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Research Paper

Objectives of Teaching Chemistry in Modern Schools

Chemistry

KEYWORDS : inquiry, sharing, mobile science, green chemistry,exploring

Prof.R.S.Mani

Professor of Education, Department of Education, Faculty of Education and Psychology, The Maharaja Sayajirao, University of Baroda, Vadodara 390002,Gujarat, India

ABSTRACT

In this paper an attempt is made to delineate the objectives of teaching chemistry at school level with a purpose to bring the modern thinking and facilitating interaction in the immediate environment for developing a purpose of inquiry, creativity and share thoughts and experiments to develop process of thinking and experimentation in the systematic way possible to facilitate more examination by student and share ideas in more meaningful ways. The strategies of reflection, thinking and contemplation needs to be made more explicit for understanding. The teachers need to become facilitators of learning, developing skills, sharing, organizing activities around the immediate environment to bring meaning to the context and explain the process for its benefits and problems of destroying the environment. The objectives of teaching chemistry need to be universal in its application and thinking but specific in terms of the context of understanding (laboratory, field, classroom, industry etc,). The language of chemistry as determined by IUPAC2005 need to be made conversant to students and apply knowledge in action through experimentation.

Objectives of Chemistry have changed periodically to suit the needs and purposes of the school and society. In each of the country modernization is accepted as the need of the society. For example, Slater's Chemistry Curriculum in Britain. The change that has taken place in terms of the facilities, outlook and purpose determines the objectives for consideration. The mobile science curriculum for rural area is a new initiative of the Sarabhai Community Science Centre, Ahmedabad.The Homi Bhabha Centre for Science Education; Mumbai visited many rural areas in Maharashtra and tried to improve the laboratory in schools. They started a new science centre in Sholapur.N.C.E.R.T., New Delhi has developed school kits in science to demonstrate the science experiments.Ekalavya Teacher education initiative of a NGO in Hoshangabad has brought a new idea of inquiry based science learning in primary schools of Hoshangabad.These innovations have given some indicators of development to begin thinking in new ways to organize the science curriculum and experiments.

Objectives of teaching chemistry provide the chemistry teacher the required direction, the starting point for inquiry. It also sets the boundary to be drawn for the teaching of chemistry at school level. Teaching of chemistry is planned process of transformation of knowledge into principles and the required planned action (experimentation) for understanding. The chemistry teacher tries to describe, elucidate and explain concepts and solve problems of relevance. The chemistry curriculum needs to be essentially local specific to cater to the needs of the people with a national framework in the matrix. The National Curriculum Framework 2005 tries to describe the type of science curriculum that India needs to meet the present and future challenges in Chemistry. The chemistry curriculum need to be more constructive and the teacher need to be facilitative in order that the students engage scientific inquiry, do experiments and discuss concepts in chemistry to refine ones understanding of the nature of chemistry and its application in life.

NCF2005 guidelines are integrated into the objectives of teaching chemistry at school level.

The following are the important objectives of teaching chemistry at school level.

1. To develop a basic knowledge and understanding of Chemistry at school level.
2. To understand the relationship of chemical substances, its properties, and their application in life.
3. To explore content, process and the language of chemistry teaching to communicate with the learners age –range and cognitive reach.
4. To facilitate teacher to enable the students to engage in acquiring methods and processes that nurtures their curiosity, creativity and strengthens the interaction with environment.
5. To develop awareness of environmental concerns to permeate the entire school curriculum.
6. To develop scientific attitude and scientific thinking.
7. To develop laboratory skills in chemistry at different levels.
8. To develop safe consciousness in practicing chemistry in school and life.
9. To develop scientific values of inquiry, creativity, perseverance, honesty, tolerance, accuracy, respect for natural products and their properties.
10. To place the curriculum in the wider context of childrens' environment to equip them with the requisite knowledge and skills to enter the world of work.

In the following paragraphs an attempt is made to develop descriptive understanding of the objectives.

1. To develop a basic knowledge and understanding of Chemistry at school level. Teachers of Chemistry need to provide the conceptual structure of chemistry to students in an organized way through continuous interaction and active participation of students in developing the conceptual structure. The teacher needs to facilitate the students to show the inter-relationships between concepts and integration of it in a meaningful way for a clear understanding of the local milieu. For example, each of the substance has a particular structure showing specific physical and chemical properties is a fundamental understanding (Carbon, Hydrogen, Oxygen, Mercury, Iron etc.).

