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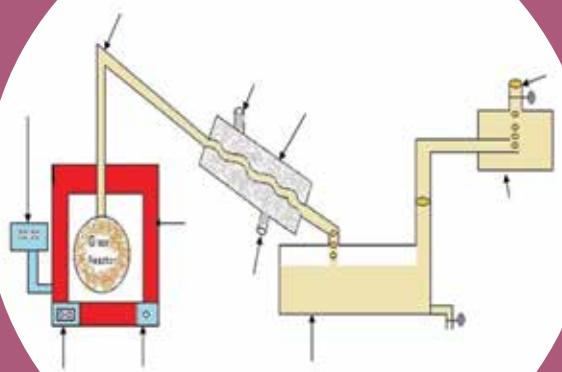

Pyrolysis of waste plastic bags to produce fuel— need of the hour.

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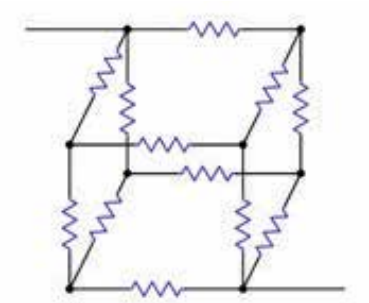

EDITORIAL

This special issue of *School Science* includes selected review articles and research papers which were presented during the conference 'National Conference on Science Education' held at the Regional Institute of Education, Ajmer from 24 to 26 November, 2016. There are 25 research papers and review articles in all.

In the article '*Science Learning Through Experimentations*', the author highlights the process of science learning through experimentation, in which a robust ecosystem for active learning is promoted as it uses the inherent curiosity of children.

The next research paper studies 'Awareness of Education for Sustainable Development among Class IX Students of Yadadri Bhuvanagiri District in Telangana' and recommends that education for sustainable development be given more weightage in the school curriculum and related activites be organised in the school throughout the year for more awareness.

The research paper 'The Effectiveness of Hands-on Activity Teaching in Learning Acid and Base Concepts at the Secondary Level' infer that students taught through investigative hands-on activity approach learned better and there is a significant increase in understanding of the concept of acids and bases than among the students taught in traditional way.

'To Study the Effect of 'Live' Miraculous Demonstrations on Increasing Interest in Chemical Sciences', clearly highlights that live experiments can boost student's eagerness to learn chemical sciences.

'A Study of Students' Conceptual Understanding of the Content of EVS at the Primary Stage' highlights a considerable difference in conceptual understanding of EVS between two groups of students studying in Hindi and English medium schools.

'Effectiveness of Digital Technology on Biology Learners at the Secondary Level', reports a positive impact on the biology learning and enhances their fascination towards the subject and their zeal to learn.

'A Study of the Working Style of Different Types of Institutes and Attitude of Entrant Science Students of Class XI', highlights increasing tendency of students entering Class XI to join coaching institutes to crack competitive examinations due to the fear of unemployment.

In the paper 'Relation of Sustainable Development with Science Education and Human Needs and Greed', the authors attempt to find out the relationship of the two independent variables— science education and humans, future aspirations and plans for expenditure with one dependent variable— sustainable development.

The major findings of the research papers 'Availability of Science Laboratory in Schools at the Secondary Level' discuss the necessity of local resources and virtual laboratories for learning science and to bridge the gap of learning and understanding science at the school level.

The paper 'Live Zoology Beyond the Classroom: A New Era of Science Education' suggests that the live zoology concept allows capacity building of students to study organisms of the same and other species in their natural habitats without disturbing them.

'Learning of Flame Test Using a Low Cost Experiment' suggests the method of using of low cost reagents for qualitative analysis of some basic radicals.

The study 'Transcending Disaster Education: A Developmental Approach Ensuring Sustainability' focuses on harm caused by disasters to our environment and the study allows devising better ways to mitigate them by educating all about disasters and disaster management.

'Teaching of Science in Upper Primary Special Training Centres for Out-of School Children' is a presentation of successful intervention of science teaching with groups where science, based on relevant societal problems in interactive and laboratory activities, is taught.

'Study of Indicators on Acids and Bases' focuses on constructivist science classrooms where the role of students changes from knowledge gainers to knowledge constructors.

'Periodic Table as a Constructivist Model of Teaching-learning at the Secondary Level' presents a model for constructivist learning of periodic trends allowing students to apply critical thinking skills and to boost their mind.

'Science Education for Sustainable Development: A Theoretical Framework' highlights the role of science education in sustainable development and attainment of millennium development goals.

The studies 'Hands-on Activities Vs Multimedia Content in Science in Developing Pre-service Teachers' Competence' and 'Learning Science by Use of Innovative Hands-on Activities' reveal that students' achievement and teachers' competence was better when the science concepts were dealt using hands-on activities in teaching-learning processes.

The paper 'Sustainable Practice of Knowing Medicinal Plants through Environmental Education Theme Park at RIE, Ajmer' provides the elaborate description of eight plants of medicinal importance.

The research paper 'Liquid Hydrocarbon Fuel Collected from Waste Plastic by Using $CuCO_3$ catalyst' presents a solution to the issue of plastic waste management by conducting pyrolysis of waste plastic bags.

The paper 'Science Education and Sustainable Development' critically analyses the factors causing environmental issues like climate change, global warming, ozone depletion, etc., and finds how to overcome these problems by inculcating scientific temperament among children.

In the present study 'Orienting Senior Secondary Physics Students about Measuring Conductivity of a New Material and its Applications' the conductivity of PEO:NH_4ClO_4(85:15 wt %) polymer complex was enhanced by addition of plasticiser, propylene carbonate, so that it becomes good material for the fabrication of a rechargeable solid state proton battery.

The article entitled 'Embedded, Laminated and Mounted Specimens of Plants and Animals' provides technique of embedded specimen as a replacement of the traditional

dry and soak specimen catering better understanding of the species.

The article on 'Innovative Heavy Metal Waste Disposal System: Modular Approach for Senior Secondary Chemistry Teachers' describes an approach to combat the hazards of laboratory waste by safe disposal of heavy metals.

In the paper 'Using Affinity Chromatography and Western Blotting - The Purification of Polyclonal Antibody from Rabbit Antisera', anti E. Coli lysate antibody was purified using affinity chromatography and the immunoactivity of the antibody was confirmed using SDS PAGE and Western Blotting.

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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AWARENESS OF EDUCATION FOR SUSTAINABLE DEVELOPMENT AMONG CLASS IX STUDENTS OF YADADRI BHUVANAGIRI DISTRICT IN TELANGANA

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The purpose of the study was to find out the awareness of education for sustainable development among Class IX students of Yadadri Bhuvanagiri district in Telangana. The major objectives of the study were to study the awareness of sustainable development goals and utilisation of non-renewable resources with respect to sustainable development. The investigators adopted the descriptive survey method. The data were collected by using tools, viz., questionnaire (both open and closed-ended) and semi-structured interview. Purposive sampling (N=63) was used. The sample of the study was constituted of Class IX students of Gowtham Model School, Bhongir, District Yadadri Bhuvanagiri, Telangana, which is a private English medium school affiliated to the Directorate of School Education, Telangana. The two sections of Class IX students were selected as sample. The total sample (63) was: Section A consisting of 31 and Section B consisting of 32. The collected data were analysed by using both quantitative as well as qualitative techniques. The major findings showed that the students were not aware (61 per cent) of education for sustainable development. It was observed that students were much aware about utilisation of non-renewable resources. It was also observed that the syllabus needed to be incorporated more comprehensively on the topics of education for sustainable development and also students opined that activities should be organised in the school on education for sustainable development programmes at regular intervals. It may be noted that the recent national and international initiatives on education for sustainable development are taken keenly on inculcation of activities and placing curriculum in various levels of school education programmes.

Key words: *Sustainable development goals, Non-renewable resources*

Introduction

The UN Document *Gathering a Body of Global Agreements* (n.d.) describes sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. According to United Nations Educational, Scientific and Cultural Organization (n.d.) education for sustainable development allows every human being to acquire the knowledge, skills, attitudes and values necessary to shape a sustainable future. Education for sustainable development means including key sustainable development issues into teaching and learning; for example, climate change, disaster risk reduction, biodiversity, poverty reduction, and sustainable consumption. It also requires participatory teaching and learning methods that motivate and empower learners to change their behaviour and take action for development. This research paper discusses the study of awareness of education for sustainable development with respect to sustainable development goals and utilisation of non-renewable resources. After reviewing related literature for the present study, few

questions are raised with respect to education for sustainable development. They are,

1. Are the students aware of the education for sustainable development?
2. To what extent are students aware of non-renewable resources?

Objectives of the Study

1. To study the awareness of sustainable development goals among Class IX students.
2. To study the awareness of utilisation of non-renewable resources with respect to sustainable development among Class IX students.

Methods and Procedure

For attaining of the projected objectives of the study, descriptive survey method was adopted.

Sample: For collecting required data, the investigators employed the purposive sampling technique. The sample of the study was constituted of Class IX students of Gowtham Model School, Bhongir, District Yadadri Bhuvanagiri, Telangana, which is a private English medium school affiliated to the Directorate of School Education, Telangana. The two sections of Class IX students were constituted as a sample for the study. The total sample of the study was 63 (Section A consisted of 31 and Section B consisted of 32).

Delimitation of the Study: The present study was delimited to Class IX students of Gowtham Model School, at Bhongir, Yadadri Bhuvanagiri District in Telangana State.

Tools and Techniques of Data Collection: Considering the stated objectives of the study, the following tools and techniques were used for data collection.

Questionnaire: A questionnaire was prepared by investigators to study awareness of students with respect to awareness of sustainable development goals. The first draft of the questionnaire consisted 17 dimensions (i.e., No Poverty, Zero Hunger, Good Health and Well-being, Quality Education, Gender Equality, Clean Water and Sanitation, Affordable and Clean Energy, Decent Work and Economic Growth, Industry, Innovation and Infrastructure, Reduced Inequalities, Sustainable Cities and Communities, Responsible Consumption and Production, Climate Action, Life Below Water, Life on Land, Peace, Justice and Strong Institutions, and Partnerships for the Goals), and 34 close-ended items and 10 open-ended items. The first draft questionnaire was sent to subject experts for tool validation. After receiving the constructive feedback from them, four open-ended questions were deleted. The final draft of the questionnaire consisted 17 dimensions— 34 close-ended items and six open-ended items.

Semi-structured Interview: The semi-structured interview prepared by investigators to study awareness of students with respect to awareness of utilisation of non-renewable resources with respect to sustainable development among Class IX students. The first draft of semi-structured interview was designed with 12 questions and it was sent to subject

experts for tool validation. After receiving constructive feedback from them, three out of 12 questions were deleted. The final draft of semi-structured interview schedule was designed with nine questions.

The collected data were analysed by using both quantitative and qualitative techniques including Frequency, Percentage and Content Analysis.

Results and Discussion

The major findings of the study were:

1. Most of the students (61 per cent) were found unaware of the education for sustainable development.
2. Majority of the students (89.66 per cent) were found to be aware of utilisation of non-renewable resources with respect to education for sustainable development.
3. It was observed that students were well aware about education for sustainable development with respect to concepts of poverty, good health and being, and clean water and sanitation.
4. From the interview of the students, it was observed that the syllabus needs to be designed more comprehensively on the topics, such as, utilisation of non-renewable resources and their effect on human life.
5. The students responded that more topics need to be imparted in the syllabus with respect to education for sustainable development.
6. The students responded that more activities or programmes should be organised in the schools at regular intervals.

The purpose of the study was to find out the awareness of education for sustainable development among Class IX students of Yadadri Bhuvanagiri District in Telangana. The major objectives of the study were: To study the awareness of sustainable development goals and to study the awareness of utilisation of non-renewable resources with respect to sustainable development. After deep insight of the study findings the investigators provided the following suggestions:

1. Education for sustainable development should be provided more space in the school curriculum.
2. Education for sustainable development related activities or programmes should be organised in the school at regular intervals.

Conclusion

Education for sustainable development should be given more weightage in the school curriculum at all levels of education and also be given more weightage in assessment and evaluation. From the findings it was also concluded that education for sustainable development related activities or programmes should be organised in the school throughout the academic calendar year. Finally, it can be concluded that education for sustainable development need to be treated as significant area and every student must be aware of it.

