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Oral Presentations

O-1

Promoting students' understanding of bonding using a constructivist instructional approach

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Research in teaching and learning of bonding has brought out students alternative conceptions in bonding after formal instruction. Traditional methods of teaching are not able to address students' difficulties in understanding the abstract and complex ideas of chemical bonding. Recent literature in science education research has proposed a new pedagogical approach to teach bonding, with emphasis on presenting all bonds as forces of attraction. There is a need for research on instructional strategies used in classroom settings to promote students' conceptual development.

A study using a constructivist approach to teach bonding and phase changes, with use of multiple external representations, was conducted by the first author in a regular classroom of Class XI with 35 students in a school in North Delhi. This paper describes a part of this study, and specially focuses on the students' concept development of covalent bond, bond polarity and ionic bond. Students' conceptions of bonding were determined through an open ended questionnaire, followed by in depth conceptual interviews of students who agreed to be questioned further. A teaching module was then designed, based on constructivist principles, with the purpose of facilitating students understanding of bond as a force of attraction, and energy minimization associated with bond formation. The constructivist class had the following steps: students expressing their prior conceptions, engaging with the external representations, peer interaction, presenting their ideas to the class, restructuring their ideas, applying the ideas to new situations, and reflection on the learning taking place. Student generated diagrams, written explanations, interviews and researcher's field notes were the data sources. Data was qualitatively analysed. It was found that teaching-learning sessions based on constructivist principles facilitated students' understanding of 'chemical bond'

beyond the "octet" to more scientifically advanced explanations. However, there were also practical problems in conducting such sessions in a classroom setting with large number of students. It is suggested that the teachers can modify and use these strategies to their classroom situations and students' learning requirements.

O-2

Application of 'Kirigami models' as working models in introducing the basic principles of stereochemistry and optical activity

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Stereochemistry which deals with the static and dynamic aspects of three dimensional shapes of molecules is key to understanding the structure and reactivity of molecules. This fascinating subject is introduced to students in their higher secondary and later in the undergraduate curriculum for much deeper discussions and understanding. The subject is introduced by drawing the attention of students to the inherent chirality of nature, e.g. as manifested in the building blocks of nature such as amino acids, nucleic acids and sugars. Later different objects having non-congruent mirror images such as a pair of screws, a pair of shoes or gloves or even one's left and right palms is used in order to imbibe the mirror image relationship. Followed by this the differently substituted tetrahedral carbon is introduced and often the discussion continues with model sets to introduce additional concepts pertaining to stereochemistry instruction. Many students find it difficult to understand the concept of optical activity and its connection to chirality. We have come across an excellent model which helps students to understand the concepts of asymmetry as well as optical activity by making them construct a 'kirigami paper fan' (Fig. 1) and use it as a working model. In our approach, we take the analogy that the blowing wind is like the plane polarised light which consist of both right and left circularly polarised light and the fan choose the direction of rotation according to its configuration. We found this as an excellent tool that makes stereochemistry instruction highly exciting and can be further extended to show optical inversion during bimolecular nucleophilic substitution reactions.

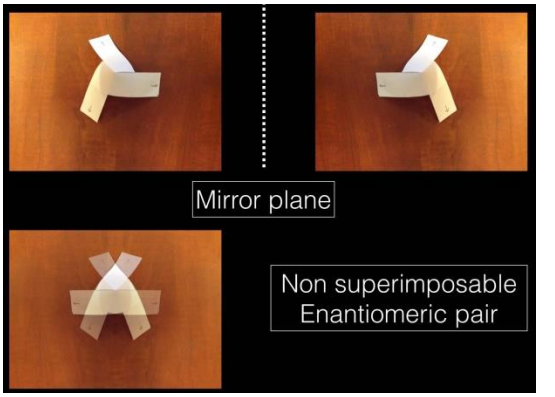

Fig.1 The ‘kirigami paper fan’ as a working model for introductory stereochemistry classes.