It is also necessary to understand the relationship of properties of elements in relation to its structure and position in the periodic table of elements. The students need to understand and use the Chemical nomenclature given by IUPAC (2005). They need to develop the chemical vocabulary to describe the nature of chemical reaction in chemical terms and conditions. Teacher need to help the students in doing this activity systematically and familiarize the right way of representation chemical concepts and use of notation. Students need to be facilitated to understand the fundamental theories in chemistry to represent the organization of knowledge in chemistry. For example, Oxygen exists in three forms, i.e. Oxygen (O_2), Ozone (O_3), $_{1/2}O$. However, Oxygen in O_2 form is relatively stable. Carbon shows allotropic forms such as graphite, diamond, and Charcoal. These variations in the properties show the chemical activeness of the element and the nature of organization. The nano carbon shows more strength than the iron. Elements of the same group have some similar properties

for example; halogen group of elements Fluorine is highly electronegative, followed by Chlorine, Bromine, and Iodine.

The theories and hypotheses formed by students need to be examined for its appropriateness and help the student develop the proper understanding. In this process, students need to share exchange and interact closely to develop and change the ideas for constructing a better relationship. Teachers need to create an environment of sharing, working together and participate in the process of understanding. The elements placed diagonally in the periodic table show certain common properties.

2. To understand the relationship of chemical substances, its properties, and their application in life. The chemical substances are classified according to their molecular structure into four blocks namely s, p, d, f. The electronic configuration of the element describes the structure of the element. However, the mass and size (atomic radii), shape and electro negativity, the ionization potential tries to specify the properties of the individual elements and its relation with other elements properties. The chemical substances are classified as solid, liquid, gas or fused state (including its nano forms) that are presented in STP conditions.

There are substances that show allotropic forms for example, Carbon, Sulfur, There is a need to describe the element, molecule, and concept, explain and experiment with asking questions of relevance. Students need to be involved in thinking about their environment in chemical terms, describe it and explain the phenomena such as Ozone hole, global warming, climate change, acid rain, fermentation and their significance, forms of preservation, ways of purifying substances, synthesizing, condensing and extracting for study. The modern methods such as ultra filtrations, scintillation, X-ray crystallography, NMR spectroscopy, IR spectroscopy, use of Atomic Force Microscope, Irradiation as a method, etc, may be discussed in detail for understanding the use of analytical method, instrument, and their relation to the element or molecules structure and properties. Some fundamental methods need to be developed such as filtration, sublimation, addition, esterification, fermentation, titrations, gravimetric methods of estimation, use of vapour pressure, viscosity, surface properties, and solubility of substances etc.

Students could prepare chemical analysis charts, arrange periodic table, read, interpret and relate with properties of elements for its more appropriate use.

Chemistry teacher needs to introduce each of the concept, theory and hypothesis with care and share the idea to relate more with the phenomena.

3. To explore content, process and the language of chemistry teaching to communicate with the learners age –range and cognitive reach.

The content discussed must be to the level of the learner and cognitive reach. The simplest presentation in the IUPAC language will facilitate more questions and discussions among students. The procedure needs to be properly familiarized to students to plan, organize and execute the experiment in more systematic ways to bring thinking in the more meaningful means and ends. The curiosity of the student, the creativity of the group and individual need to be nurtured to facilitate more inquiry at home, school, and immediate environment to bring home more activities and experiments that makes meaning to students for example, finding pH of the substance. Classify substances as acidic, basic and neutral.

4. To facilitate teacher to enable the students to engage in acquiring methods and processes that nurtures their curiosity, creativity and strengthens the interaction with environment.

Teacher may ask questions to students to answer in the classroom. Facilitate students to ask questions and maintain a record in their dairy for reflection. Allow students to interact with each other in planning experiment, organizing, and conducting them in pairs or small groups, tabulate results, analyze, and discuss results with others (previous experiments of similar kind).Explain the anomaly, find solution for accuracy, find more means of accommodating the process in scientific way to simplify the phenomena to suit the local conditions for example, use of micro scale experiments by each of the student or in pairs to conduct experiments such as titrations, filteration,distillation, discuss fractional distillation, use of autoclave,. Use of indicators of vegetable origin, small single cell reactors. Show osmosis, reverse osmosis, surface phenomena. Discuss the monolayer contribution and thin layer technology and its advantages.

Question such as how thermocouple could be safely used in chemical laboratory and the needed precautions and safety measures need to be cognized.

5. To develop awareness of environmental concerns to permeate the entire school curriculum.

Students may be encouraged to take samples of air in their school and its surroundings and study the problems of pollution. The aerosol concentration could be mapped with the help of teacher in parts per million. The nearby industries need to be informed about use of appropriate precipitators, use of green processes and technology for eliminating or replacing Chlorofluoro carbon and lessening the use of fossil fuel. Discuss the possibility of use of solar cells and technology to give solutions to the environmental problems. Develop energy efficiency table of fuels and chemicals. Discuss the use of energy efficiency methods and processes in chemical transformation. Discuss harvesting of rain water, purifying the water for potable purposes. Prepare green maps and messages for building green environment.