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THE EFFECTIVENESS OF HANDS-ON ACTIVITY TEACHING IN LEARNING ACID AND BASE CONCEPTS AT THE SECONDARY LEVEL

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Acids and bases are encountered at every walk of life and their concept is very essential for students. This paper reports the conceptualisation of acids and bases and their identification using synthetic and natural indicators with the help of simple investigations. A study was done on 50 Class VII students of United Public School of Kanpur district of Uttar Pradesh, by making two groups of 25 students each. The students were put in Group A with odd roll numbers while the students with even roll numbers were put in Group B. Group A was taught this concept in traditional way while Group B was taught through investigative hands-on activity approach. An investigative technique using pre- and post-test have been used. The pre-and post-test questionnaire consisting of 25 questions were made and the tests were executed. The response sheets were collected and analysed. The results clearly showed that the Group B with hands-on activity learnt and performed significantly better and there is a significant increase in learning and understanding of the concept of acids and bases. On further analysing the responses it was found that the students of Group B were able to answer High Order Thinking Skill (HOTS) questions in a much better way than the students of Group A. Thus, it can be seen that there is a significant increase in learning and understanding of the concept by the students of Group B. They showed better skill development and were able to draw conclusions correctly. The investigative approach created interest and curiosity in them about the subject. The hands-on activity generated a feel of the subject. The students, for the first time, went to do some experiments on their own. They learnt the concept of acids and bases through doing themselves. This led to a much better learning and performance. Thus, the objectives of the research project were fulfilled.

Key words: *Acid-base indicators, synthetic and natural indicators, universal indicators, hands-on activity.*

Introduction

The acids and bases play a very important role in everyday life. It has a significant role in the digestion of food, tooth decay, soil fertility and plant growth, acid rain, defence mechanism of plants and animals, and many more. The sour and bitter taste of the food are due to acids and bases (or alkalies), respectively, present in them. We know that acids are sour in taste and they change the blue litmus indicator to red. The bases, on the other hand, are bitter in taste and change the red litmus to blue. Thus, a clear concept of acids and bases and their distinction and identification is essential for students at the secondary level.

Objectives

To make the students aware about acids and bases, the answers to the following questions be searched;

- How can acids and bases be identified?
- How can a substance more acidic or more basic than the other be identified?
- What are natural acid-base indicators?
- What are synthetic acid-base indicators?
- What are universal indicators?
- What should be given to a person suffering from indigestion due to

overeating baking soda or vinegar? And so on.

Hypothesis: Hands-on activity teaching is more effective than traditional (chalk and talk) teaching.

Methods and Procedure

Tools: An investigative technique using pre- and post-test has been used. The pre- and post-test questionnaire consisting of 25 questions were made. Some of the questions are given below.

1. The vinegar is sour in taste. Is it acidic or basic in nature?
2. If a food is bitter to taste, will it be acidic or basic in nature?
3. A substance turns blue litmus solution to red. Is the substance acidic or basic in nature?
4. Does turmeric powder turn red from yellow in presence of acidic or basic substances?
5. Is turmeric powder or an acid-base indicator or stain indicator?
6. Are litmus solution and turmeric powder synthetic or natural indicators?
7. Is phenolphthalein colourless or red in acidic medium?
8. Phenolphthalein turns pink in basic medium. Is it an acid-base indicator or stain indicator?
9. Is phenolphthalein a synthetic or natural acid-base indicator?
10. Can vinegar (acetic acid) and hydrochloric acid be detected by litmus solution or universal indicator?
11. Can ammonium hydroxide and sodium hydroxide be detected by phenolphthalein or universal indicator?
12. Can ammonium hydroxide and acetic acid be detected by litmus solution, phenolphthalein or universal indicator or all of these?
13. What should a person suffering from acidity be given— baking soda or vinegar.

Sample Size and Selection Procedure: The Class VII of United Public School of Kanpur District of Uttar Pradesh consisting of 50 students was grouped into two Groups— A and B of 25 students each. The groups were made through random selection. The students were put in Group A with odd roll numbers while the students with even roll numbers were put in Group B.

Materials: Some acidic and some basic food items, some natural indicators namely, turmeric powder and litmus solution, some synthetic indicators namely, phenolphthalein and universal indicator were taken.

Procedure: After grouping the students in two groups– A and B, as indicated earlier, a pre-test was administered. A questionnaire containing 25 questions was distributed to both the groups, a briefing was done and students were asked to answer them, with full honesty, in the given stipulated 20 minutes. The response sheets were collected and later analysed.

On the next two days, the students of Group A, now treated as the test group, were

taught the concept of acids and bases in the normal traditional way using chalk and talk method.

After Group A, the students of Group B were asked some questions (already given in the objectives of this project so as to create interest and curiosity in the subject and interactions in the class). They were allowed to conduct the experiment and also to draw the inferences themselves. When they were allowed to taste certain common foods such as curd, vinegar or lemon, they called them sour to taste and identified them as acids. Similarly, they found certain other foods as bitter in taste and identified them as bases. After this, they were asked to identify the acidic and basic substances through acid-base indicators. The students used turmeric powder and litmus solution to distinguish acids and bases. They also repeated the experiments with a synthetic indicator— the phenolphthalein. The abrupt colour change in both natural and synthetic indicators filled them with curiosity and enthusiasm. The answer to the question— how can we identify the strength of two acidic or two basic substances was solved by using universal indicator. The universal indicator is a mixture of several dyes and it produces different colours at different pH, i.e., at different acidities or basicities. After two days of learning by doing, i.e., hands-on activities, a test was conducted to see the effect.

On the next day, a post-test was conducted. It was done by distributing a questionnaire consisting of 25 similar questions to the students of both the Groups A and B. The students were asked to answer them with full honesty, in the given stipulated time of 20 minutes. The response sheets were collected and analysed.

Results and Discussion

The results show much better conceptualisation of acids and bases by the students of Group B. Now they are able to distinguish between acids and bases. They are also able to identify them using natural as well as synthetic indicators. Apart from this, they can also tell which is a stronger acid or a stronger base between the two with the help of universal indicator.

The responses given by students of both Groups— A and B for the pre- and post-test were analysed, and are shown below in Table 1:

Table1: Response of Students in Pre-test (out of 25 questions)

Group	Number of correct answers Pre-test	Number of correct answers Post-test
A	6	12
B	7	23

On further analysing the responses it was found that the students of Group B were able to answer High Order Thinking Skill (HOTS) questions in a much better way than the students of Group A. Thus, it can be

seen that there is a significant increase in learning and understanding of the concept of acids and bases in the students of Group B. They showed better skill development and were able to draw conclusions correctly. Thus, the objectives of the research project were fulfilled. The investigative approach created interest and curiosity in them about the subject. The hands-on activity generated a feel of the subject. The students, for the first time, conducted some experiments on their own. They learnt the concept of acids and bases by themselves. This led to a much better learning and performance.

Conclusion

Based on our results, we can conclude that our hypothesis is correct, i.e., the hands-on activity based teaching is more effective than traditional (chalk and talk) teaching.

Acknowledgements: We thank the Principal of United Public School, Kanpur, class teacher, chemistry teacher and students of Class VII for their cooperation to complete this research project. The lab facility and the chemicals provided by the school is thankfully acknowledged.

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TO STUDY THE EFFECT OF 'LIVE' MIRACULOUS DEMONSTRATIONS ON INCREASING INTEREST IN CHEMICAL SCIENCES

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Chemistry educators are familiar with traditional demonstrations, with which concepts in chemistry are made simpler. By doing 'live' miraculous demonstrations, concepts like exothermic reactions generally leading to combustion and the principle underlying of titrations involving colour change are made easy and understandable. The 'live' miraculous demonstrations are used to develop interest in students' about chemical sciences, explanation of so called miracle and to develop scientific temper. The 'live' miraculous demonstrations can be done safely with prior training and knowledge. Many students do not favour chemistry because of lack of interest in the subject. So there is a need to develop interest in it. A large number of people believed in various types of so called miracles because of lack of scientific knowledge, attitude and scientific temper. Many godmen, quacks and conmen with similar motive of exploiting and harming mentally, physically and financially the superstitious people in society perform so called miracles. Therefore, there is a need of explaining the scientific knowledge of so called miracles, through students. In the present study 'live' demonstrations of so called miracles and booklet prepared about it, is used at undergraduate level as an educational tool. The sample of the study was students studying in SYBSc class in the University of Pune jurisdiction area. The feedback of students through pre- and post-questionnaires was analysed and showed that (i) miraculous demonstrations are favoured by students as an attempt to increase interest in chemistry, (ii) students have an urge to know the chemical science behind the so called miracle, (iii) miraculous demonstrations are exciting and surprising, and (iv) miraculous demonstrations should be incorporated in chemistry curriculum.

Key words: *Demonstrations, miraculous, chemistry, education*

Introduction

Laboratory experiments are used in teaching and learning of science since many centuries. From 1980, the constructivist approach is used in teaching and learning. The role of hands-on experiments in learning science have been realised by many teachers, including those of chemistry. The demonstrations are preferred to laboratory experiments in teaching and learning of science, because they are performed in the safest way. The lecture demonstrations introduce fun; students like them because they are attention seeking, and they provide breaks from lectures too. The students of chemistry do report that demonstrations helped them to understand the theories behind the chemistry. At the school level, laboratory demonstrations in the teaching of chemistry can provide colourful, surprising and dramatic effects, such as, placing a small tablet of sodium metal piece in a transparent container containing two to three drops of phenolphthalein in water, to motivate students. For demonstrations to be effective, the role of the demonstrator is as a mediator of student learning and an interpreter of the content of science. The demonstrations are made more student-centred by demonstrator using Predict-Observe-Explain (POE) activities. In this activity, students are given a chance to predict what would happen next in a demonstration.

Methods and Procedure

The miraculous demonstrations which are performed using chemicals and chemical or physical properties of commonly used materials are only studied in the present study. A sample of 174 students of S.Y. B.Sc. class from various colleges affiliated to Pune University from Nashik, Ahmednagar and Pune districts was selected for the present study. A booklet of 10 miraculous demonstrations was prepared according to guidelines of self instructional material. The way of writing it and the prototype of it were like: Title of miraculous demonstration, Concepts of chemistry associated, Material, Procedure, Observation/Effect, Theoretical principle, Reaction, Safety precaution, and References. The pre- and post-questionnaire was tested for reliability and validity. The pre-test was conducted and then actual miraculous demonstrations were performed in front of students. The feedback was taken and then booklet of miraculous demonstrations was distributed to them and explained in required depth. Then post-test was conducted.

Result and Discussion

The feedback of students through pre- and post-test questionnaire is analysed mainly for four points. The results (Box 1) for the point that 'Miraculous demonstrations increase interest in chemistry' show (Table 1) 54.02 per cent students are of the same opinion. The increase of 5.11 per cent in 'total agree' responses (Table 2) from 86.77 per cent (pre-test) to 91.94 per cent (post-test) directly indicates that miraculous demonstrations increase interest in chemistry. When asked directly that whether by using miraculous demonstrations student's interest in chemistry is increased, 94.82 per cent students replied 'yes' (Table 3) indicating that miraculous demonstrations increase interest in chemistry. When further asked (Table 4) why interest will be increased by using miraculous demonstrations, then 20.6 per cent replied 'Understand the concept behind it', 24.84 per cent replied 'Curiosity is satisfied', 21.21 per cent replied 'seen knowledge last forever', 12.72 per cent replied 'It involves chemical science', 13.93 per cent replied 'Make to think' and 5.45 per cent replied 'Live and entertaining'. When asked about the use of the booklet of miraculous demonstrations to increase interest in chemistry, 97.12 per cent replied (Table 5) it is useful and when further asked (Table 6) 'How is it useful?' then 27.21 per cent replied 'Understanding the concept', 21.3 per cent replied 'Contain miraculous demonstrations and chemistry behind it', 40.82 per cent replied 'Gives clear-cut idea and knowledge about chemistry of compounds and commonly used materials' and 10.65 per cent replied 'Try to do more reactions'.

Box 1: The replies for the point that miraculous demonstrations are favoured by students as an attempt to increase interest in chemistry' in different ways.

Abbreviations: SA- Strongly agree, A- Agree, NI- No idea, DA- Disagree, SDA- Strongly disagree, NR- No reply, MD- Miraculous demonstrations.

