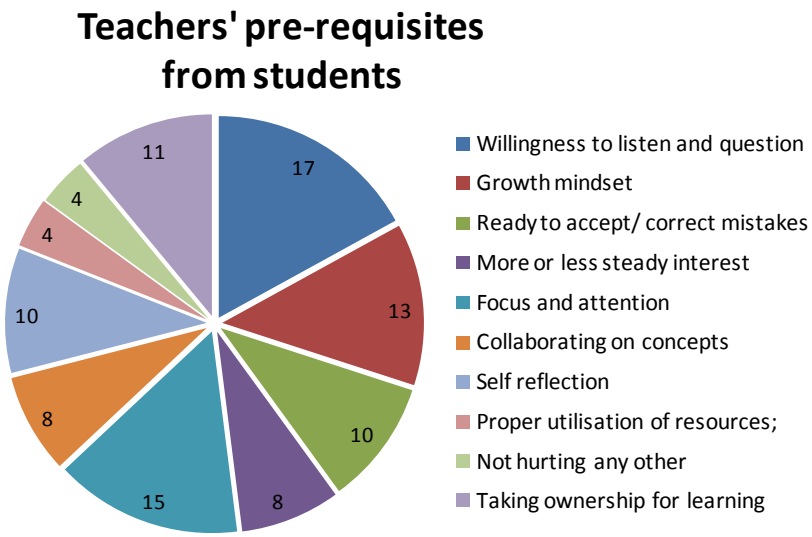
Interestingly, this survey revealed that the teacher was not as critical in spurring students to drop a subject as (s)he is to get them to like it! Here, it is *the way that the subject is perceived* that gets students to drop it.

I now collated the results of my efforts to find out *what makes students comfortable with their teachers*. The reason I probed this aspect was because I had seen that the teacher's role is critical in creating an interest in the subject. Unless students are comfortable with their teacher, I surmised, they will not get interested in the subject that the teacher teaches. So I invested some efforts in examining the various factors that make students comfortable with their teachers. The results are shown in the pie chart alongside.

Here it is evident that:



- The highest percentage (21%) of students feels comfortable with teacher when they can maintain personal as well as professional relationship.
- The second highest percentage (16%) of students feels comfortable with a teacher who respects students' goals and priorities.
- The next highest percentage (15%) of students feel comfortable with the teacher when there one-on-one caring relationship (correcting mistakes without hurting student) is built and maintained .
- And fourth highest percentage (12%) of students feels comfortable with the teacher who gives them individual attention, as well as time and repeated chances to finish their work.



From the above findings, I gained the understanding that it is not enough if I care for my students: *they should perceive* that I care for them. Now I was curious to know what teachers expected from their students. If students' expectations of their teachers affect the teacher-student relationship, then, will not

the teacher's expectations of a student also impact the teacher-student relationship? Here, I found (see pie chart above):

- The highest (17%) prerequisite expected by teachers is students' willingness to listen and question.
- The second highest (15%) prerequisite is for students to focus and be attentive in class.
- The third highest (13%) prerequisite is student' growth mindset: participation/dedication/interest/curiosity/response/zeal/enthusiasm to learn/logical thinking/mental calculations.
- The fourth highest (11%) prerequisite is students taking ownership for their own learning.

I also collated the findings from a set of questions that served to explore the teacher's perception of his/her role – apart from teaching their subject. For want of space, I am presenting the gist of the findings here: Most teachers (19%) perceived their role (other than subject teaching) as being able to sensitise students to reflect. The second highest percentage (14%) of teachers' perceived their role (outside subject teaching) as giving a chance to students to express their creativity, and their collaborative, analytical and critical thinking skills. An equal percentage (14%) of teachers perceived their role as helping build life skills (like emotional stability) in their students, and they stated that they should give students tips for cognitive thinking, critical thinking and critical analysis. The fourth highest percentage (13%) of teachers perceived their role as demanding the teaching of values (truthfulness/humaneness/moral values/ethics/social etiquette/culture/responsibility/self and social awareness/respecting others/ taking guidance to deal with tough situations) and respect student and the subject.

After conducting interviews of students and teachers and collating the findings with my own experiences during my student days, I learnt that along with subject teaching, a teacher should i) bring out the abilities of the student to learn the subject ii) create comfortable situations to motivate them and give them confidence. Overall, I learned that instead of simply holding certain expectations from students, we should prepare students to meet our prerequisites for learning the subject. Having analysed the reasons why students fear the subject and are disinterested in it, I now went on to the third step of Action Research: i.e. Identification of strategies to tackle the problem.

Identification of Strategies: Slowly, I came to realise that there are so many ways which students can enjoy learning. Each subject has its own flavour. So, I wondered, why can't we help students learn Chemistry concepts through enjoyable stories and activities? When I shared this with my facilitator, she narrated a story with which she usually begins her first Chemistry class. She said that she excites her students' interest by telling them of a metal that is so highly reactive that we cannot touch it with our hands – it has to be stored under oil. She then tells them of a non-metal which is a gas at room temperature and which is so poisonous that it was used to kill the enemy during the Second World War. Yet, when this untouchable metal and poisonous non-metal combine, they produce something which we

simply have to add to our food daily: else, we will declare the food to be tasteless. *If this is not magic*, she asks, *what is? THIS IS CHEMISTRY!* I was struck by this novel way of describing the formation of sodium chloride and of igniting the interest of students in the subject – right from the word 'go'.