Discuss the advantages of green buildings and design. How recycling may help in solving problems. How much of recycling or reuse is advisable is a question that needs debate.

6. To develop scientific attitude and scientific thinking.

Students need to be trained to think in more purposive ways to organize their environment more systematically and view the world with more meaning. The faith in solving problems needs to be encouraged in students. The desire for experimental verification needs to encourage and teachers need to guide students to verify the processes and principles in use. The students' curiosity need to be nurtured and objective attitude need to be promoted. Aversion to superstition need to present for liking scientific explainations.The suspended judgment could be practiced in the need for more evidence for distinguishing hypotheses and solutions. There is a need for developing respect for theoretical structures, quantification, and acceptance of probabilities and acceptance of warranted generalizations. The scientific attitude requires long time to practice and develop in individual. However, school is the right place for developing Scientific attitude and think in more systematic and resourceful terms.

Anderson states that scientific behavior has the following components: Curiosity, Rationality (habit of looking for natural causes for natural events), and willingness to suspend judgment, open mindedness, objectivity and honesty.

7. To develop laboratory skills in chemistry at different levels. The laboratory skills are predefined by the secondary and higher secondary education board in each state. However, the labora-

tory skills needed for life need not be confined to the laboratory of the school or home environment. The field experiments' could be carried out with mobile laboratory. teacher needs to guide the students to carry out experiments and share experiences for example, testing of quality of water in river, pond, the water in tap, tank, etc, gives an idea of the purity needed and effort needed to process systematically to make water potable. Students could join hands in developing green kit, solar kit, energy efficiency testing, use of devices,apparatus,equipment,and calibration and use of measuring equipments, use of safety measures and the need for testing ideas ,planning and executing.

Some students in school showed the extraction of bio diesel from Jatropa plants in Vadodara.A pilot plant was put up by the government of Gujarat at Ankaleshwar.

Certain skills in the laboratory need to be emphasized such as:

Planning experiments, Setting up experiments, systematic observation, reading instruments properly, use of equipment properly, finding equivalent weight of a substance, finding normality of a given solution, reading spectroscopic data, understanding thematic maps from IRS satellites, reading for the minerals, developing basic skills such as filtration, distillation, crystallization, evaporation, sublimation, fermentation, decantation, fumigation, finding boiling and melting points of given substance, reading class tables, writing electronic configuration of elements, mapping chemical relations of elements, writing chemical equations, balancing equations, gravimetric analysis, quantitative and qualitative analysis of chemical substances. Grouping and characterizing ionic substances. Finding atomic distances and its significance. Use of various notations and symbols.

Writing chemical equation, reading, and interpretation and comparing, reporting.

8. To develop safe consciousness in practicing chemistry in school and life.

The safety consciousness needs to be built gradually into the Psyche of the individual. Some of the essentials may be to:

Use laboratory coats, maintain silence, and use appropriate instruments, equipments, and apparatus in the required quantity. Understand the nature of chemical transformation. Plan and proceed systematically for care and meaning. Use goggles when needed for the eyes. Make it a point to be near the experiment most of the time. Switch off the heating devices as soon as chemical is heated to the required level. Use desiccators for carrying the synthesized substance for measurement. Use the measuring scale systematically. Accuracy always helps in understanding and shows better results. Read instructions, labels and guidelines and instruction chart. Prepare for experiment, plan and arrange the required apparatus, chemicals to be used in order for flexible use and better results. Follow Baker's dozen safety rules (Plus 1).

Follow the rules always correctly.
Bakers' dozen safety rules (Plus 1):
No eating or drinking in the laboratory.

Handle everything as if it's pathogenic for example, in micro processing of chemicals. In micro biological experiments. Handle sample properly , avoid contamination, Autoclave sterilize for 0.5 hour or use freshly prepared 10% bleach for 0.5 hour and rinse before disposing in the regular trash. The national center for biotechnology education in Great Britain is a clearing house for many biotechnology lab activities.

Keep flame and flammable solutions far apart.

Keep Electrical equipment far from water Clean spills from the outside In.

6. Use proper safety protection-fume hood, goggles, and gloves.

Always clean glassware before you use it to be sure that residues are cleaned away. Add at least some water first, before adding any liquid or solid solutes.

Be careful weighing out chemicals and reagents. Do NOT return excess materials to the stock container. Learn vocabulary of chemical safety.