Table 1

Item	Reply	%
In my opinion interest in chemistry can be increased by using	Computers	22.98
	Demonstrations	54.02
	Home assignments	12.64
	Any other way	9.77
	No reply	0.57

Table 2

Item		SA%	A%	NI%	DA%	SDA%	NR%
MD increases interest of students in chemistry	Pre	45.4	41.37	8.62	1.72	1.72	1.14
	Post	47.12	44.82	5.17	2.29	0	0.57

Table 3

Item	Yes %	No %	NR %
Can using MD increase student's interest in chemistry?	94.82	5.17	0

Table 4

Item	Reply	%
Can using MD increase students' interest in chemistry? If Yes, Why?	Understand the concept behind it	20.6
	Curiosity is satisfied	24.84
	Seen knowledge last forever	21.21
	It involves chemical science	12.72
	Make to think	13.93
	Live and entertaining	5.45

Table 5

Item	Yes %	No %	NR %
Can using booklet of MD increase student's interest in chemistry?	97.12	2.87	0

Table 6

Item	Reply	%
Can using MD increase student's interest in chemistry? If Yes, how the booklet will help to increase interest in chemistry?	Understanding the concept	27.21
	Contain miraculous demonstrations and chemistry behind it	21.3
	Gives clear-cut idea and knowledge about compounds	40.82
	Try to do more reactions	10.65

The results (Box 2) for the point 'the students have an eagerness to know chemical science behind miraculous demonstration' show that (Table 7) 78.73 per cent of them do not know the reason behind the most liked miraculous demonstration, and only 21.26 per cent replied that they know the reason. But when asked to mention the reason (Table 8) 78.37 per cent answered incorrectly, and only 21.62 per cent could gave correct answer. When further asked (Table 9) whether they wish to know the reason behind the miraculous demonstration 82.18 per cent of them replied 'yes', clearly indicates the eagerness of students to know the science behind the miraculous demonstration.

Box 2: The replies for the point that 'The students have an eagerness to know chemical science behind miraculous demonstration' (Abbreviation: NR- No reply)

Table 7

Item	Yes %	No %	NR %
Do you know the reason or science behind above mentioned miracle?	21.26	78.73	0

Table 8

Item	Reply	%
Do you know the science behind the above mentioned miracle? If Yes, give details of it	Correct	21.62
	Incorrect	78.37

Table 9

Item	Yes %
If No, would you like to know the reason behind it?	82.18

The results (Box 3) for the point that 'miraculous demonstrations are exciting and surprising' show increase (Table 10) of 6.90 per cent in 'total agree' responses from 86.19 per cent (pre test) to 93.09 per cent (post-test) directly indicates that miraculous demonstrations are exciting and surprising. When asked (Table 11), why they like miraculous demonstration, 65.51 per cent replied that it is exciting and surprising.

Box 3: The replies for the point that 'Miraculous demonstrations are exciting and surprising.'

Table 10

Item		SA %	A %	NI %	DA %	SDA %	NR %
MD are exciting and surprising	Pre	40.22	45.97	8.04	4.02	1.72	0
	Post	47.12	45.97	1.14	4.59	1.14	0

Abbreviations: SA- Strongly agree, A- Agree, NI- No idea, DA- Disagree, SDA- Strongly disagree, NR- No reply, MD- Miraculous demonstrations

Table 11

Item	Reply	%
Why do you like the most liked miraculous demonstration?	Interesting	22.41
	Surprising	65.51

The results (Box 4) for various items (Table 12) to support the point that 'miraculous demonstrations should be incorporated in chemistry curriculum' show increase of 7.21 per cent in 'total agree' responses from 89.64 per cent (pre test) to 96.85 per cent (post-test) for the item 'Miraculous demonstrations motivate to learn chemistry' directly supports that miraculous demonstrations should be incorporated in chemistry curriculum. The increase of 4.41 per cent in 'total agree' responses from 89.70 per cent (pre test) to 94.11 per cent (post-test) for the item 'Miraculous demonstrations keep my interest during lecture/session' directly supports that miraculous demonstrations should be incorporated in chemistry curriculum. The increase of 2.83 per cent in 'total agree' responses from 88.49 per cent (pre test) to 91.32 per cent (post-test) for the item 'Miraculous demonstrations are effective in initiating scientific enquiry' directly supports that miraculous demonstrations should be incorporated in chemistry curriculum. The increase of 4.59 per cent in 'total agree' responses from 75.28 per cent (pre test) to 79.87 per cent (post-test) for the item 'Miraculous demonstrations should be incorporated in chemistry curriculum' directly indicates that miraculous demonstrations should be incorporated in chemistry curriculum.

Box 4: The responses in pre and post-test for various items to favour the miraculous demonstrations should be incorporated in chemistry curriculum.

Table 12

Item	SA %		A %		NI %		DA %		SDA %		NR %	
	PR	PO	PR	PO	PR	PO	PR	PO	PR	PO	PR	PO

MDs motivate to learn chemistry	40.22	53.75	49.42	43.1	6.89	0.57	2.29	2.29	1.14	0.57	0	0
MDs keep my interest during lecture/ session	52.87	52.02	37.93	42.19	4.02	1.72	3.44	3.44	1.72	0	0	1.14
MDs are effective in initiating scientific enquiry	43.67	50.28	44.82	41.04	7.47	3.44	2.29	3.44	1.14	1.14	0.57	1.14
MDs should be incorporated in chemistry curriculum	32.18	37.35	43.1	42.52	16.66	9.77	4.02	6.32	1.72	3.44	2.29	0.57

Abbreviations: SA- Strongly Agree, SDA- Strongly disagree, NI- No Idea, DA- Disagree, SDA- Strongly disagree, NR- No reply, PR- Pre test, PO- Post-test and MD- Miraculous demonstrations

Conclusion

From the above results and discussion it is concluded that (i) miraculous demonstrations are favoured by students as an attempt to increase interest in chemistry, (ii) students have an eagerness to know the chemical science behind the so called miracle, (iii) miraculous demonstrations are exciting and surprising, and (iv) miraculous demonstrations should be incorporated in the chemistry curriculum.

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A STUDY OF STUDENTS' CONCEPTUAL UNDERSTANDING OF THE CONTENT OF EVS AT THE PRIMARY STAGE

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A study of students' conceptual understanding of the content of EVS has been carried out in ten primary schools in Ajmer district of Rajasthan. Research tools were administered on the students of three English medium and seven Hindi medium schools. Classroom transactions of the content of EVS taught by the teachers at primary stage were observed. Besides, teachers were interviewed to seek specific information in relation to their academic and professional qualifications as well as classroom transaction and medium of instruction. It was found from the analysis of the responses that the performance of students of English medium schools was better than that of students of Hindi medium schools. Reasons for such performance have been correlated with the lack of infrastructure in government Hindi medium schools and appropriate transactional strategies of the content of EVS.

Key words: *Conceptual understanding, primary stage and EVS*

Introduction

The objectives at primary stage of education are to nurture the curiosity of the child about the world and to have the child engage in exploratory and hands-on activities. Science and social science should be integrated as 'environmental studies' with health as an important component and its teaching should be recast so that it enables children to examine and analyse everyday experiences. Do students face problems in understanding the concepts of EVS due to the medium? Keeping the above in view, investigations into the conceptual understanding of students about the content of EVS at the primary stage have been carried out in ten schools of Ajmer district of Rajasthan.

Methods and Procedure

The research study was restricted to only ten schools (three English and seven Hindi medium) of Ajmer district situated both in rural and urban areas (Yadav and Sharma, 2011). Research tools were developed in workshop mode by a team of experts for assessment of conceptual understanding of students about the content of EVS. The tools were passed through a process of refinement and validation. In order to optimise the reliability and validity of the test, the test was first given to a group of 30 students of the primary stage. Tools were finally administered to the students of Classes III–V at three English medium schools and seven Hindi medium schools. All the responses given by the students were analysed and classified into three categories, namely, Acceptable Response (AR), Unacceptable Response (UR) and No Response (NR) for the analysis purpose.

Sample: The present study was conducted to only ten schools with 60 teachers and 625 students studying EVS in Classes III–V of Ajmer district situated both in rural and urban areas.

Analysis of the Responses

In Hindi medium schools, 83.3 per cent teachers are postgraduate, 14.3 per cent graduate and 2.4 per cent teachers are with the qualification of 10+2 whereas in case of English medium schools 38.9 per cent teachers are postgraduate, 44.4 per cent are graduates and 16.7 per cent are having 10+2 qualification. It was found that Hindi medium school teachers are more qualified than English medium school teachers. The professional qualifications of the teachers of Hindi and English medium indicate that the percentage of untrained teachers in Hindi medium schools is only 4.8 per cent whereas in English medium it is 11.1 per cent. All the responses given by the students were classified into three categories—Acceptable Response (AR), Unacceptable Response (UR) and No Response (NR) for the analysis purpose. Students' responses on the basis of the medium of instruction were obtained by administering assessment tools for studying the students' conceptual understanding about the concepts of EVS in Classes III–V of Hindi and English medium schools. Graphical representation of AR, UR and NR is shown in Fig. 1. Percentage of responses is given on Y-axis and number of items is given on X-axis. Examination of responses shows that out of 10 items pertaining to conceptual understanding of students studying in Classes III- V, the performance of students of English medium schools is better as compared to the performance of the students of Hindi medium schools.

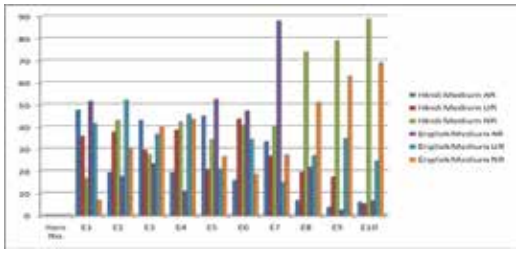

Fig. 1. Students' responses on the basis of medium of Instruction: EVS

Graphical representations of school-wise responses of students in EVS are shown in Figures 2–11. Percentage of responses is given on Y-axis and number of item is given on X-axis. In order to analyse the response we assumed that if students' response was equal or greater than 40 per cent, their conceptual understanding was considered as up to the mark. It is evident from Fig. 2 that the performance of the students of school No. 1 is satisfactory in EVS. Analysis of the responses of students of school No. 10 in EVS indicates that the performance of the students is sound whereas performance of students of schools Nos. 8 and 9 is better. School Nos. 8 and 9 are located in urban area whereas school No.10 is situated in rural area. School No. 8 is a government school and the remaining two English medium schools are private. Out of three English medium schools, conceptual understanding of the students about the content of EVS is not up to the mark in school No. 10 where only one item was responded correctly by 43.8 per cent students.