O-3

POGIL and Organic Chemistry: An exploratory study

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Process Oriented Guided Inquiry Learning (POGIL) is a student-centric approach to teaching- learning that uses a learning cycle of exploration, concept invention, and application.[1] In the present study, we have explored the POGIL approach for some core concepts in organic chemistry in the regular college setup of Mumbai. The attempt was to develop a first-hand experience of implementing a co-operative learning approach in the traditional setting. The main focus was on the concept of 'Resonance' in organic chemistry, but the pre-requisite concepts of Lewis structures and formal charge were also incorporated in the activity.
The worksheets used for the activity were originally sourced from a standard POGIL book[2] and were modified in terms of language and content to suit undergraduate students. These sheets were validated for their content by subject experts and were pilot tested.

The POGIL activity was then conducted over a period of four days for a class comprising 31 second year undergraduate students, arranged in groups of three. Of the three conductors, one assumed the role of the facilitator, while the other two observed the activity. The activity was preceded by a short MCQ test and followed by exercise worksheets on 'Resonance'. A second equivalent MCQ test was administered and a detailed feedback on the activity was collected from the students. The whole activity was repeated at another institution for a class of 27 first year undergraduate students with one facilitator.

Students' response to the activity has been encouraging and they appreciated the peer interactions as part of the group work. This presentation will discuss the structure, content feedback and reflections on the activity in detail.

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O-4

Activities to address students' alternative conceptions in elementary thermodynamics

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Thermodynamics is considered a difficult subject by most undergraduate students[1]. The inherent abstractness of the subject is one of the reasons why students often develop strong alternative conceptions in elementary thermodynamics[2]. Our study is about the use of an activity based approach to deal with students' alternative conceptions and enhance their understanding in elementary thermodynamics.

In our previous work, undergraduate students revealed several alternative conceptions in areas like pressure, heat, temperature, heat transfer mechanisms, and thermal equilibrium. One of the prominent alternative conceptions about pressure shared by a large number of students was related to 'weight of a vertical column' model of pressure. Thus, students perceived that pressure exists only at the bottom of a container containing fluid, and not on its walls[3]. With respect to the understanding of thermal equilibrium, we observed that students do not believe objects kept in a constant temperature enclosure, even for a sufficiently long time, attain thermal equilibrium and reach the same temperature as the enclosure. They rather believe that the temperature reached by such objects depends on the size and on the material of the objects[4].

With this background, we have designed and developed a module comprising activities on these topics to address students' alternative conceptions. These activities were presented in the predict-observe-explain (POE) approach. Students' predictions based on their naïve ideas were at variance with the reality they observed. The cognitive conflict thus created forced them to reflect upon their alternative conceptions and helped them understand concepts in a better way. This presentation will present the developed activities and our study in detail.

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O-5

Categorization of multiple external representations by chemistry undergrads: an eye-tracking study

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Multiple external representations (MERs) are crucial in the learning and practice of chemistry. Representational competence (RC), the ability to simultaneously process, integrate, and transform between MERs, marks expertise in chemistry. Student difficulties in learning chemistry are often attributed to problems in simultaneously processing and integrating MERs, such as equations, graphs, reaction mechanisms, and molecular structures. Johnstone's model of three thinking levels describes three different levels of representations in chemistry (symbolic equations, molecular models and reaction phenomena). Supplementing this model with Baddeley's model of working memory, Johnstone attributes student difficulties to the way the thinking levels interact with the limited capacity of human working memory. Explanations, for student difficulties and expert-novice differences, inspired by Johnstone's accounts, range from problems with working memory (students have less working memory skills), context and practice (students lack exposure to these) and conceptual understanding (students have superficial understanding). In contrast to this classical information processing framework, our approach seeks to understand the cognitive mechanisms underlying the processing of MERs, using recent cognitive theories such as distributed and embodied cognition. In this paper, we report the gaze patterns and grouping strategies of six chemistry undergrads, during an MER categorization task. The students were presented with 3D molecular animations (depicting only molecular level reaction dynamics, without symbols and text), graphs, chemical equations and videos of certain chemical reactions, and were asked to categorize the given MERs. Eye-tracking was used to obtain fine-grained data about students' gaze and eye movement patterns while they viewed these representations.