Check all water baths with a thermometer before putting your hand into the water.

All sharps (needles, razors, pins, toothpicks) should be discarded in a sturdy container. Coke container could be used by making a slit on the top of the required size.

Science and writing go hand-in- hand. Maintain a proper laboratory note book, manual, write standard operating procedures.

Be prepared (40 steps to a safer laboratory, Laboratory Safety Institute). Wash your hands before and after lab work.

Refer: Madison Area Technical College Lab safety guide.

Learn how the professionals learn about safety (HHM! Laboratory Safety Program) Simple slide show.

Find good resources for school laboratory safety (Finn Laboratory Safety Guide) Check out several different school laboratory safety resource guides.

Example School Lab Safety Contracts Appleton area, W1 Erie PA., Generic Science Supervisors, California examples.

Refer: http://schmidel.com site developed by Dr.Toby Horn, CASE, Carnegie Institution of Washington.

Tata Institute of Fundamental Research, Homi Bhabha Centre for Science Education, Mumbai has prepared safety rules for handling nuclear materials in the laboratory and outside. Visit: http://tifr.hbcse.res.ac.in.

Ensuring safety while using Oxidizing materials: Chlorates, per oxides, per chlorates and perchloric acid, sodium chlorate and potassium chlorate. These substances need to be kept away from strong acids. Since they react to produce toxic chlorine di oxide and may explode. They should also be kept away from any substance that are easily oxidized such sulphur, sulphides, phosphorus, sugar, alcohols, organic solvents, ammonium compounds, powdered metals, oils , or greases.

Using Mercury: Mercury vaporizes even at the temperature at which water freezes. It produces an odorless, tasteless and colorless vapour. The concentration of which depends upon the temperature. This vapour is toxic and can result in damage to the nervous system.

Mercury enters the body readily by inhalation, by ingestion, or through the skin. Chronic exposure may result in cumulative poisoning indicated by nervous and psychic symptoms. Mercury must be stored in dark, cool place where direct sun rays do not reach. While using Mercury, it is advisable to use non-porous gloves and rubber-soled shoes. Wash hands as soon as the experiment gets over. Check cloth for any spill over on cloth.

Inhalation of Chemicals: Keep your nose away from the chemi-

cals. Many of the common solvents are extremely toxic if inhaled in any quantity over a period of time. Do not evaporate excess solvents in the laboratory; use the hood or a suitable distillation apparatus with a condenser. Some compounds such as acetyl chloride, will severely irritate membranes in your eyes, nose, throat, and lungs, while others, such as benzyl chloride, are severe lachrymators, i.e. they induce eye irritation and tears. When in doubt, use the hood or consult with the laboratory instructor about the use of chemicals required for your work. Specific safety information about chemicals used is included in each experiment write up.

MSDS (Material Safety Data Sheets) are available on the DCIS file server and summarize safety information about substances used in the laboratory.

Safety in purview:
1. Prevention of accident is better than giving chances for accident to occur.

2. A systematic approach (scientific method) experimentation provides better insight of the context of experimentation.

3. A minimal knowledge of first aid is very essential for every scientist and scientist in the making.

9. To develop scientific values of inquiry, creativity, perseverance, honesty, tolerance, accuracy, respect for natural products and their properties.

Students need to be encouraged to develop values. Facilitate discussion on values and develop values for chemistry learning. Autobiography scientists, stories of scientists working honestly, famous scientists in India and abroad who shown excellence, perseverance need to highlight such as Linus Puling, Madame Currie, P.D.Currie, Faraday, etc, some skits could be prepared to play and enact as drama.

Some excellent scientists such as P.C. Ray, Bhavnagar, C.N.R. Rae, etc, could be discussed in detail for their contributions to science and society. Some movie clips could be prepared and shown to students.

10. To place the curriculum in the wider context of children's' environment to equip them with the requisite knowledge and skills to enter the world of work.

Children must be made aware of the various scientific institutions that are working with more efficiency in India and abroad. Students may be given opportunity to visit research institutions. Kishore Vigyan Protshan Yojana gives opportunity for young students to visit the Indian Institute of Science , Bengaluru and interact with them for one month. They are also allowed to observe the experiments taking place in the advanced laboratories. INSPIRE programme gives them opportunity to do experiment and know the scientists. Children develop an understanding of the use of knowledge and understanding of chemistry in industries such as Chemicals, leather, textiles, polymer, petrochemicals, pharmaceuticals, biological, and fertilizer, analytical laboratories, drug laboratories, pathology laboratories, seed preservation centres.Renewable energy projects, energy conservation projects,etc.

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