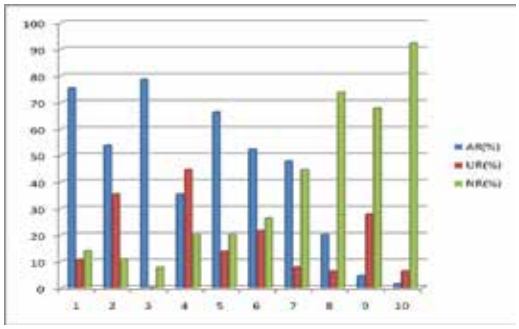

Fig. 2. School-wise students' responses for conceptual understanding of EVS (School 1)

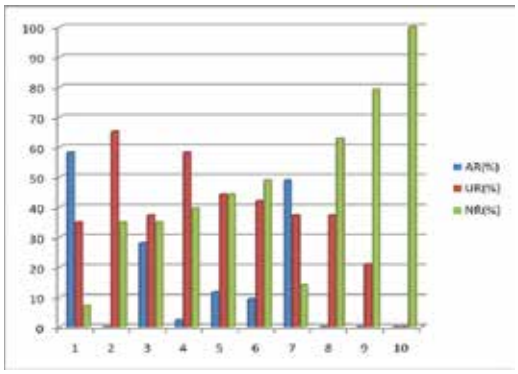

Fig. 3. School-wise students' responses for conceptual understanding of EVS (School 2)

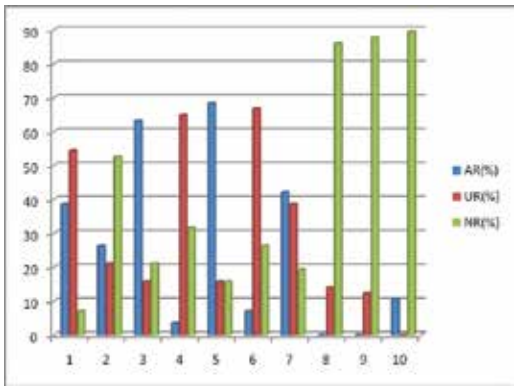

Fig. 4. School-wise students' responses for conceptual understanding of EVS: (School 3)

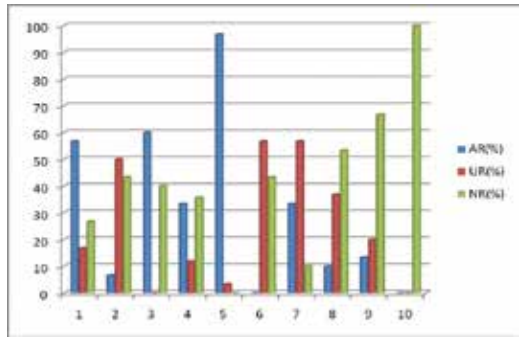

Fig. 5. School-wise students' responses for conceptual understanding of EVS (School 4)

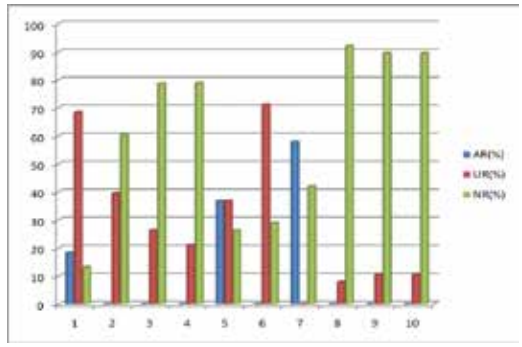

Fig. 6. School-wise students' responses for conceptual understanding of EVS (School 5

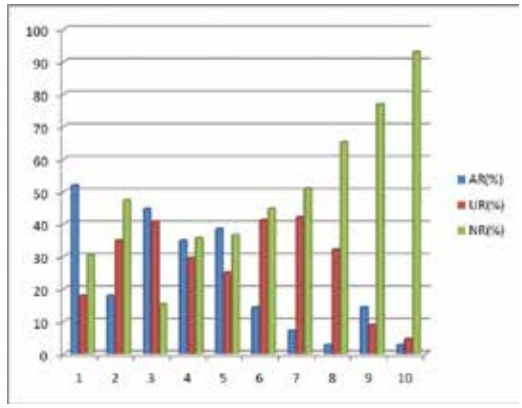

Fig. 7. School-wise students' responses for conceptual understanding of EVS (School 6)

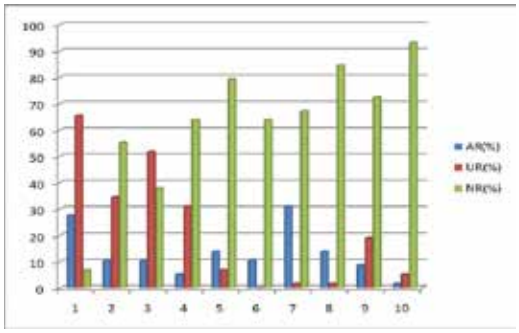

Fig. 8. School-wise students' responses for conceptual understanding of EVS (School 7)

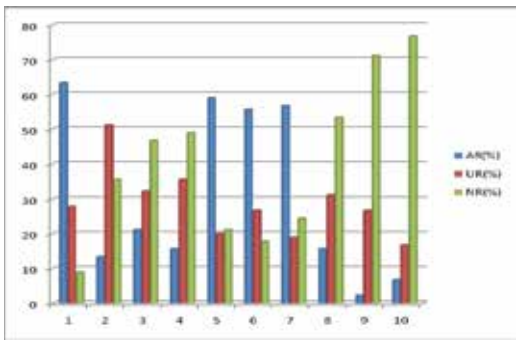

Fig. 9. School-wise students' responses for conceptual understanding of EVS (School 8)

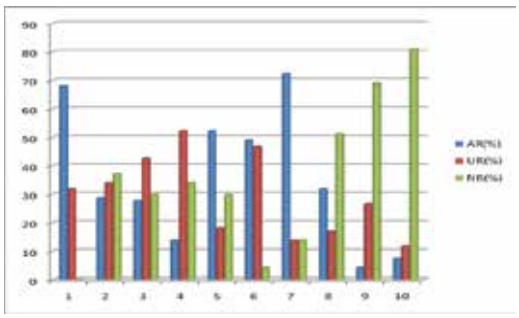

Fig. 10. School-wise students' responses for conceptual understanding of EVS (School 9)

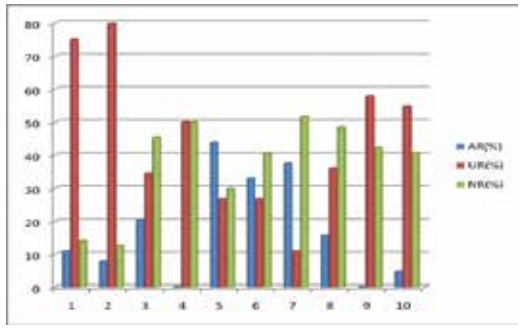

Fig. 11. School-wise students' responses for conceptual understanding of EVS (School 10)

It has been found from the classroom observations that the Hindi medium government schools were lacking in infrastructure and physical facilities and the teachers by and large were using traditional teaching methods (Figs. 13–18, photographs 2-6) whereas the English medium private schools were found rich in infrastructure and the teachers were using latest computer-assisted techniques in classroom transaction as can be seen from the Fig. 18 (photograph 7). The different methods used by the teachers in classroom for transacting the content of EVS in schools are shown in the following Figures 12–18 (photographs 1–7):

Fig. 12. Photograph 1

Fig. 13. Photograph 2

Fig. 14. Photograph 3

Fig. 15. Photograph 4

Fig. 16. Photograph 5

Fig. 17. Photograph 6

Fig. 18. Photograph 7

Findings

On the basis of the analysis of data, the major findings are as follows:

- Academic qualifications of Hindi medium school teachers were found better than that of their English medium counterparts. Analysis also revealed that the percentage of B.Ed. degree holder teachers was 76.2 per cent in Hindi medium schools and in English medium schools it was 73.2 per cent. Hindi medium school teachers possessed more teaching experience in terms of years than that of English medium school teachers. However, teachers were unexposed to the in-service training or refresher programmes.
- The number of students was found less in Hindi medium schools and the teachers were also not in sufficient number to engage the classes. It was also noted that there was no use of ICT in the classroom of Hindi medium schools. However, some of the English medium schools were found having ICT.
- The medium of instruction in none of the schools was purely English or Hindi for transacting the content of EVS. When the teachers asked questions in English about the content of EVS to the students, only a few students replied in English that too in broken English. When students faced problem in replying in English about the content of EVS, the teachers used Hindi (including local variety) and as a result, students were able to answer the questions in Hindi.
- From the analysis of students' response of conceptual understanding of EVS on the basis of medium of instruction it was found that the performance of students of English medium schools was better than that of Hindi medium schools. The maximum percentage of teachers in Hindi and English medium schools who encouraged students' participation in classroom interaction and contributed in creating conducive learning environment is 69 per cent and 89 per cent respectively.

Discussion and Implications

The present study was carried out on 60 teachers and 625 students studying EVS in Classes III–V in different schools of Ajmer District of Rajasthan State.Therefore, the results of the study cannot be generalised to other parts of the country.However, on the basis of findings, the following recommendations are made:

- It was found from the analysis of the responses of conceptual understanding test of EVS that the performance of students of Hindi medium schools was not up to the mark than that of students of English medium schools. Reason for this performance may be related to lack of infrastructure in government Hindi medium schools. It was also observed that in English medium schools there were sufficient number of teachers but in government Hindi medium schools, there was shortage of teachers. Lack of sufficient number of competent teachers may be one of the reasons for not

performing well in subject content of EVS. Although the Hindi medium school teachers are more qualified and experienced than their English medium counterparts, students' performance in their schools is not as good as that of English medium students. It may be because of teachers' frequent involvement in other assigned duties and responsibilities, which may adversely affect the performance of the teachers as well as students in conceptualisation of the content of EVS. Hence, it is suggested that sufficient number of teachers should be made available in the government schools and their additional responsibilities may be minimised so that teachers can devote more time in teaching-learning activities.

- It was found that there were teachers who were unexposed to in-service training programmes for refreshing their subject both in content and pedagogic aspects. Therefore, teachers may be provided opportunity to participate in in-service training programmes for refreshing their subject at least once in a year. They may be suggested to lay more emphasis on the activity-based teaching-learning process leading to meaningful learning the content of EVS.
- Interaction with the students while transacting the subject content of EVS needs to be encouraged. Teachers are expected to link classroom experiences with the experiences outside the classroom situations during content transaction. The infrastructural challenge involved in making available computer hardware and software and connectivity to every school should be ensured for making teaching of EVS interesting and meaningful to the students.

Conclusion

It may be concluded from the analysis of the study that there is a considerable difference in conceptual understanding of EVS between the two groups of students: those who were studying in Hindi medium schools and those who were studying in English medium schools. It is worthwhile to mention here that together with other factors such as the teachers' ability and their methods, mother tongue as medium of instruction plays a vital role in students' full participation in classroom teaching-learning process and conceptual understanding of the subject content of EVS.

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EFFECTIVENESS OF DIGITAL TECHNOLOGY ON BIOLOGY LEARNERS AT THE SECONDARY LEVEL

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Development and usage of digital classroom for teaching and learning process is one of the key areas for development of ICT in schools. An Interactive White Board (IWB) facilitates teaching in digital classroom and is an instructional tool that allows computer images to be displayed onto a board using a digital projector. The study was an attempt to investigate the effect of digital classroom on learning biology concept of secondary school learners of government and private schools of Delhi. It was a Pre-test Post-test Control Group Design. Using digital classroom, the experimental group was taught. Five chapters of Class IX Biology, i.e., 35 lessons were delivered using interactive white board while the control group was taught by traditional chalk and talk method. Pre-test was consisting of 30 items and post-test consisting of 100 items. Data was collected and analysed by using t-test. Result showed that digital classroom has positive impact on learning process as the learners of digital classroom have higher achievement level in biology in comparison to the learners of traditional classroom. In both, government as well as in private school, the learners taught through digital classroom have higher achievement level in the post-test in comparison to learners taught in traditional method.

Key words: *Digital classroom, interactive board, achievement level, ICT, chalk and talk method*

Introduction

Technology has substantially changed the nature of education. Now the classrooms are no more learning islands, they become collaborative learning centres. 21st century is called the era of ICT based education. It has been claimed that ICT in education has a huge potential. It can bring enrichment in the formal education system. There are different ways in which ICT has been used in the field of education. Use of digital classroom in the school is one of the ways of ICT integration in formal school education. Digital classroom is also called smart class, it consists of interactive white board and teaching is done by using e-content. An interactive whiteboard is an instructional tool that allows computer images and videos to be displayed onto a board using a digital projector. The instructor can then change the elements on the board by using his finger as a mouse, directly on the screen. It has been said that this digital classroom technology has brought about a complete transformation in the traditional rote methods of learning as it provides innovative learning solutions using digital instruction material. Most of the schools in Delhi are opting and has opted digital classroom because students get to learn a lot and it makes the learning process pleasurable. In this paper the researchers tried to study the influence of this digital classroom on biology learning among secondary school learners of the government and private schools of Delhi.

Objectives

1. To compare the academic achievement of secondary school learners of

traditional and digital classes in government (Kendriya Vidyalaya) and private schools.

2. To compare the academic achievements of secondary school learners of traditional and digital classes.

Hypothesis

1. There is no significant difference in academic achievements of secondary school learners of traditional and digital classes in government (Kendriya Vidyalaya) and private schools.
2. There is no significant difference in academic achievement of secondary school learners of traditional and digital classes.