Students have difficulties in chemically relating animations to other representations such as graphs and equations. They tend to focus on surface

features, and ignore any cues relating to dynamics of the reactions, in both static (such as graph) and dynamic (such as animation) MERs. Integrating molecular dynamics with equations and graphs requires generating dynamic features using static equations and graphs. Imagination of dynamics, and the cognitive mechanisms underlying such imagination, seem critical to RC in chemistry.

O-6

To understand different learning styles of engineering students using Felder's model to enhance teaching learning process

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Students with different backgrounds, curricula, demographic set up, economic status, and exposure to technical skills make up a heterogeneous class at the first year in an engineering college. During the class hours, often these students do not engage themselves in active participation. As a result, they do not acquire the competencies that are required to perform well in their studies and career.

It is challenging task even for experienced teachers to engage such diversified group of students with teaching learning processes in the classroom. In order to meet the challenge, this study attempts to understand different learning styles of the students. Such information is important for teachers so as to adapt suitable teaching – learning style.

In the present study, the different learning styles of the first year engineering students (sample size= 140) at SRM University was studied by administering Felder-Silverman model. The Index of Learning Styles, in the form of a self-scoring questionnaire was given to the students. They had to answer the questionnaire without spending too much time for each question. The responses on the questionnaire were compared with the standardised answer key. The scores of the individual students help to group them into different learning styles. The learning styles namely visual, verbal, sequential, and global were identified. With such awareness, the teacher adopted the suitable teaching-learning processes. This measure helped in transforming the regular class into an interactive one. Peer-sharing and peer-teaching generated lot of discussions and led to better bonding amongst students. With the teacher acting as the facilitator, students explored and engaged themselves in learning beyond the text. It was observed that performance of the students was also enhanced.

O-7

Understanding organic chemistry practicals using concept maps at senior secondary classes

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The importance of experimental work in science curriculum is well known. Chemistry is an experimental science and students can understand various concepts of chemistry only by conducting laboratory experiments. The main goal of this study was students' understanding of organic chemistry practicals through pre-lab and post-lab sessions. Pre-lab and post-lab sessions were conducted during and after the laboratory session, which help students understand the concepts involved in the experiments they perform. The study was conducted during field work in senior secondary school with 40 science students in class XII. The experimental group was exposed to pre-lab and post-lab sessions, while the control group directly conducted the practicals in classes. Concept mapping was developed to help students make conceptual connections while doing laboratory work. Both groups took 20 item achievement tests one week after each experiment. The students' performance was evaluated after each experiment. Students were interviewed to investigate their perceptions regarding usefulness of pre-lab and post-lab sessions in chemistry practicals. Significant differences were found between experiment and control group with respect to students' understanding as determined by achievement test. Through pre-lab and post-lab sessions students' learning difficulties were reduced. Students responded very positively towards the use of pre-lab and post-lab sessions. They felt strongly that pre-lab and post-lab sessions helped them understand the theory and reasoning behind the experiments. Students' perceptions concerning the usefulness of the concepts maps in chemistry practicals were also explored. The use of concept maps in practicals is intended to stimulate the students' interest in conducting organic chemistry practicals.

O-8

Study of alternative conceptions amongst Chemistry teachers and students

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Alternative conceptions inhibit the ability of a learner to grasp the exact scientific explanation and are fundamental blocks to understanding many concepts in science. They are regarded as important issues in chemistry education. Thus alternative conceptions need to be identified and their sources should be revealed. With the above background, the purpose of this study was to identify the commonness of the concepts of acids, bases and salts. Alternative conceptions held by middle school science teachers and their students of four blocks (Magarload, Dhamtari, Kurud and Nagari) of Dhamtari district, and to find those influences that lead to such alternative concepts, with specific importance given to the role of the teacher. The study was done over the last two years. Seven alternative concept statements grouped into three categories (classroom observation, free response assessment following with interviews and follow up), served as the research tool for identifying teachers' and students' alternative conceptions. These responses were analyzed quantitatively using SPSS software. In addition, teaching was identified as one of the possible factors for transmittance of alternative conceptions. The alternative conceptions were mainly related to microscopic aspect of chemistry concepts. This study discusses difficulties in teaching of concepts in chemistry, and the factors affecting them. Multiple factors contribute, in varying degrees, to the gaining and holding of alternative conceptions.

