INCULCATION OF VALUES THROUGH SCIENCE EXPERIMENTS AT THE SECONDARY LEVEL

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Science is a systematic study and knowledge of natural and physical phenomena. In this era, scientific education is much emphasised in all societies the world over. The main goal of science education is to prepare the right type of environment for the individual, to allow learners grow physically, mentally and spiritually in order for them to develop harmoniously over time together with fellow human beings. According to *NCF-2005,* a teacher should act as a facilitator and not as a transformer of contents where they can think, realise, analyse and develop their own way of learning something beyond the textbook. The *National Curriculum Framework* for school education brought out by NCERT (2005) mentions that school education in the country seems to have developed some kind of neutrality towards the basic values. The *National Policy on Education* (NPE) (1986) has clearly emphasised the need of learning of science as a part of general education without compartmentalising into its different disciplines. The NPE (1986) reflects the government's desire to make readjustments in the curriculum in order to make education a forceful tool for the cultivation of social and moral values. Science operates through its processes. Hence, science teaching is to be different from that of the other subjects. Mere question answer method will not be enough. Thinking based upon keen and minute observations with the help of activities/experiments skill is to be generated amongst the learner. Teaching-learning of science needs to be characterised by focused emphasis on processes of science. Learning of science increases the spirit of enquiry, creativity and objectivity along with aesthetic sensibility. It aims to develop well-defined abilities of knowing, doing and being. It also nurtures the abilities to explore and seek solution to the problems related to environment and daily life situations and to question the existing beliefs, prejudices and practices in society. Science concerns itself with the fundamental knowledge of universe, world and its environment. In the light of NCF, it is now being felt that technology (science of mechanical and industrial arts) is increasingly influencing our quality of life. Hence, there is a need to promote values through technology infused science using practical skills at the upper primary and secondary stages. The main objective of this article is to develop practical skills in order to enrich the science teachers in learning the systematic performance of science experiments to relate the science concept values effectively at the school level.

Key words: Value, science and technology, practical/experiment skill, scientific process.

Introduction

Science teaching through value education and society is indispensable. Society equips education with the values to be transmitted while science education exposes each generation of young people to the existing beliefs, norms and values of their culture. This demands a careful selection of the values that would help to integrate the society and promote the mutual relationship between man and his environment. Science operates through its processes. Hence, science teaching is to be different from that of the other subjects. Mere question answer method will not be enough. Thinking based upon keen and minute observations with the help of activities and experiments, skill

is to be generated amongst the learner. Teaching- learning of science needs to be characterised by focused emphasis on the processes of science which may consist of the following steps,

(i) Careful observation

(ii) Sensing of problems

(iii) Making hypotheses

(iv) Literature survey or consulting teachers or a friend

(v) Identification of a particular problem

(vi) Experimentation for seeking solution

(vii) Data collection and analysis

(viii) Interpretation of data

(ix) Drawing inferences

(x) Modification of hypotheses and scope for further studies.

In our classroom teaching, we will have to perform activities for removal of misconceptions, if any, and develop and strengthen the concepts on the basis of seeing, doing and thinking. This will lead to the development of one very important value, i.e., truthfullness besides the other related values of critical thinking and reasoning. The experiment should be so designed that its results are clearly interpretable. Interpretation becomes difficult if the variables are not identified and suitably controlled. The initial design of the experiment must be carefully looked into so that some of the possible sources of error can be located and steps are taken in the design to correct them. Before actually starting the experiment, a list of materials required must be prepared and procured. It would also be convenient if a method of recording the data has been decided upon, so that the necessary tables, etc., could be prepared before the experiment is started. During the experiment, accurate observations must be made and duly recorded, exactly as they happen. The data collected should be arranged in a methodical manner so that interpretations would be facilitated. The results and conclusions of the practical experiment will have to be presented finally as a report. There are a number of ways in which the experiments can be modified and improved. If these practical skills can generate ideas not only for improvement of the suggested designs but also for new experiments, their purpose would be amply served. Science teachers at the school level must be trained properly to perform some basic experiments in order to inculcate scientific temperament and appreciation for science. Use of the practical skills for science concepts may be helpful to understand several scientific terms which include the following:

1. To stimulate an interest in science.
2. To improve experimental and communicational skills and to develop scientific attitude and interests.
3. To inculcate divergent thinking and cooperative attitude among students.
4. To establish a sound fundamental knowledge of facts and principles.
5. To satisfy scientific curiosity.
6. To encourage independent thinking.
7. To make use of the environment.
8. To practice critical thinking.
9. To develop problem solving techniques.

10. To make scientific principles more meaningful.
11. To increase self-confidence.

The value of experiment skill for science concepts can make the study of science more exciting, enjoyable and educational. This provides an opportunity to teachers and learners to get a first hand experience of the process involved in scientific concepts at the school level. It represents method of helping learners explore their special interests in depth. The findings are often far more valuable to the students who are involved than the information presented in regular class periods.