Methods and Procedure

Quasi experimental with pre- and post-test design was adapted for the present study. Investigator through purposive random sampling selected two schools, one is a central government school, i.e. Kendriya Vidyalaya and one private school in west Delhi. After the selection of the school, investigator randomly selected two sections of Class IX, one section taken as experimental group and the other as control group. In Kendriya Vidyalaya there were 43 students and in private school 30 students were present in both groups— experimental as well as control. The entire biology syllabus of Class IX was taught to the experimental group by the investigator by using digital classroom, where e-content and interactive white board was used. Whereas the control group was taught in traditional classroom using chalk and talk method. The design comprised of three stages. The first stage has involved pre-testing of all the students of both the groups, i.e., control and experimental in both the schools. The second stage involved treatment of 5 months during which control group was taught by traditional method and experimental group was taught by using digital content. During this period, total 35 lessons was delivered in both the groups. During the third stage, the students were subject to post-test which consists of an achievement test of 100 items based on entire Class IX syllabus of biology. Description of experimental procedure has been given in Table 1.

Result and Discussion

The data obtained from the achievement test was quantitative in nature. The researcher has analysed the data by using t-test. The

Table 1

Experimental Procedure

S. No.	Phase	Duration	Control Group	Experimental Group
1.	Pre-Test	1 Day	Achievement Test	Achievement Test
2.	Treatment	5 Months	Teaching Biology Using Chalk and Talk Method	Teaching Biology using Digital Content and Digital Board
3.	Post-Test	1 Day	Achievement Test	Achievement Test

Table 2

Post-test data (based on biology lesson) of experimental/digital and traditional classroom of the government school

S. No.	Group	Treatment	Mean	N	S.D.	t	df	Sig. (2-tailed)
1.	Digital Classroom (Experimental)	Post-Test	60.26	43	13.26	2	42	0.05
2.	Traditional Classroom (Control)	Post-Test	55.12	43	10.25			

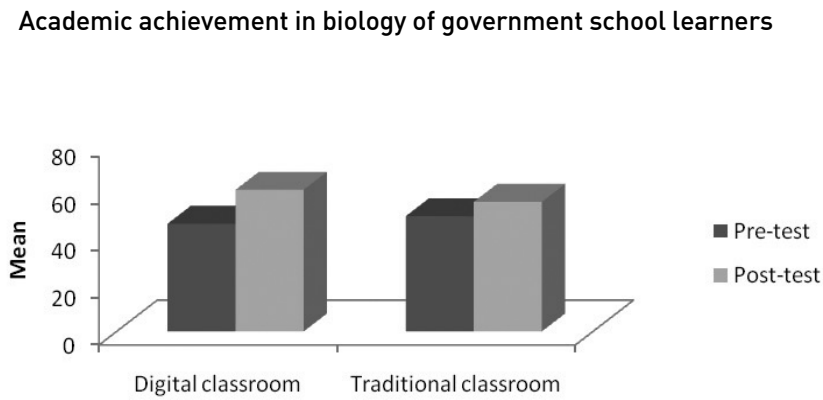

Fig 1. Mean score of digital and traditional classroom learners of the government school

statistical analysis of the pre-test scores of control and experimental groups indicated that both the groups were at equivalence in the beginning of the treatment. In government school the two-tailed p value (0.263) and the computed 't' value (-1.135) which is non-significant at 0.05 level and at 0.01 level, showing that both the groups are at equivalence. A similar kind of result was found in private school where the two-tailed p value (.69) is considered to be not statistically significant. The't' value (-1.88) is also non-significant at 0.01 and 0.05 levels. Thus on the basis of this data it was clear that both the groups (control as well as experimental) were equivalent in terms of their academic performance before the treatment.

The above data and the graph indicate that the mean score of the experimental group was higher than that of control group. The p value (.05) indicates that the performance of the two groups is extremely significant. The computed 't' value is significant at .05 level which suggests the effectiveness of treatment of teaching through digital board and digital content over traditional chalk and talk method.

Table 3

Post-test data (biology lesson) of digital and traditional classroom of private school learners.

S. No.	Group	Treatment	Mean	N	S D	T	df	Sig. (2-tailed)
1.	Digital Classroom (Experimental)	Post-test	58.23	30	8.58	1.88	29	0.05
2.	Traditional Classroom (Control)	Post-test	52.33	30	12.481			

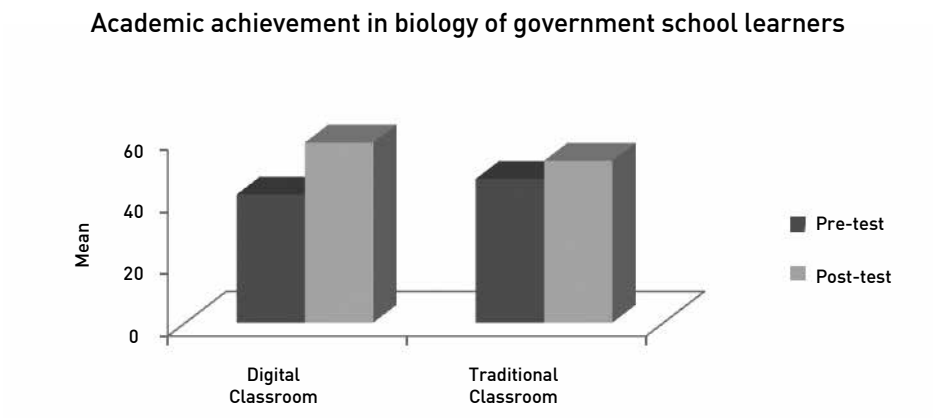

Fig 2. Mean score of digital and traditional classroom learners of private school

There is improvement in the academic performance of the experimental group over the control as indicated by the data and graph given above. The 't' value (1.88) which is significant at 0.05 level indicates that the digital technology is better than the traditional chalk and talk method. On the basis of this analysis the Hypothesis 1 there is no significant difference in academic achievement of secondary school learners of traditional class and digital class in government and private school is rejected.

A comparison of the pre-test data of experimental and control group learners of government and private school indicated that both the groups were at equal level of their academic performance. The two tailed p value (1.45) indicates that that the difference between the two groups is not statistically significant. The computed 't' value (1.4) for the mean of the two groups was also not significant at 0.05 and 0.01 level which indicates the equivalence of both the groups.

Table 4

Post-test data of digital and traditional classroom learners of government and private schools

S. No.	Group	Treatment	Mean	N	S D	T	df	Sig. (2-tailed)
1.	Digital Classroom (Experimental)	Post-Test	59.42	73	11.54	2.77	72	0.01
2.	Traditional Classroom (Control)	Post-Test	53.97	73	11.54			

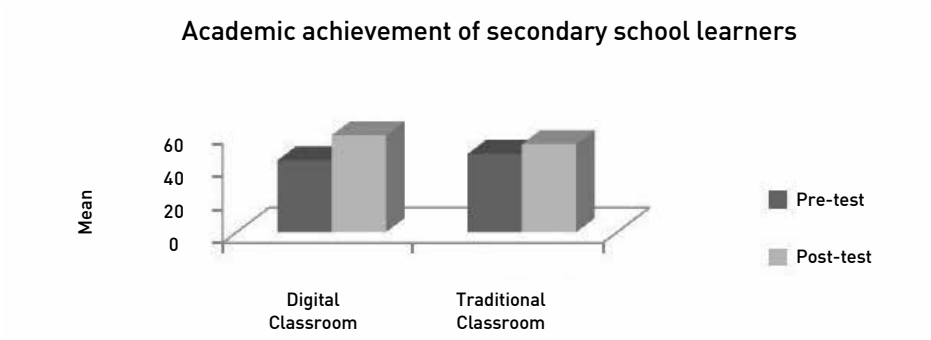

Fig 3. Mean score of digital and traditional classroom learners of both the schools together

The data and graph given above show that the academic performance of the experimental group has improved much more than the control group. The two-tailed p value (.01) indicates that the performance of the two groups is extremely significant. The computed 't' value (2.77) is highly significant at both 0.05 level as well as 0.01 level. This indicates that those learners taught by using digital technology has better performance than the learners taught through traditional chalk and talk method. On the basis of this analysis, it is clear that the Hypothesis 2 (there is no significant difference in academic achievement of secondary school learners of traditional class and digital class) is rejected.

Conclusion

The result of this study showed that learning in teaching of biology through digital technology is more effective in comparison to traditional classroom. It is because the digital technologies appeal to all the three senses, i.e., viewing, hearing and touch, which help the students to learn best through these dominant senses. In the present study, effectiveness of the digital content was studied by giving intervention and assessing the level of achievement in biology. In the study, after conducting the pre-test on learners of both the schools the group with low mean score was taken as experimental

group and taught with digital content in digital classroom although statistically there was no significant difference between the two groups. The other group, i.e., control group of both the schools were taught with lecture method. In the independent variable of t-test of both the government and private schools, it was found that there is a significant difference on the post-test scores of learners of biology taught with digital content. Thus the null hypothesis is rejected. Although there is difference in both the groups but the mean score of post-test of experimental group is higher than the control group. The difference of mean value indicates that the learners taught with digital technology have better performance than the learners taught with traditional method. This is because the multi-media aspects of digital board increase the engagement and attention span of learners. As biology is the subject, full of diagram, through digital technology teacher can show the 3D images of different organisms and their different parts which increase the concept clarity. In this digital world digital things fascinates students a lot which proves that teaching through digital content enhances their learning. It can be concluded on the basis of the findings that digital technology enhances learning in biology.

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A STUDY OF THE WORKING STYLE OF DIFFERENT TYPES OF INSTITUTES AND ATTITUDE OF ENTRANT SCIENCE STUDENTS OF CLASS XI

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Recent trends show that popularity of coaching institutes for science studies is rapidly increasing and spreading among students and their parents at the entry level of Class XI. There is an increasing tendency of joining coaching institutes after passing out Class X simultaneously with enrolment in dummy schools in Class XI for completion of +2 level science studies. In this study an effort is made to know the reasons why this tendency of entrants to Class XI science subjects of the school system is increasing. A tool is constructed and administered on pass-out students of government and private schools, entrants in coaching institutes and on teachers in these three types of institutes to collect relevant data. The tool covers various dimensions on an experience scale for teachers, students and researchers. A sample of 30 teachers and 60 students of Ajmer district was randomly selected. Various statistical techniques were applied on the collected data. ANOVA test results show that there are no significant mean differences in experiences of teachers, students and researchers regarding various dimensions on the experience scale scores. However, ANOVA test results indicate significant difference in working style of government schools, private schools and coaching institutes which results in increasing tendency in joining coaching institutes.

Key words: *Recent trends, dummy schools, coaching institutes*

Introduction

The aim of the education is to bring about the growth and the development of an individual regarding the physical, mental, emotional and spiritual abilities. A scheme of education is ultimately to be valued by its success in fostering the highest degree of individual excellence. Schools must make, therefore, efforts to help the children to develop above mentioned abilities completely. Children must be facilitated to develop their in born capacities. Children learn more freely with a consideration for each other, self-activity, creativeness, social cooperation and concrete expression.

On the other hand, people (Taneja, V. R., 1976) said that all the knowledge the child has gained, all the culture the child has acquired in the school will be of no use if he could not make both ends meet as an adult member of the community. The education should so train him that he is able to earn a reasonable living. The knowledge the child acquires in school must become instrumental in earning a decent income in later life.

In order to cater to the future needs of children many educational coaching institutes/centres are opened and provide competitive skills to find success in the competitive exams (Bray, M., 2003 and Bray, M., 2005). They also provide various courses at various levels fulfilling students' needs which is one of the major factors of coaching classes.

Recent (Paul, M. and Beri, et al., (2013)) trends show that the popularity of coaching institutes for science studies is rapidly

increasing and spreading among students and their parents at the beginning of Class XI. There is an increasing tendency of joining coaching institutes after passing out Class X simultaneously with enrolment in dummy schools in Class XI for completion of +2 level science studies. Under this study an effort has been made to know the reasons why this tendency of entrants to Class XI science subjects of the school system is increasing.

Objectives

(i) To study experiences of students, teachers and researchers on experience scale.

(ii) To investigate differences in working styles of the three types of institutes: government schools, private schools and coaching institutes.

Hypothesis

(i) There are no significant mean differences in experiences of teachers, students and researchers (regarding the total score on experience scale) for all the three types of institutes.

(ii) There are no significant mean differences in the working style of the three types of institutes.

Methods and Procedure

A tool is constructed, standardised and administered on 60 students of government and private schools and entrants in coaching institutes and on 30 teachers in these three types of institutes to collect relevant data. All the teachers and students were administered with the same tool in three sets for collecting data relevant to government schools, private schools and coaching institutes respectively. The researcher also recorded the data in three sets of the tool for the three types of institutes on the basis of their self observation.