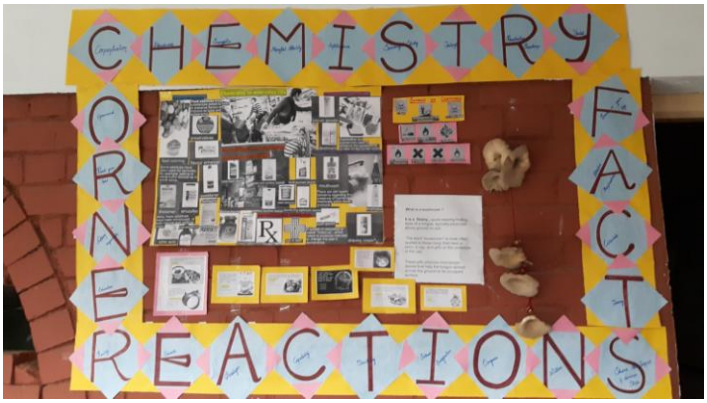
I selected appropriate strategies to make Chemistry interesting from these findings as well as from the guidance that I received from my facilitator after her class room observations. From the huge amount of data that I gathered, I have listed below only those strategies which are applicable to chemistry:

Methods to teach subject	**Methods to create interest/motivate student**
1) Asking questions in a curious way so as to catch students' interest	1) Providing information about future opportunities that open up by learning the subject
2) Providing opportunity for student to guess/ research a solution/topic – Student-centred teaching, from known to unknown	2) Encouraging students' innate abilities gives confidence
3) Breaking up complicated concepts into smaller and easier ones, and providing basic information so as to allow them to then find the rest on their own	3) Displaying willingness to listen to their questions
4) Clear explanation from basics and giving extra information that is not found in the text book	4) Giving them chances to express their creativity and to collaborate
5) Making connections between topics, and from a topic to real life situations	5) Telling inspiring true stories of achievements and hard work of scientists
6) High lighting applications of concepts in real life	6) Conducting games/quizzes, making puzzles related to the subject
7) Practical work/ showing videos/ demonstrations	7) Involving students in seminars, making charts/PPT/working or non-working models
8) Discussions/debates (interactive ways of learning)	8) Making funny presentations
9) Creating and narrating stories based on characteristics of elements/compounds as well as moral stories	9) Asking students to do their own documentation
10) Drama/ role play/ mono acting on some topics	10) Drawing pictures
	11) Developing Self evaluation skills in

	students
	12) Taking students out on field trips
	13) Clarifying doubts clearly and appreciating their openness to ask questions

Implementation of Selected Strategies: I now began implementing the following strategies:

1) I arranged a '**CHEMISTRY CORNER**' and prepared a chart with pictures on the use of chemistry in our day-to-day lives. Every day, I raised questions related to the importance/ presence of chemistry in our lives. E.g. (a) which chemicals are used in the synthesis of perfumes in order to have pleasant aroma? Ans: Esters



E.g. (b): You must have experienced shedding tears while cutting an onion. This is due to the presence of..... Ans: Sulphur in the cells

As I kept changing the questions every day, I also stuck some word building exercises related to element symbols. E.g.: C Ar B O N.

Soon, I found some of the students discussing the likely answers amongst themselves. So I hoped that their curiosity was getting aroused – a first step to building a scientific temper.

2) To teach the differences between physical and chemical changes to IX graders, I divided them into teams and asked them to collect a minimum of ten different things from within the school premises within 10 minutes and then reassemble in the class. Then I assigned two of them as 'collectors': one for collecting the results of physical changes and the other for collecting the results of chemical changes. Whatever the teams had collected was brought to the 'collectors', one by one. All of them discussed whether it belonged to the 'physical change collector' or to the 'chemical change collector' and why. Then they handed over their objects to that particular collector. During the discussion, I either supported or corrected their conclusions and also gave my reasons for doing so. By the end of this activity, they were able to list almost all the properties of physical and chemical changes. Finally, we wrote out all the points to consolidate the topic. Even after the class, I noticed that during break, they were looking around and discussing whether the things around them represented a physical or a chemical change.

3) To make sure that students learn the basics that demand usage of their memory, I would conduct quizzes. E.g.: To learn symbols of elements, valencies of ions, chemical formulae of compounds, etc, I would set one group to question the other group. I would allocate 2 marks for questioning as well as 2 marks for answering correctly. While they questioned others, I noticed that they tried their very best to recall a maximum number of answers. As they discussed the answers within their groups, I also saw that the student who did not know the answer slowly came to learn.
4) I then conducted role plays based on content in class XII. E.g. Distinguishing between molarity, molality, mole fraction, etc. is bound to be confusing. So each student played the role of one of these terms – while an anchor asked questions, that role player introduced her/himself and also explained how he/she differed from the rest.
5) Students of grade IX prepared their own power point presentations and presented seminars in class; some even prepared a chart of the entire periodic table on their own.

Reflection: All my strategies for teaching led to a major impact on students' responses towards chemistry. I came to see that I was slowly achieving the objectives of my Action Research. After eight months, at the end of the second term, I asked my formerly disinterested students a few questions about their current opinions on chemistry. Their answers - which were as follows – led me to conclude that my AR had been successful:

Questions	Answers
1) What do you feel about chemistry today?	I understand now, I improved, I can do it, but I didn't work hard; now whatever I read, I am able to understand; I like it; good; it has become easy for me.
2) How did you feel about chemistry at the beginning of the year?	Confusing subject; very hard to learn; I don't like it; I don't have hopes that I can do it because it is very difficult to understand.
3) Why has it changed?	I'm able to understand it better; basics are clear; easy to work on that; I scored marks even in chemical reactions in which I couldn't last year because I understand them now.

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