O-9

Effectiveness of videos and flip teaching in an undergraduate Chemistry laboratory education

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In this study the effectiveness of videos consisting of visuals; description of various steps, stages and techniques involved in several chemistry experiments was investigated and the learning gains and attitudes of undergraduate students' towards flipping chemistry laboratory class were evaluated. *Flip classroom* is a pedagogy that is gaining momentum amongst educators over the world wherein the fundamental instructions and concepts are moved out of the classroom, either in the form of videos or texts and application oriented discussions; and problem solving is focussed upon in the classroom. As against a traditional classroom, flip teaching challenges the conventional order of teaching by employing video lectures as homework, and active, group-based problem solving activities in the classroom. Use of technology in education, has begun to see increased use and support. However, for evaluating the effectiveness of a given technology and underlying pedagogy to contribute to an effective learning experience, research must be done to determine how students learn from the technological tools, and how the technology can be designed to benefit the students to the best. This study is aimed at contributing to this requirement, specifically from the point of view of laboratory courses which are generally skill-based courses. The undergraduate students were expected to view the videos created by the author and answer pre-laboratory questions posed in the videos, before performing a given experiment. These questions were then discussed in the laboratory before starting with the experimental work. The videos created by the author were in the form of screen-casts and were made available to the students, in *mp4* format and *quick-time* formats, which were viewed by the students on their computers. Some of the students even shared the videos on some social-networking sites. The study group consisted of two different groups of second year undergraduate students over a period of two different academic years. A questionnaire, consisting of several items based on Likert-type scale, was

administered to the students to obtain their views on several aspects of the methodology and gauge their learning gains. The results showed that the students understood the theory underlying the experiments well and were able to interpret the complex practical procedures with great ease after seeing the videos. Their anxiety towards using several instruments in the physical chemistry laboratory and towards performing complex practical steps was highly reduced. The work efficiency of the students was enhanced by shortening the time span of performing the experiment. The methodology used instilled a positive attitude in the students towards learning in the chemistry laboratory. The findings of this study have implications for chemistry educators looking for ways to enhance undergraduate self-learning in a chemistry laboratory and to promote discussion based learning in laboratory courses.

O-10

The Effectiveness of Modular Instruction in Teaching Inorganic Chemistry among Freshman Civil Engineering students in the University of Eastern Philippines, Philippines

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The study aimed to ascertain the effectiveness of modular instruction in teaching Inorganic Chemistry among Freshman Civil Engineering students of the University of Eastern Philippines. It drew up a profile of the freshmen college students taking a four (4) unit Inorganic Chemistry at the University of Eastern Philippines in terms of age, intelligent quotient (IQ), and sex. It likewise looked into whether modular instruction and the traditional methods of teaching chemistry affected the students' performance. The level of effectiveness in teaching Inorganic Chemistry using modular instruction for both control (Traditional Instruction) and experimental (Modular Instruction) groups were determined in this work.

The quasi – experimental research design with the nonequivalent control group was used. Frequency counts, percentages and means were used to describe the profile of the students & to assess the performance before and after the exposure. Majority of the subjects were adolescents above average in intelligence and mostly male. The experimental groups obtained passing scores, majority in the control group got failing scores. Modular instruction is a more effective method of teaching Inorganic Chemistry than the traditional method as it increased the students' performance.

Poster Presentations

P-1

Molecular modelling approach to study the reactivity of substituted benzene towards electrophilic reaction

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Reaction mechanism is one of the important topics in organic chemistry and is integral to any chemistry syllabus. The effect of the substituents on the aromatic electrophilic substitution reaction is taught extensively throughout in undergraduate organic chemistry courses. Students often resort to memorization due to confusion: whether a substituent is an *ortho/para* or *meta* director. The aim of the present work is to lay down in a simple way, the concepts of reaction mechanism through methods of molecular simulation.