The tool covered four dimensions on an experience scale for teachers, students and researchers. Dimensions covered in the experience scale are:

(i) Infrastructural facilities (IF)

(ii) Foundational development (FD)

(iii) Quality of teachers and their mastery in the subject matter (QTMSM)

(iv) Development of competitive skills (DCS)

Ten items were constructed for each dimension involved. Three-level rating scale was used for scoring: fully agree, agree and disagree. Scores assigned for these three levels are 2, 1 and 0, respectively.

Results and Discussion

Table 1 shows mean scores and SDs of students, teachers and the researcher for government schools (GS), private schools (PS) and coaching institutes (CI) while Table 2 shows summary data and analysis of variance from total scores of experience scale for all the three types of institutes.

Table 1

Mean scores and SDs of the three types of Institutes

	Students		Teachers		Researcher	
	Mean	SD	Mean	SD	Mean	SD
Government Schools (GS)	42.58	5.01	47.07	7.46	42.00	--
Private Schools (PS)	39.73	5.64	42.13	5.74	39.00	--
Coaching Institutes (CI)	42.85	6.96	41.37	6.54	45.00	--

Table 2

Summary data and analysis of variance from total scores of experience scale

	Government Schools				Private Schools				Coaching Institutes			
Sources of variance	Sum of Squares	df.	Mean squares	F	Sum of Squares	df.	Mean Squares	F	Sum of Squares	df.	Mean Squares	F
Between groups	427.51	2	213.75	4.409	117.53	2	58.76	1.83	50.92	2	25.46	0.55
Within groups	4266.45	88	48.48		2831.21	88	32.17		4102.62	88	46.62	

Table value of F is 4.85 at 0.05 level of significance.

Highest mean score was found of students for coaching institutes like the researcher and unlike the teachers. However, teachers gave highest mean score to government schools.

Calculated F values are 4.409, 1.83 and 0.55 respectively for government schools, private schools and coaching institutes, which are less than the table value of F, i.e., 4.85 at significance level of 0.05. Hence there are no

Table 3

Total and dimension-wise mean scores and SDs of the three types of institutes

N	Dimension 1 (IF)		Dimension 2 (FD)		Dimension 3 (QTMSM)		Dimension 4 (DCS)		All dimensions combined	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
91 (GS)	11.60	2.80	11.67	2.93	7.46	2.69	7.85	3.21	40.53	5.66
91 (PS)	14.85	2.05	13.73	2.01	7.26	2.66	7.42	2.76	43.68	6.32
91 (CI)	6.38	2.77	7.05	2.97	13.33	3.01	13.35	3.01	43.30	7.11

significant differences among the experiences of students, teachers and the researcher for all the three types of institutes.

In Table 3, total and dimension-wise mean scores and SDs of the three types of institutes are presented.

As far as infrastructural facilities and foundational development are concerned private schools are found to be better while regarding quality of teachers and mastery of subject matter and development of competitive scales are concerned coaching institutes are found to be better as compared to remaining two types of institutes. Teachers teaching in coaching institutes were found to be more efficient than that of government and private schools, classes of coaching institutes helped the students to achieve better results in their examinations.

Individual attention, additional guidance, enough instructional material, frequent revision and updating of courses, solution of content difficulties, better interaction among teachers and students, and development of better self study material contributed to get better success in examination.

Total and dimension-wise summary of data and analysis of variance is given in Table 4.

All the calculated F-values for each dimension separately and all dimensions combined are greater than table value of F at significance level of 0.05, which shows that there is a significant difference in the working style of the three types of institutes.

Table 4

Total and dimension-wise summary of data and analysis of variance

Sources of Variance	Dimension 1 (IF)		Dimension 2 (FD)		Dimension 3 (QTMSM)		Dimension 4 (DCS)		All dimensions combined	
	BG	WG	BG	WG	BG	WG	BG	WG	BG	WG
Sum of Squares	3317.03	1775.14	2713.88	1924.93	2161.85	2104.40	1993.12	2430.73	538.82	11027.43
d.f.	2	270	2	270	2	270	2	270	2	270
Mean Squares	1658.52	6.57	1356.94	7.13	1080.92	7.79	996.56	9	269.41	40.54
F	252.26		190.33		138.67		110.70		6.6	

Table value of F is 4.68 at 0.05 level of significance. BG-Between Groups and WG-Within Group

Conclusion

The results from the present study reveal that government and private schools are not able to cater to the needs of children to crack the difficult nation-wide entrance examinations for getting admission to top medical and engineering courses which produce professionals with high market demand and social reputation and a big handsome package. The demand of placement of youth in international and national top job giving organisations is met with competitive preparation in coaching

institutes. Coaching institutes are meeting all such needs of entrants of Class XI and pursuant of professional courses. Hence either such competitive exams without assessing and nurturing the potentialities of future generation in true sense should be discouraged or the government and private schools should be empowered to cope with such timely demand of the youth entering in their studies of +2 level or higher stage after completion of a general study up to Class X.

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RELATION OF SUSTAINABLE DEVELOPMENT WITH SCIENCE EDUCATION AND HUMAN NEEDS AND GREED

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The challenge of meeting needs for human development while protecting the life support system on mother earth confronts scientists, technologists, policy makers and communities from local to global level. Many believe that *people who have studied science* play central role in sustainable development. While many other believe that human needs and greed eradicates the discrimination between them and *those who have not studied science*. Keeping in view the role of science education and the role of human needs and greed, this paper is an attempt to find out the relationship of the two independent variables—science education and humans' future aspirations and plans for expenditure with one dependent variable—sustainable development. To carry out this study, the following standardised tools were used:

(i) Scale for way of fulfillment of daily requirement (SWFDR)

(ii) Scale for general awareness for the future consumption pattern (SGAFCP)

The sample consisted of 90 (–45 studied science and –45 did not study science) persons belonging to middle class families in the age group of 21 to 60 years from Ajmer city. The data were collected using random sampling and execution of above tools. Using relevant statistical techniques, it is found that there is a significant mean difference between the groups of science educated and non-science educated persons on the scale SWFDR scores, on the basis of the obtained scores employing SWFDR, three groups were formed for higher, lower and average scores. No significant difference is found among these three groups on the basis of second scale (SGAFCP) scores. This shows that science education plays central role in sustainable development, however, humans' needs and greed eradicate the difference between science educated and non-science educated persons.

Key words: *Sustainable development, human needs and greed, science educated persons, non-science educated persons*

Introduction

Sustainable development [Mebratu, 1998 and NCERT, 2003] implies meeting the basic needs of everyone and extending to all the opportunity to satisfy their aspiration for better life without compromising to the needs of the future. Development is the essential process for human society, countries and world. Today the world is facing various crises. The rising populations in the developing countries and the affluent consumption and production standards of the developed world have put a great stress on the supplying resources and management of assimilating waste. Many resources have become extinct and the waste generated is beyond the absorptive capacity of nature. Human greed for the demand of resources for both the production and consumption has gone beyond the rate of regeneration of resources increasing the pressure on the absorptive capacity of the nature and has led to degradation of resources.

The challenge [Jai Ganesh, et. al, 2013] of meeting needs for human development while protecting the life support system on mother earth confronts scientists, technologists,

policy makers and communities from local level to global level. Many believe that science educated persons play central role in sustainable development. While many others believe that human needs and greed eradicate the discrimination between people who have studied science and those who have not keeping in view the role of science education [Heuer, 2013] and the role of human needs and greed, this paper attempts to find out the relationship of two independent variables— science education and humans' future aspirations and plans for expenditure with one dependent variable—sustainable development.

To assess which factor is influencing more or plays a key role in the present scenario of sustainable development, this study involves both who are educated in science and technology and those who are not educated in science and technology at the graduation level.

To determine the role of science and technology which would lead the development of sustainability, following standardised tools were used.

(i) Scale for way of fulfilment of daily requirement (SWFDR)

(ii) Scale for general awareness for the future consumption pattern (SGAFCP)

Objectives

(i) To measure the differences of the two groups on scores against SWFDR with various dimensions, and

(ii) To measure the effect of their way of fulfilment of daily requirements on their future expenditure pattern or plan which provides clues for the path of sustainable development.

Hypothesis

(i) There is no significant difference between mean scores of two groups for SWFDR.

(ii) There is no significant effect of the way of fulfilment of needs or requirements on general awareness for their future planned expenditure.

Methods and Procedure

In this study, the authors tried to measure the way of fulfilment of daily requirements. Two groups were formed. One group was consisted of randomly selected science teachers and science graduates of all age groups belonging to middle class families. The other group consisted of traders, contractors, brokers and housewives belonging to middle class families. To assess how they meet their needs, SWFDR was conceptualised. This scale included the following four dimensions:

(i) Consumption of energy,
(ii) Changing pattern of lifestyle,
(iii) Garbage management, and
(iv) Re-cycle and reuse of things.

Every dimension was represented by ten items. There were total 40 assessment items in this scale. Both positive and negative items were used in the scale. A three-point (level) rating scale has been used to measure requirements against SWFDR in the form of always, sometimes and never. Scores assigned for responses of positive items were 2, 1 and 0, while 0, 1 and 2 were for responses of negative items.

Table 1

Mean and SD of scores of SWFDR

Score	N	Mean	SD
Science graduates	45	56.58	18.37
Non-science graduates	45	42.27	19.10

Table 2

Summary Data and Analysis of Variance from score of SWFDR

Sources of variance	Sum of Squares	d.f.	Mean squares	F
Between groups	4608.18	1	4608.18	13.13
Within groups	30895.78	88	351.09	

Table value at .01 level 3.95, at .05 level 6.92

To measure the general awareness for future consumption pattern, the tool against SGAFCP was also administered on the same group simultaneously. This tool also included total 40 assessment items consisting of positive as well as negative items. Three-point scale was used for rating the scores in the same way as was done for scoring of responses against SWFDR. In SGAFCP, items regarding respondents, future consumption or expenditure pattern were constructed along with items for the way of disposal of old things replaced by new ones. In this manner we intended to measure respondents' awareness for environment and resources, greed and practice followed for the use of non-traditional resources.

To cover the objectives of the study, primary data were collected administering tools for both SWFDR and SGAFCP. Random sampling method was used to select units from the population. The sample consisted of 90 (–45 people who have studied science and –45 of those who have not) persons belonging to middle class families in the age group of 21 to 60 years from Ajmer city.

To know the mean difference of two groups, means, standard errors and critical ratios were used. Also, to know the effect of the way of fulfilment of needs or requirements on general awareness for their future planned expenditure ANOVA (F-Ratio) was used.

Results and Discussion

Mean and SD of scores of SWFDR are presented in Table 1 while summary data and ANOVA results on the scores of SWFDR are given in Table 2.

Calculated F value is 13.13 and is greater than the table values at significance level of both .01 and .05. Hence there is significant difference between groups of science graduates and non science graduates. The first hypothesis is clearly rejected.

People who have studied science scored higher and others obtained lesser compared to their average score. This shows that science education plays the prime and central role to proceed on the path of sustainable development. Persons educated in science

use (consume) less energy and use scientific and improvised methods rather than traditional methods. They effectively used or managed garbage and e-garbage which is very harmful for the nature.

On the basis of the obtained mean score for first tool three groups were formed:

groups regarding general awareness for the future consumption pattern.

Conclusion

The results from the present study reveal that every person had a dream to raise income, improve the standard of living and live lavishly

Table 3

Mean and SD of higher, average and lower score groups

Score	N	Mean	SD
Higher	23	41.83	14.42
Average	44	39.82	17.14
Lower	23	41.65	18.31

Table 4

Summary Data and Analysis of Variance from score of SGAFCP

Sources of variance	Sum of Squares	d.f.	Mean squares	F
Between groups	83.33	2	41.67	0.15
Within groups	24585.07	87	282.59	

Table value at .01 level 3.95, at .05 level 6.92

(i) Higher score group: 25 per cent of the sample (i.e., 23 persons with higher score)

(ii) Average score group: 50 per cent of the sample (i.e., 44 persons with middle score), and

(iii) Lower score group: 25 per cent of the sample (i.e., 23 persons with higher score)

Calculated F value is 0.15, which is much less than the table values for both significant levels of 0.01 and 0.05. This shows that there is no significant difference among these three

irrespective of the person is science graduate or non-science graduate. As income of the people increase their consumption of goods also increase. They also imitate or copy the consumption level of their neighbours or other families in community. So 'demonstration effect' (Ahuja, 2010) is observed. Their needs also keep on multiplying irrespective of their educational background. With increasing demand for goods, the environment has not been able to regenerate itself. The carrying capacity or absorptive capacity of the environment continues to be stretched. The supply of every resource, which was in

abundance, is now limited and the quality of resources have been deteriorated. So, the fact is clearly established that if the present is miserable, it is due to increasing needs and greed and, therefore, needs and greed are to be checked immediately. Clearly, the future must not inherit the problems but the resources to achieve a better life.

