SCIENCE LEARNING THROUGH EXPERIMENTATIONS

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One of the success stories of the 'National Children's Science Congress' — a mega event initiated and organised annually by Department of Science and Technology, Government of India— is that students get themselves involved in finding feasible solutions of some context specific issues, with great excitements. Learning microbiology without support of sophisticated equipment is not easy. Efforts were made to develop such a module on 'Microbiology', which is very easy to handle and can demonstrate nearly 40 experiments even at classroom situations. Before delivery of a lecture, if we conduct experiments in front of students the subjects become interesting and students are able to ask the questions. This is the beauty of learning science with experiments. The author was able to develop similar science learning modules in physics, chemistry, mathematics, biology, microbiology, astronomy, soil science, explaining science behind miracles, water and soil testing kit (Parkhee), etc. These modules were evaluated by students of B.Ed. and M.Ed courses of Delhi University. They found that these modules to be very useful.

Key words: *Science learning, experimentation, modular approach*

Introduction

We are living in a world increasingly shaped by science and technology and information has the primary resource for all levels of population. The rote learning of science has proved to be neither successful nor create any kind of excitement among the learners. Several efforts have been made worldwide individually and institutionally to promote an ecosystem for learning science with experiments. Experiments may be small or big but producing some kind of results which has the capability or source of excitements to the students who is conducting the same. Unique experiments have been done while interacting with community or society to get the feedback for certain problems being faced by them in their daily work providing another challenge to find new and innovative experiments. Students are required to engage in active learning, to exploit their natural curiosity about science and to get them to ponder the question, before we try to give them answers. Conducting experiments in class with discussion before, during, and after the experiments is an effective and enjoyable way of moving from passive to active learning.

Learning science through experimentation either in classroom situation or out of the classroom, students work in group on carefully designed plans. Materials are provided to students with the means of collecting data through interaction with their group members (outside classroom situations) as well as with typical laboratory materials, data simulation tools or decision making environment and a series of questions that lead to discovery-based learning (experiments on classroom situations).

The Process

The author got an opportunity to involve in conducting National Children's Science Congress (NCSC) across the country for around 23 years and was able to develop once

in every 2 years an 'Activity Guide Book' on certain focal themes, which has proved to be a Bible both for guide teachers and students. Students identify a locally relevant problem underlined with one of the subthemes of the year and start working. It is a group activity targeted to 10–17 years age group of child scientists. The NCSC provides opportunity to child scientists to showcase their creativity through the activity. It is a mini research project which allows the child scientists to design, develop their own experiments using 'method of science' for finding feasible solutions of the problem identified by them. It gives them enough freedom to choose their own problem from the society, make observations, conduct experiments, validate the results, collect the data, analyse the data, make their own hypothesis, interpret the results, discuss, interact the issues with guide teacher and come to the conclusion. Nearly ten lakh students around the country are participating in this activity annually. It is organised first in block level, district level, state level and finally in national level. Some selected students also participate in the Indian Science Congress. In this programme not only our participants but international students from ASEAN countries, Middle-East, Bangladesh also participated, annually.

During conducting the experiments the role of the guide teacher/instructor is to act as facilitator. Classroom experiments may differ from classroom demonstration because the students are involved in collecting data or observations. All the experiments whether conducted in classroom situation or outside classroom ambience provide opportunities to share all individual ideas, develop consensus among the ideas, distribute responsibilities what we call it the spirit of working together in a group for finding a feasible solution in the form of collecting, collating observations date, etc., in order to try to find the answer of the question or solve a problem.

Classroom experiments often help students to learn more about the materials they are studying. In this case the hypothesis to be listed will generally be derived from material contained in the module developed (resource material). Experimental materials are developed by involving subject matter specialists, who are allowed to develop resource material which is exactly not similar to textbook, however, the suggested experiments which are designed and developed definitely give an insight to the students while following the so called pedagogical modules (teaching-learning science experiments).

Another model of learning by experimentation is design and development of science learning modules. The author has been involved in developing a good number of modules and kits for learning science in classroom situations. These modules are: to understand microorganisms; solid waste management using vermi-compost as base; learning mathematics through origami; science behind so called miracles; understanding astronomy; know your own soil; measuring quality of water and soil with simple kit *Parkhee*; identify your neighbourhood birds; simple doable experiments on physics (300 experiments in 3 volumes); simple experiments on chemistry; experiments on eye (optics) and simple task great concepts (100 experiments on life sciences). All these modules provide the opportunities to students to ponder on out-of-box thinking and provide altogether different environment to conduct varieties of

the experiments. These experiments ignite the excitement for science learning. All these modules were developed in a series of workshops conceptualised, catalysed and supported by NCSTC, DST by the involvement of subject experts. These modules were evaluated and found very useful by students of B.Ed. and M.Ed courses of Delhi University. These modules were used to orient several NCSC and NTSC resources Persons. A brief account of such programmes is given below in Table 1.

Table 1: Developing resource persons by organising workshops/events/exhibitions/demonstrations of science activities

S. No.	Nature of Activity	Workshops	NCSC	NTSC	Perfect Health Mela	Exhibitions (beneficiaries)
1.	Microbiology	40/1200 RPs	09/2250 RPs	08/2000 RPs	09/2250 RPs	2500
2.	Water/Soil Testing	04/120 RPs	04/1000 RPs	02/80 RPs	04/160 RPs	1200
3.	Social Insects	40/1200 RPs	09/2250 RPs	04/1000 RPs	04/160 RPs	1000
4.	Vermi-composting	40/1200 RPs	07/2000 RPs	03/900 RPs	04/160 RPs	2000
5.	Low Cost Aids	60/1800 RPs	09/2250 RPs	08/2000 RPs	08/2100 RPs	3000
6.	Explaining Science behind Miracles	100/3500 RPs	12/3000 RPs	08/2000 RPs	08/2100 RPs	5000
7.	Aerodynamics	15/450 RPs	04/150 RPs	02/70 RPs	03/105 RPs	200
8.	Astronomy	05/150 RPs	04/150 RPs	02/70 RPs	03/105 RPs	250
9.	Simple Task Great Concepts	40/1600 RPs	04/160 RPs	02/70 RPs	02/70 RPs	300

NCSC: National Children's Science Congress;
NTSC: National Teachers' Science Congress
WS: Workshops; RPs: Resource Persons

Conclusion: The Impact of the Process

While conducting these experiments which are investigatory kind always attract the attention of the students and their attendance is always more than satisfactory

level and encourage them to ask questions and the tutor is prepared to answer the questions raised by students. After sufficient experimentation, research analysis and synthesis of information, students have been asked to re-evaluate the status of their acquired knowledge and understanding of the problems. Problem revision or redefining took place as students developed a deeper and broader understanding of the problems. Tutors and educators, sincerely involved for ways to meet the new challenges of science learning can choose among several instructional techniques. Among these, problem-based learning provides the scaffolding to simultaneously achieve the goals of making students apprentice scientists, using realistic, ill-structured problems, and focusing on cognitive skills. All the students are enthusiastically adopting responsibility for the problems, finally feeling some ownership over the learning process and understanding which Judson (1980) referred as 'The Rage to Know'. The National Children's Science Congress and National Teacher's Science Congress are successfully developing a science culture and providing a forum to child scientists, active science teachers, resource persons and science communicators at district, state and national levels to share their efforts for many years.

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