Computational chemistry has now been accepted as a useful and powerful tool for academic research as well as industrial research. We may begin explaining chemical behaviour through electronic structure using computer based modelling. The difference in the reactivity of the positions can be assessed using Molecular Modeling. To determine the susceptibility of the substituted benzene towards attack by an electrophile, the charge on each atom including the substituent was calculated and indicated numerically. The combination of theory with computational calculation can increase student's understanding of the effect of a substituent on the orientation of an electrophile. This exercise provides an explanation of the concepts taught in a traditional way in a classroom and also supports observations in laboratory experiments. It facilitates understanding of the principles of chemistry involved. This approach not only enhances learning reactions, but also helps to hold students' interest in learning difficult concepts in reaction mechanism presented in the lecture. Students can gain complete understanding of structure, bonding, and reactivity.

P-2

Evaluation of perception of teachers about including OERS for Chemistry Teaching in the state of Gujarat

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In India, the past few decades have witnessed wide spread growth of chemistry research. However, the practices of chemistry teaching and learning have not undergone much change. Still teaching chemistry in schools and colleges is mainly done through lectures and notes; even though epistemologically it is quite different. A report on Chemical Science research in India, as per Science citation Index (SCI-2002), reveals that India contributes 4.5% to the global R&D output. Thomson Reuters Essential Science Indicators (2009) reveals that in 1999-2003 the share of chemistry research was 4.42% of India's R&D output, with 21,206 papers, which again rose up to 33,504 (5.7%) in 2004-2008. In spite of such quantitative growth, the quality of chemistry teaching has not ushered well in our schools and colleges; an example being the vacancies of pure chemistry seats at B.Sc. and M.Sc. levels in Gujarat. A Joint Review Mission by MHRD reveals that Gujarat is in the process of revising its teacher education curriculum and has renewed school curricula and school textbooks, post NCF 2005 and NCFTE 2010, based on inputs from teachers and other stakeholders (JRM, 2013).

The present study has been conceptualised to augment the need of revamping chemistry education in the state of Gujarat with four major objectives: (i) To find out the perception of secondary and senior secondary school teachers about Open Education Resources (OER) usage in chemistry teaching in schools of Navsari district, (ii) To review the state of affairs of chemistry teaching in schools of Gujarat, (iii) To study the reactions of the Chemistry teachers towards the effectiveness of OERs, and (iv) To recommend all possible measures for making the present chemistry teaching more joyful by using OERs.

The major findings are: the quality of OER content is good (80%). But many of the respondents feel that content mapping is required at school level (57.5%). 67.5 % of teachers said that OERs will provide higher quality

educational experiences for the learner but more research on OER is needed for schools (47.5%). Nearly 55% of the teachers said that there is no specific policy framework for OER usage in K-12 segment in Gujarat. We need broad band connectivity for effective use of OER (67.5%) and the same should be available in local languages (64.5%). Due to its sharing option, OER is widely acceptable (60%). More orientation is required for teachers for effective implementation of OERs (42.5%).

P-3

Chemriddle- A student-friendly method of teaching and learning

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The conventional "chalk-and-talk" method concentrates on completion of course curriculum, where students often become passive listeners, eventually losing the interest in the subject. However, if the students are made creative participants in the learning process, so that each individual in the classroom has an opportunity to share ideas, they feel motivated. Thus the generation of motivation is the real challenge to us.

The aim of the present work is to probe whether riddles in chemistry can generate original thinking in the students. To study this, intercollegiate contests and films were organized/ produced to enthuse students. The films were telecasted on the UGC-CEC Vyas national network. From this experiment it was apparent that the students took the challenge in solving the riddles, enjoyed them and were satisfied with the solutions. In turn, the teachers could assess the students' analytical ability.

One riddle is presented as an example with four leading questions. The active learning style involved should be emphasized.

Example 1 (Theme: principles of solubility product and common ion effect; their importance in solubility and precipitation)
I am a silvery white metal. I produce vigorous effervescence with acid. I pair with sulphide of hydrogen sulphide gas in alkaline medium, but not in acid medium.
a) Who am I? b) What is the effervescence due to? c) What compound is formed with hydrogen sulphide? d) Why does the alkaline medium promote my reaction with hydrogen sulphide, but the acid medium hinders?