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AVAILABILITY OF SCIENCE LABORATORY IN SCHOOLS AT THE SECONDARY LEVEL

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The study determined the availability of science laboratories for teaching learning of science at the secondary level in selected secondary schools of Rajasthan. The research design adopted for the study was stratified random sampling— out of 33 districts of Rajasthan— three districts, namely, Jaipur, Nagaur and Ajmer were randomly selected. Then seven government secondary schools from each district were selected. Three instruments, which were prepared by a team of faculty members and RMSA cell members were used for the collection of data for the study. They are questionnaires for principal/headmaster of the school, teachers and students focus group discussion. The data were collected by visiting the concerned school personally by faculty members. The study showed that laboratory facilities are highly inadequate, far below the expectation and in most of the schools experiments are not conducted. It is, therefore, recommended that government should include practicals in science as a part of assessment and take immediate steps to set up science laboratories across the state for effective teaching and learning of science. It is also suggested to make the science teachers more resourceful in providing alternative material for science teaching and learning so that learners learn by doing and develop thinking skills and attempt at innovations.

Key words: *Science lab study, secondary stage, science kits, science practical*

Introduction

Education is one of the basic needs of human beings. Science education needs to build on the knowledge and skills acquired by the learners so that students can understand the scientific principles, laws and theories. Progress of science can be checked by understanding the crucial role of experiments. Path breaking discoveries and inventions are possible only through investigations done usually in laboratories. Teaching and learning can be effected if teaching and learning centre is having adequate laboratory facilities. The laboratory has a direct effect on both students' attitudes and academic performance. Based on the instructional theory of learning interaction, It is generally believed that constant practice leads to proficiency in what the learner learns during classroom instruction; hence, the dictum 'practice makes perfect'(Hager, 1974). Adequate laboratory facilities should be provided to secondary schools for effective teaching and learning. The laboratory has been a distinctive feature in science teaching and learning (Hoftein and Ginetta, 1992). A study on the objective of laboratory work in chemical education argued that laboratory work can contribute to improving conceptual understanding, practical skills and inter-variable relationship among learners (Garnett and Hackling, 1995). The adequacy of laboratory facilities used during science instruction helps to develop values that aid the learners in decision making (Lagoke, 1997). The adequacy of laboratory facilities makes chemistry teaching more concrete and stimulating and hence for better students'

academic performance in secondary schools. Academic performance depicts the level of educational attainment of an individual. It differentiates one with high knowledge content from the other with low and less competency in academic performance (Eshiet 1996). The role of practical work in science education is ill-defined. The author suggests that one of the familiar aims of practical work, teaching for the development of 'experimental skills', is best regarded as having a distinct knowledge base linked to the understanding of scientific evidence. The significance and value of an understanding of evidence for employment in science, engineering and in regard to scientific literacy in the community is discussed (Gott and Duggan, 1996). The adequacy of laboratory facilities had a significant effect on the students' academic performance in chemistry (Okafor, 2000). The influence of adequacy of laboratory facilities and academic performance in chemistry had found that adequacy had significant influence on students' academic performance in secondary school chemistry teaching (Aburime, 2004). He, while investigating the relationship between adequacy and academic performance in Chemistry, had examined adequacy of laboratory facilities in terms of using frequency counts and percentages. For students to learn efficiently, teachers should ensure that adequate laboratory facilities are procured. The extent of adequacy of laboratory facilities for science teaching depends on the population of students in a particular school. A few studies have been reviewed to understand the status of laboratory uses and its implications. In the present era of education, a good quality science education is needed because constantly new information is added to the existing information. In a welfare state like India, it is the responsibility of the government to provide education to all. In support of this and the Convention of the Rights of the Child (CRC, 1989), India has promulgated the Right of the Child for Free and Compulsory Education Act and provides free education to children up to the age of 14 years or till the completion of elementary education (RTE Act 2009). However, there is a public demand to extend free education up to the secondary level. At this level, children study several subjects as compulsory and one of them is science which comprises physics, chemistry and biology. While performing learning activities in the form of practical work in science, students observe, investigate and develop an understanding of the world around them, through direct, often hands-on experience of phenomena or manipulating real objects and materials. Laboratories play a significant role in transacting effective science education at secondary level (*NCF, 2005*). *The National Curriculum Framework (NCF)* has clearly stated the objectives of teaching science to bring change in the ways of thinking and action in young minds of the school going children. It also emphasises that the teaching of science should result in enabling children to examine and analyse everyday experiences. The objective of science teaching includes:

1. To understand the cumulative nature of science and scientific knowledge.
2. To find inter-relationship and interdependence of different branches of science.
3. To recognise and enjoy some scientific aspects of their natural and manmade environment.
4. To acquire skills.

Beside the above objectives at the secondary level, students should be equipped with the skills of accessing information in the science laboratory with some general features like:

1. The science laboratory attempts to vary the learning environment in which students develop their understanding of scientific concepts, science inquiry skills, and perceptions of science.
2. The science laboratory, a unique learning environment is a setting in which students can work cooperatively in small groups to investigate scientific phenomenon.
3. The social environment in a school laboratory is usually less formal than in conventional classrooms; thus, the laboratory offers opportunities for being productive. Cooperative interactions among students and with the teacher have the potential to promote a positive learning environment.

Need of the Study

In the context of Universalisation of Secondary Education (USE), large-scale inputs in terms of additional classrooms, teachers and laboratory facilities need to be provided to meet the challenge of numbers, credibility and quality. *NCF (2005)* stated that schools, particularly those in rural areas, are poorly equipped with science labs, or equipment for mathematical activities. The absence of such facilities drastically narrows subject options for children, denying them equal opportunities for learning and future life chances. It is, hence, important that resources are made available for laboratories with adequate facilities in schools. While elementary schools can benefit from a science and mathematics corner, secondary and higher secondary schools require well-equipped laboratories. In the RMSA framework importance has been given to schools to setup laboratories as a part of strengthening infrastructure and utilise them. There is need to identify the need of laboratories and their utilisation in government secondary schools. The present work has been taken in view to identify the laboratory facility in the selected government schools and their utilisation with the objective to identify the availability of lab facilities for teaching of science.

Methods and Procedure

The sample of the study was based on stratified random sampling. At the first stage, out of the 33 districts of Rajasthan, three districts namely Jaipur, Ajmer and Nagaur were randomly selected in consultation with the RMSA of Rajasthan. At the second stage, from each of the districts seven government secondary schools were selected. As complete information could not be collected from two schools each in Nagaur and Jaipur, later two more schools were selected from these districts which were not in the original list. Therefore, the total number of schools was 23, the total number of teachers was 24 as there were two teachers each in three schools. With regard to principals, from 21 selected schools, the person who was heading the school on the day of the visit of the Investigator was considered as principals in the study. Therefore, the number of principals was 21. With regard to students, Structured Focus Group Discussion (FGD) was held in all the schools separately for

Classes IX and X. For classes IX and X, 19 and 18 FGDs were held respectively. In each group there were 10-15 students representing the class.

Tools used in the study: Three tools for principals, teachers and for students in the form of questionnaires were developed at NCERT by the RMSA Project Group involving the selected faculty from all the Regional Institutes of Education. Description of each tool is given in the following paragraphs.

Data collection: Faculty from the Department of Education in Science and Humanities from Regional Institute of Education, Ajmer were allotted schools for visiting and collecting the data. As per the schedule, the faculty visited the schools, observed the laboratory facilities, and administered the tools to the principal, teachers teaching science at the secondary level and the students of Classes IX and X. While each principal of the school and teachers teaching science for Classes IX and X were given the questionnaires to be filled by them, the students were administered the interview schedule. With regard to the students, FGD was held for the representatives of students from Classes IX and X separately in each of the schools. The responses given were tabulated for the purpose of analysis.

Results and Discussion

The responses regarding the availability of Laboratory facilities in schools are presented in Table 1.

Laboratory is expected to be present in every secondary school for the conduct of experiments in science. It is surprising to note that out of the 23 schools selected for the study, only one school has a working science lab. As per the responses given by the teachers, only eight teachers (33.33 per cent) have said that they have an integrated lab for science whereas the rest 66.67 per cent of the teachers have said that they do not have a lab for science. With regard to principals of the schools, 60.86 per cent said that they do not have labs in the schools and further, students in 22 FGDs also said that they do not have labs in the schools. While students in 9 FGDs said that they use lab once a week, students in three FGDs said that they use lab twice a week.

The responses regarding the accessibility of Curricular materials are presented in Table 2.

Table 1

Availability of Laboratory Facilities

Responses					
Principal		**Teachers**		**Students' Focus Group**	
Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)
9 (39.14)	14 (60.86)	8 (33.33)	16 (66.67)	15 (40.54)	22 (59.46)

Table 2

Accessibility of Curricular Materials

Accessibility of Curricular Materials	Teacher Responses	
	Yes (%)	No (%)
NCF-05	6 (25)	18 (75)
RSCF	5 (20.83)	20 (83.33)
Syllabus	20 (75)	6 (25)
Textbook	13 (54.17)	11 (54.83)
Supplementary Materials	12 (50)	12 (50)
Lab Manual	6 (25)	18 (75

Learning and teaching is always strengthened by referring to curricular materials. When teachers were asked whether they have access to *NCF–2005*, 25 per cent of the teachers have said that they do have, but 75 per cent of the teachers said that they do not have access to *NCF–2005*. It is well known that Rajasthan has not developed its own Rajasthan State Curriculum Framework (RSCF), but follow textbooks of NCERT at the secondary level. In spite of that, when asked whether, the teachers have access to RSCF, 20.83 per cent of the teachers have said 'Yes'. This shows the awareness of teachers with regard to RSCF. Curriculum is always followed by syllabus, when teachers were asked whether they have access to syllabus of science, though 75 per cent have said 'Yes' 25 per cent have said 'No', which means there are teachers or schools which do not have a copy of the syllabus or they are not made available to teachers.

In our country textbook is the whole and sole in most of the schools, even then, teachers were asked to respond whether they have access to any supplementary materials in science. While 54.17 per cent have said 'Yes', 45.83 per cent have said 'No'. This indicates that only around 50 per cent of the teachers have access to supplementary materials in science. With regard to accessibility of lab manual, it is very poor. Only 25 per cent of the teachers have said that it is accessible to them and the students of 34 FGDs informed that they do not have any manual or guide. But as per *NCF–2005*, manuals and resources for teachers are as important as textbooks and there is also a need for teachers' handbooks. These would provide tips for teachers, which they could use for lesson planning. But the reality is different. Teachers usually are accustomed to do anything whenever there is some official instruction. When the teachers were asked, whether the curriculum document of the state and the textbooks provide experimentation in science lab, about 65 per cent of the teachers said that they are expected to conduct experiments in the lab whereas the rest (35 %) said that the curriculum does not recommend and there is no scope in the textbook for conducting

experiments. Some examples which indicate the scope in the textbook for conducting the experiments are listed below. Chemical reaction, oxidation and reduction, pH paper experiments.

Major Findings of the Study

- Integrated lab for science is available only in $\frac{1}{3}$ of the schools.
- One fourth of the teachers have access to *NCF-2005* and lab manual whereas ¾ of the teachers have access to science syllabus and ½ of the teachers have access to supplementary materials to teach science.
- Many teachers have said that they are expected to conduct experiments in the lab as per the curriculum and the guidelines given in the textbook.
- There is availability of recurring grant for procuring the chemicals as per the words of about 16 per cent of the teachers but as per the words of 95 per cent of the teachers there is no grant for replacing the equipments that are broken/ malfunctioning, etc.
- Student-computer ratio is very high in most of the schools.
- Many labs are not equipped enough to conduct activities and in most of the schools experiments are not conducted.
- For making learning science effective, teachers use science kit, models and CDs/AV materials.
- For breakage of lab materials students are neither fined nor punished.