Values: The word, value is derived from the Latin word, '*Valeric*' meaning to be strong and vigorous. Value means 'worth', 'importance' and 'utility'. To be of value is to have certain virtues. A widely accepted definition considers value to be conceptions of the desirable influencing selective behaviour. A value is a belief upon which a man acts by preference. Values are attributes that confer on man humanism and peace. Values are concepts that conserve, comfort, promote and protect life. They shape the moral personality of an individual. Values enhance the finer side of one's potential. A value is a real relationship between a person and an environmental situation which evokes an appreciative response in the individual. Kireet Joshi (1981) mentions that the education that promotes among youth the values of self-control, discipline and right habit of thought and conduct is necessary. True education is a man making education. Values foster peace, order, dignity, grace and delight. Value in one word is the divine side of a man. Real education should become an instrument of social change and national development. It should move towards humanism, liberalism and universalism.

Any human activity, thought or idea, feeling, sentiment or emotion which could promote self-development of the individual in all its dimensions could be said to constitute a value. Value should also confine to the welfare of the larger social units, such as, the family, the community, nation and ultimately the whole world of which the individual is a member. Value education is not simply a matter of choosing a set of values from among competing values and then transmitting them to the students but internalizing those values in one's personal life.

The National Policy on Education (1986) lays emphasis on value education. The NPE clearly reflects the government's desire to make readjustments in the curriculum in order to make education a forceful tool for the cultivation of social and moral values. *National Curriculum Framework for School Education* brought out by NCERT (2005) mentions that school education in the country seems to have developed some kind of neutrality towards the basic values. The curriculum further emphasises that a comprehensive programme of value inculcation must start at the earliest stage of school education as a regular part of the school's daily routine. The entire educational process has to be such that the boys and girls of this country are able to know 'good', to love 'good' and to do 'good', and grow into mutually tolerant citizens.

SCIENCE PRACTICALS AND VALUES—
A five-days training programme (24–28 October 2015) on practical skills for secondary science

teachers of the western states (Madhya Pradesh, Maharashtra, Gujarat, Chhatishgarh, and Goa) were conducted by the authors for the implementation of NCF (2005) in their respective states. The participants were taken to the chemistry laboratories at the Regional Institute of Education, Bhopal for conducting a few simple science activities and experiments to discuss whether some values can really be developed by performing some experiments. The following experiments were conducted:

1. Determination of pH of various solutions.
2. Determination of chemical properties of metals and non metals with oxygen and nature of their oxide.
3. Separation of mixture compound (by sublimation method).
4. Cleaning of muddy water.
5. Separation of two immiscible liquids

Participants of the groups were of the view that a large number of values can be developed among learners through various science experiments, provided they are conducted scientifically. The values, which the groups feel can be inculcated through science experiments, are:

1. Systematic procedure
2. Keen and minute observations
3. Analytical thinking
4. Scientific attitude
5. Open mindedness
6. Mutual cooperation
7. Patience
8. Sense of belongingness
9. Social concern
10. Self-confidence, etc.

Details of a few simple experiments along with a list of various values developed through each of them are given below:

Determination of pH of Various Solutions

Principle: pH of solutions (lemon juice, tomato juice, baking soda and washing soda solution) can be determined with the help of pH paper. A substance is said to be acidic if its pH lies below 7 to 1 and alkaline if pH lies above 7 up to 14. The pH bears a spectrum of colours corresponding to different pH values.

Mental Processing: Preparation of given fruits and salts solutions keeping a solution in mind.

Procedure: The pH of solution can be determined by dipping the pH paper in the solution and matching the colour thus obtained with the standard colours indicated on the pH paper. When the fruit juices of commonly available fruits like lemon, orange, tomato, baking soda and washing powder solutions were used for determination of their pH, the results as given in Table 1 were obtained by the participants. The values which can be developed as a result of this activity as reported by the participants are given below:

1. Keen observation
2. Confidence
3. Mutual cooperation
4. Scientific temper
5. Reasoning
6. Truth

Table 1: pH and colour change with pH paper of different solutions

S. No.	Fruit juice/ solution	Colour change	pH
1.	Lemon	Orange	4
2.	Tomato	Orange	4
3.	Baking soda	Dark green	9
4.	Washing soda	Dark blue	11

Determination of Chemical Properties of Metals and Non Metals with Oxygen and Nature of Oxide

Principle: When magnesium ribbon/metal burns in the air (burner) it forms magnesium oxide. If MgO dissolves in water it forms Mg $(OH)_2$ which turns red litmus blue.