P-4

A 'FMO Simulator': Pedagogy for visualization of Frontier Molecular Orbital interactions in pericyclic reactions

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Pericyclic reactions are the essential portions of graduate and post-graduate chemistry syllabi. Teaching-learning of these reactions needs extreme imagination to infer correct stereochemical outcomes. A simple FMO (Frontier Molecular Orbital) simulator can meet the need of extreme visualization, which is otherwise difficult with "chalk-talk" and even an animated slide presentation. This FMO simulator can be made from simple office stationary and can be intelligently incorporated in teaching process. This simple pedagogy proved extremely useful while explaining molecular symmetry, regiochemical and stereochemical outcome of several electrocyclic, cycloaddition, and sigmatropic reactions. It also can be effectively used to derive laws of orbital rotatory motions. This pedagogy can also be used to groom students' imagination.

This simulator has been a part of regular teaching since last three years and proved extremely useful while teaching pericyclic reactions. The understanding was evaluated in three subsets of students, one with the simple blackboard teaching, second with an animated slide presentation, and the third with the simulator. The subset in which the above simulator was used showed exciting results. It also saved a lot of time that would require in verbal expressions and gestures. The construction and application of this pedagogy in effective teaching learning process of pericyclic reactions is presented.

P-5

Satellite Communication Technology and its role in teaching Chemistry in the state of Rajasthan

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Department of Science and Technology, Government of Rajasthan, has been using Satellite Communication (SATCOM) technology for the promotion of science education through its popular scheme for helping the Hindi medium students to prepare for medical and engineering examinations. Chemistry is one of the core subjects which is being taught live by experts using multimedia tools and delivering the content to the economically backward students of Government schools in the geographically diversified areas of Rajasthan state. This is empowering the learners specially the girls and educators.

Quality and effective teaching plays an important role in developing interest among students[1]. There is great demand of introducing new technological tools for better understanding of the conceptual topics[2]. The beneficiaries of SATCOM are students studying in Government schools in rural and backward areas. These students understand local and Hindi languages only, which is the reason behind choosing Hindi as instruction medium. One of the main objectives of delivery of chemistry lectures through SATCOM, which was started in 2011, is the promotion of science education at the XIth and XIIth levels. This programme also aims to teach chemistry using the dedicated framework of SATCOM technology at remote places in Rajasthan state.

A state of the art studio at Jaipur has been established to deliver lectures of eminent experts in the field of chemistry, online using SATCOM technology. A dedicated network of terminals at the Taluka, Panchayats, Zila Parishad levels has been established, using 114 satellite interactive terminals (SIT's) and 247 receive only terminals (ROT's). Institutional engagement at the school level has been achieved through the positive cooperation of school education department. The lectures are delivered to students in Hindi, with the help of multimedia e.g. PPTs, videos, animations, live use of chemistry

software. There is also a provision of regular assessment of the students. The students can also raise queries in between the lectures using SIT's and ROT's that are satisfied telephonically by the experts. Presently, all the notes and study material are being uploaded on the DST website from where students can easily access them. Besides, this content is also provided to the students in the form a book (in Hindi). Shortly, there will be a complete website for the purpose promoting this scheme from where students can download the study material in Hindi and also can post their feedback. DST also supports the students by providing incentives for attending regular lectures.

Rajasthan state is the biggest state of India (area-wise) with diversified areas. It is a challenging and difficult task to provide chemistry education to the students residing here. This programme has been implemented as a mission and has inspired interest in science, particularly in chemistry. It has helped in popularizing the chemistry subject and created interest among the learners.

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P-6

Organic Chemistry made enjoyable through problem solving activities

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Organic Chemistry is often perceived as a difficult to understand subject by a large number of undergraduate students. Further, the current examination pattern promotes mere memorization, thereby forcing students to rely on rote learning. Problem solving is important for conceptual understanding but sadly, it finds no place in the curriculum, in particular in the regular college setups. In our opinion, problem solving must be made an integral part of teaching-learning, as it creates opportunities for a learner to revisit and apply the newly-taught concepts to a variety of situations, thereby de-emphasizing rote learning.

With this background, we have initiated a number of activities emphasizing on the problem-solving approach for different core Organic Chemistry topics:

(a) Problem-solving workshops held twice in an academic year - organized for the last three years for second year B.Sc. students, with each workshop of 3-4 days duration and attended by 50-60 students from different local colleges.
(b) Weekly post-lecture session for motivated students.
(c) Tutorials in regular classes: For second and third year B.Sc. students, implemented for the last six months.
(d) Study-circle: Running for two decades.