$2Mg+O_2 \rightarrow 2MgO$

$MgO+H_2O \rightarrow Mg(OH)_2$

Whereas, when sulphur is burnt in the air it forms sulphur dioxide or sulphur trioxide. Sulphur dioxide when dissolved in water forms sulphurous acid, which turns blue litmus red.

$S+O_2 \rightarrow SO_2$

$SO_2+H_2O \rightarrow H_2SO_3$

Mental Processing: Metals and non metals occur in ore and mineral forms. They contain different types of properties which indicate their specific behaviour or character during an experiment.

Procedure: Hold magnesium ribbon using tong and burn it on a Bunsen burner. Collect the ash in a watch glass; note its colour and state. Dissolve the collected ash in 15 mL distilled water in a beaker and check the nature of this solution with red litmus. For sulphur take a deflagrating spoon with sulphur powder and burn, and immediately introduce in the gas jar containing water, cover the lid tightly. When the fumes cover the whole jar remove the deflagrating spoon. Shake and stir the jar gently, so that the gas gets completely dissolved in water. Check the nature of the solution with blue litmus.

Values Developed

1. Reasoning
2. Problem solving
3. Systematic approach
4. Critical thinking
5. Learning by doing
6. Decision making
7. Scientific temper

Separation of Mixture Compound (by Sublimation Method)

Principle: Some substances change directly from solid to vapour state on heating and on cooling vapour changes into solid. This phenomenon is called sublimation.

Mental Processing: Thinking, reasoning and changing the state of the substance.

Procedure: The mixture of two compounds (Iodine and sand) was taken and its physical properties were observed. One compound was found to be soluble in water having unique smell. The smell resembled that of iodine. We were told that one of the compounds converts into gaseous state directly on heating. The mixture was taken in a beaker and placed on a tripod stand. Cold water and an ice containing conical flask kept were on beaker. On heating, iodine changed

into vapour directly and condensed into a solid substance on the surface of the conical flask from where it was collected easily. Sand was left as is inside the beaker. In this way, the two compounds got separated.

Values Developed

1. Patience
2. Thinking
3. Reasoning
4. Systematic approach
5. Critical thinking
6. Confidence
7. Pleasure
8. Mutual cooperation

Cleaning of Muddy Water

Principle: Aluminum cations present in the potash alum fasten the process of coagulation as a result of which heavy suspended particles settle down at the bottom of the container.

Mental Processing: Thinking of a solution and cleaning.

Procedure

1. Treatment of muddy water with a small amount of alum to coagulate the smaller insoluble particles and allowing them to settle down at the bottom of the container.
2. Decantation.
3. Separation of impurity to get pure water.

Values Developed

1. Societal concern
2. Sense of belongingness
3. Patience
4. Development of a procedure
5. Development of reasoning and critical thinking
6. Importance of pure water
7. Problem solving ability

Separation of Two Immiscible Liquids

Principle: This experiment is based on the principle of difference of specific gravity. The Liquid with low specific gravity remains in the upper layer while the one with higher specific gravity remains in the lower layer.

Mental Processing: The liquids provided were clear. Each of them left some mark on the walls of the container, one of them having an offensive odour.

Procedure: Name the two liquids A and B and took 20 mL of each with the help of a measuring cylinder in a beaker. Two layers are formed. Then this solution of two immiscible liquids are transferred to a separating funnel kept on our seat. The two liquids are shaken vigorously and then allowed the separating funnel to remain undisturbed for some time on a tripod stand till two distinct immiscible layers appeared. Open the pinch-cock of the funnel and transfer the lower layer in one beaker and upper layer in the other beaker. Thus two layers of immiscible liquids are separated.

Values Developed: After completion of this simple activity we feel that the following values can be inculcated:

1. Handling of the glass apparatus and successful separation of the two liquids develop self-confidence.
2. Initiation for performing other scientific experiments.

3. Understanding of the environment and applying application of this principle in daily life.
4. Development of reasoning and logical thinking.
5. Development of scientific temper.
6. Patience ultimately leading to truth.
7. Seeking solution of problems.

Educational Implication and Inculcation of Values

1. It develops the observation skill and insight of a person.
2. It proves that whole is always important than parts.
3. We had a whole situation and on its overall observation we succeeded in reaching a logical conclusion.
4. Such type of an activity develops handling of apparatus, reasoning, scientific attitude and creativity.

CONCLUSION

The teachers and the practitioners for inculcation of values through science teaching can think of such types of classroom activities and problems in science and technology. However, it may be remembered, it is not an overnight exercise. Values are learnt or inculcated by a long and continuous process. Values can be inculcated only when we practise them, follow them in schools, colleges and society. Students consider teachers as their models. Therefore, before taking up the task of value inculcation amongst our students, we teachers, teacher educators and administrators will have to present ourselves as models for our students and rid ourselves from the clutches of politics and selfish motives.

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