All these activities involve students working in groups, with the teacher assuming the role of the discussant. The workshops are often preceded by lectures delivered by subject experts. The problems used for the above activities are sourced from standard reference books and internet resources, and are also designed by us. Each activity involves problem-types varying from multiple choice to semi open-ended and open ended.

Students have positively taken to these efforts. Participation in these activities has boosted self-confidence of the students, and has helped them perform better in major competitive examinations.

P-7

Modifying Chemistry demonstrations for large audiences

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A dramatic chemistry experiment has the amazing potential to capture a student's attention and spark an enduring interest in chemistry and even in other scientific disciplines. Experiments are also a very effective way to reinforce concepts from the classroom. To make an impression and connect with the audience, the presentation of the experiment is crucial. However, many of the experiments typically done or shown in a school lab, while perhaps instructive, are not the most spectacular and often not the easiest to show for large audiences.

The science outreach team of TIFR conducts experiments across the country, especially in rural schools where live big-screen projection, for example, is not available. We have developed a series of chemistry demonstrations which use simple apparatus, but are still more easily seen by a large audience. For example, instead of the platinum wire based “flame test” to identify different salts, fine spray bottles with suspensions of various salts are used to create small colourful fireballs that can be seen from a distance (Fig. 1(a)). The catalytic oxidation of acetone on a copper surface is another reaction that can be made into audience-friendly demonstration. While the shear-thickening properties of a cornstarch-water mixture can be appreciated even in few teaspoon quantities, having a 200 kg mixture of the same allows the rheological properties to be explored in rather dramatic ways (Fig. 1(b) and (c)). Similarly, soap bubbles provide a wonderful introduction to hydrophilic-hydrophobic interactions and interference phenomena but hardly last long enough for meaningful experiments to be performed. However large-area flowing soap films (Fig. 1(d)) provide a wonderful platform for experiments during a stage demonstration. Scaling up demonstrations also requires care in ensuring safety, both while performing the experiments as well as in disposal/reuse of the materials utilized. Our presentation will highlight some

of the experiments that have been developed and extensively field tested by us. Most of these have been developed without large financial cost.

a b c d

Fig. 1: Examples of demonstration experiments for large audiences: (a) Spraying strontium salts into a candle flame (b) preparing a 200 kg mixture of cornstarch and water in a 2m wide pit (c) dancing on a cornstarch/water mixture (d) large area flowing soap-film

P-8

Organic Chemistry through blooms' taxonomy

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Organic chemistry is an important prerequisite for all disciplines of science including biological sciences, medicine and pharmacy. Students often perceive it as a course which is vast in content, and are generally anxious to know the bare minimum that is required to successfully clear the course. The subject is studied largely by rote memorization. The concern of teachers is that students often fail to recall the content studied at earlier level even though they do clear the course. The conceptual understanding and organization of the content remain weak for most of students.

Thus, it would be worthwhile to attempt to change the trend and to develop strategies that would help students build their knowledge base quantitatively as well as qualitatively on relevant principles. This means that the students need not function only at the elementary cognitive levels of knowledge and comprehension, but should use higher level cognitive skills such as application, analysis, and synthesis. If learning stagnates at the lower levels of cognition it would be difficult to consider applications to related fields. The responsibility falls on the teachers to change learners' mindset about the subject and ensure that learning becomes constructive. Thus, we have to convince students that organic chemistry is a logical science and has a unique appeal, that may even be termed endearing by some. On the teacher's part it would require a conscious effort to lead the students from lower cognitive levels to higher cognitive levels.

An ideal example would be in organic reaction mechanism, where a thorough expertise of the involved principles is helpful to connect the possible reactivity of organic molecules in a mechanism. It can lead to a satisfying experience of discovery by self-learning, encouraging critical thinking.

The purpose of this paper is to sensitize teachers to the concept of Bloom's taxonomy for effective learning in the context of organic chemistry; taking Nucleophilic Substitution as an example. An overview of the learning

objectives, outcomes and typical questions on every cognitive level of Nucleophilic Substitution will be discussed.

P-9

Use of teaching aids in teaching Chemistry at higher secondary level

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Higher secondary school students face genuine difficulties in understanding and learning Chemistry due to the traditional methodogy of teaching. Therefore, it is important for teachers to modify their teaching methodology and use new technology. Use of teaching aids and innovative methods that enhances students' participation are important. I have been using various teaching aids like – play with periodic table, cartoons of atoms and molecules, calendar of elements, minitritration, demonstration of chromatography etc. At times, seminars and quizzes can be arranged to involve more students. Both survey and interview data indicate that such aids are useful in learning Chemistry.

The study was conducted by teaching two groups of students with and without these aids. It was observed that those students who were taught with the help of teaching aids understood the content better than those taught without such aids. The effect of using these methods was seen in test scores of the students.

From the above study, it was found that the use of teaching aids enhanced and improved the motivation to learn and students' confidence. They enjoyed learning chemistry. It creates a friendly relationship between the students and the teacher and a better environment for learning.

P-10

Comparative study of two methods for teaching Chemistry

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In the current empirical study, two methods were used for teaching of chemistry topics: namely, seminar followed by lecture and lecture followed by seminar. Two groups were randomly chosen were from second year M.Sc, and each group comprised of twenty students.

The first group, Group A was given a lecture on a topic. They were asked to prepare a seminar on the same topic and present it on the next day. Following the seminar, a multiple choice type of questionnaire developed by the researcher was administered to the group.

Students from Group B were given the same time (i.e. one day) to prepare for a seminar on the same topic. After they presented their seminar, the lecture followed and then they were given the same questionnaire. The scores of two groups were compared using t test, and results indicated that group B was significantly better than group A.

P-11

Use of innovative teaching for conceptual understanding in Chemistry

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The aim of the present work was to study effect of various activities on the conceptual understanding of students. Every student comprehends concepts by different channels- musical, visual, linguistic, logical-mathematical, body-kinesthetic, interpersonal, intrapersonal, Naturalistic. Certain chemistry chapters were chosen from different grades and the lesson plans for these chapters were redesigned. The idea behind redesigning was to introduce concepts in these chapters to students through 'multiple intelligence' related activities. Some concepts covered were as follows:

(i) Grade VI- Introduction to chemistry, apparatus used in chemistry laboratory, Matter-its states and properties.
(ii) Grade VII- Basics of chemistry laboratory, Matter - elements, compounds and mixtures, Separation of mixtures
(iii) Grade VIII- Acids, bases and salts

Once the lesson plan was designed each topic was taught in a class through various activities. Some of the findings were:

(i) In all the post tests that have been conducted for the various grades the students have shown enhanced applicatory skills to the concepts that have been taught in class.
(ii) Students developed more interest in the subject because the shift was from rote memorization to the use of various skills to understand concepts.

P-12

From Macro to Microscale Experiments in Chemistry: A Cost Analysis

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The study was aimed to analyze the cost effectiveness of using microscale experiments in chemistry. Specifically, the study compared the performance of the students who used the macroscale and microscale experiments. This also evaluated the percent cost of reduction and cost effectiveness ratio when microscale experiments were used.

The study used the randomized pre-post test experimental design. Treatment was done by using the microscale experiments to the experimental group and the macroscale experiments to the control group. Twelve experiments were performed by the students on Measurement, properties of Matter, Molecular Models, Acids and Bases, Solutions, Chemical Reactions, Stoichiometry, Gases, Thermochemistry and Electrochemistry. The academic performances of the two groups were compared using the t-test. Cost analysis was done by getting the percent cost reduction and cost effectiveness ratio.

Findings revealed that the proficiency level of students in the microscale group is significantly higher than those in the macroscale group. Using microscale experiments can reduce the cost of materials by 62% and it is cost effective by a factor of 5. It can be concluded that microscale experiments in chemistry can improve the performance of the students. The microscale experiments can be used as an alternative means of improving the student's level of proficiency in chemistry and in addressing issues and concerns involving chemistry education such as the high cost and inadequacy of chemistry supplies and materials.