Conclusion

The study was specially meant to find out the extent of adequacy of laboratory facilities for conducting practicals and students' academic performance. The study attempted at finding the adequacy of science laboratory facilities for effective teaching and learning of science in government secondary schools of Rajasthan. Findings of this study showed that laboratory facilities are highly inadequate. It is, therefore, recommended that government should take immediate steps to set up science laboratories across the state for effective teaching and learning of science. It is also suggested to make science teachers more resourceful in providing alternative materials for science teaching and learning so that learners learn by doing and develop thinking skills and attempt at innovations.

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LIVE ZOOLOGY BEYOND THE CLASSROOM: A NEW ERA OF SCIENCE EDUCATION

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The curriculum of zoology in most of the universities, colleges and schools in India used to emphasise the study of dead animals in the form of dissection, vivisection, museum specimens and histological slides are designated as 'dead zoology'. Those species, evolved and came into existence in nature during the course of millions of years of evolution, are facing severe threats of survival due to extensive exploitation in the name of zoological studies in the classrooms. 'Live Zoology' means the study of organisms in their natural habitats without disturbing them, it literally means "teaching beyond the boundaries of classroom" and to study their interrelationship and importance as vital component of various food chains and food webs. 'Live Zoology' helps in the conservation of various ecologically important species. The concept of Live Zoology, introduced by Professor K.K. Sharma, is one of the most efficient tools to make zoology subject more understandable and increase the capacity building of students not only for identification, biosystematics and nomenclature but also for behavioural interaction with environment and organisms of same and other species. The 'Live Zoology' concept became so popular and effective in a relatively short period of time and a complete documentation of biodiversity status of many faunal species came into existence in the zoology departments of various academic institutions. With the help of this concept, now about 280 birds, 12 anurans, 25 lizards, 30 snakes and 120 butterfly species have been reported from various localities of Rajasthan and the additions of species in the list are still going on. Continuous education and concern of live zoology must be provided to all the aforesaid stakeholders (students, pre-service teachers and teachers) to gain proper awareness about the zoology subject and standards of bioethics. The educational experiences with the live zoology and wildlife can facilitate the development of positive attitudes towards animals and to restore the population status of declining species too.

Key words: *Live zoology, bioethics, understandable, biodiversity.*

Introduction

In most education institutions the curriculum of zoology has been oriented to study the animal from dead and preserved specimens purchased from the suppliers. Teachers and students are not aware about the basic information of faunal diversity present in their nearby areas. MDS University, Ajmer decided in year 2010 to study animals in nature, the concept was designated as 'Live Zoology' by Professor K. K. Sharma of MDS University, Ajmer (Sharma, et al., 2011). 'Live Zoology' means study of organisms in their natural habitats without disturbing them. And also to study their interrelationship and importance as vital component of various food chains and food webs. 'Live Zoology' also helps in preparing conservation strategies of various ecologically important species. Previously for systematic study, dead specimens were required that included collection, killing and preservation of different types of animal species that lead to severe loss of biodiversity while studying the live zoology that unnecessary killing is not required. Thus the 'Live Zoology' is a new eco-friendly humane approach to study the world of nature's treasure without exploiting it. This has great

advantages above the previous methods of studying the zoology. Simultaneously, it also helps the students, pre-service teachers and teachers to understand the subject in a better way and its various aspects too. Many organisations have started the study of zoology in nature, this resulted in documentation of large number of animal species which were not known earlier from their study areas. The concept became so popular that in August 2013, University Grants Commission, New Delhi released its guidelines for development of zoology curriculum meant for the entire country.

Methodology

After banning the dissection and animal use in teaching by UGC and other policy making bodies, there is urgent need to compensate the workload and marks distribution. To fulfil these requirements 'Live Zoology' and 'Digital Alternatives' play key roles. Thus, requirement of understanding the subject with appropriate tool will be maintained. In live zoology students have to spend more or little time into nature to observe organisms and their behaviour that not only increases the knowledge of students but also encourages the students to think in real situations about study of zoology. Several techniques were available for generating species lists or information on species richness for a site. These general techniques have been used for both long term and short term sampling projects, although long term sampling often includes both data retrieval and fieldwork and thus is more eclectic. Survey protocols, viz. Ad hoc Search Method, Visual Encounter Survey method, Transect Method, Point Count Method, Quadrate sampling technique and Call based identification tools are used to document the species.

Results and Discussions

During the conventional practice of learning and teaching of zoology in most of the universities, colleges and schools in India, it used to emphasise the study of dead animals in the form of dissection/vivisection, museum specimens and histological slides designated as 'dead zoology'. According to an estimate several animals were sacrificed for the fulfilment of these requirements at various levels of schools, undergraduate and post graduate programmes concerned to Zoology (Table 1). Those species evolved and came into existence in nature during the course of millions of years of evolution are facing severe threats of survival due to extensive exploitation in the name of zoological studies in classrooms (Sharma, et al., 2012).

After implementation of UGC regulation, to compensate the workload and marks, 'Live Zoology' was introduced with the aim of proper scientific documentation of faunal diversity. Students were assigned with the various objectives of documentation, behavioural observations and seasonal variation of faunal diversity available to the nearby areas of institution or student's residential area according to their convenience. This innovative practice with the approach of beyond the classroom teaching triggers a new zeal in students and teachers to understand the subject along with the message of biodiversity conservation as no killing was involved in this humane protocol (Sharma, et al., 2013a and b).
The impact of this new approach started a new era in zoology studies and several new species were recorded. The outcome of this approach was initiated as complete documentation of biodiversity and population

Table 1

Species used in dissection and study of other aspects of zoology at various levels of education

S. No.	Animal Species	Expected Number of Individuals
	Consequences of animal use in dissection in school education	
1.	Earthworm	1,35,48,145
2.	Cockroach	1,35,48,145
3.	Rat	81,28,887
4.	Frog	81,28,887
	Consequences of animal use in dissection in graduate-level education	
1.	Earthworm	9,47,613
2.	Cockroach	9,47,613
3.	Prawn	9,47,613
4.	Pila	9,47,613
5.	Scoliodon	9,47,613
6.	Frog	9,47,613
7.	Rat	9,47,613
	Consequences of animal use in dissection in post graduate-level education	
1.	Earthworm	69, 072
2.	Sepia	69, 072
3.	Loligo	69, 072
4.	Scoliodon	69, 072
5.	Rat	69, 072

status of many faunal species, about 280 birds, 12 anurans (belonging to 4 families), 25 lizards (belonging to 7 families), 30 snakes (belonging to 6 families) and 120 butterflies (belonging to 5 families) species have been reported from various localities of Rajasthan.

The outcomes in the form of publication of Range Extension and New Records (3 new records for Rajasthan (Figs. 1: a, b and c) and 15 new locality records); New Observation (one albinism record in crow); Behavioural Interactions (12 behavioural interactions records about feeding, prey-predator, defence, cannibalism, reproduction, etc.) and documentation of species/checklist/faunal diversity (documentation of faunal diversity of specific geographical range or area) was done and several in process (Table 2).

Table 2

Key outcomes of live zoology based studies

S. No.	Key Category	Specific Outcomes	Number of Research Publication
1.	Range extension and new records	Three new records for Rajasthan fifteen new locality records	18
2.	New observation	One albinism record in crow	1
3.	Behavioural interactions	Twelve behavioural interactions records about feeding, prey-predator, defence, cannibalism, reproduction, etc.	15
4.	Documentation of species/checklist/ faunal diversity	Documentation of faunal diversity of specific geographical range or area	1 book 1 book chapter 8 publications

Fig. 1 a: Tailed Jay Butterfly; b: Indian Painted Frog and c: Western Reef Egret)

Conclusion

Live zoology concept not only helps in the species documentation but also helps to assess the species status to refine their conservation strategies. It helps in long term planning as Live Zoology Information System (ZIS) will enrich biodiversity database and help in planning and management for conservation of biodiversity. Simultaneously, live zoology concept is emphasising studies of animals in natural conditions avoiding unnecessary killing, capturing, preserving of animals to study them in dead condition. This helps the students, pre-service teachers and teachers to understand the zoology subject in better way and also provide new fields of job opportunities in various governmental and private sectors.

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LEARNING FLAME TEST USING A LOW COST EXPERIMENT

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Flame test is the most common way of qualitative analysis of some basic radicals. Metal salts on reacting with concentrated acids impart characteristic colours to the luminous flame and colour of the luminous flame gives valuable information in their detection. Traditionally this test was carried out using costly platinum wire but recently some new experiments of flame test have been designed in which platinum is not required. In the present study a low cost experiment of flame test was introduced for learning of pre-service teachers and results are presented below.

Key words: *Low cost, flame test, metals, colour, pre-service teachers training*

Introduction

Flame test is commonly used to test alkali and alkali earth metal cations in qualitative analysis of their salts. Metal salts on reacting with concentrated HCl, form their chloride and their vapours impart characteristic colour to the flame. The colour may give reliable information about the cation present in the salt. In traditional method flame test is performed using platinum wire. However, flame test can also be performed without using a platinum wire (1-3). During the present study a low cost experiment was used for flame test and its impact on learning of pre-service teachers was investigated. The interesting results of the study are presented in this paper.

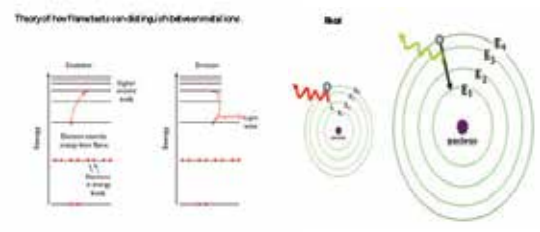
Methods and Procedure

Sample: Pre-service teacher training programmes form the four-year integrated BSc. BEd. course. In the first year of BSc. BEd. there is inorganic qualitative analysis as part of the practical chemistry syllabus. Around 100 students perform the practical experiment in a group of 20 students each. Students of the course are highly meritorious and keen to learn the different aspects of chemistry practicals.

Procedure: Pre-service teachers were very well instructed about the safety aspects while performing qualitative analysis of inorganic mixtures. They were explained about the theoretical basis of the analysis and the principle and role of flame test in qualitative analysis of metal cations. It was explained that:

- Energy and frequency of light are directly proportional to each other $E = h\upsilon$, and frequency/wavelength affects the colour of the light if energy is absorbed from visible region.
- Each element has its own distinct electronic configuration and set of energy levels. Therefore, different elements allow electrons to make different electronic or energy transitions.

- These different energy transitions result in different colours of light being emitted.



A systematic approach of flame test using platinum wire was explained and it was emphasised that platinum is a costly metal so we should use the low cost material to perform the flame test. Recently some experiments have been designed for low cost flame test and direct use of some chemicals to perform the flame test makes it highly economical. The following procedure was explained to perform the flame test using these chemicals:

Take a cleaned watch glass and place 0.5-1.0 gm of salt and then put nearly 10-15 drops of ethanol or methanol over it with a plastic dropper. The salt should properly get moistured with alcohol. Now lighten the heap with a match box. Flame will appear from the heap and may appear for about a minute or more depending on the amount of alcohol added. Now observe the colour of the flame. The following concepts were also discussed:

- Ethanol and methanol are flammable and when mixed with oxygen and ignited create an explosion.
- When an atom's electrons drop from the excited state to the ground state, a wavelength of light will be emitted. Metals have characteristic emissions of light that can be used to identify the individual metal.
- The flame colour will depend on the salt nature and will indicate the cation present and the observed flame colour will be as follows (for different cations as is seen in a flame test with platinum wire).

The colour of flames produced by different metal ions is given below in Table 1.

Table 1

Flame coloration for different metals

S. No.	Metal ions	Flame colour
1.	Na^{+}	Yellow
2.	K^{+}	Violet
3.	Ca^{2+}	Brick red
4.	Sr^{2+}	Carmine–Red
5.	Ba^{2+}	Apple–Green

Since the test does not require any specific or sophisticated arrangement, it can be demonstrated easily in classroom situation.

Fig. 1. Photograph-1: Demonstration of low cost flame test

Feedback of Learners

After performing the flame test for qualitative analysis of inorganic mixture, feedback of

pre-service teachers was taken through interview of the individuals. They reported that this method is easy to perform a flame test. Secondly, results of the flame test are very apparent and they were able to identify the metal present in the mixture on the basis of colouration of the flame. They also reported that performing a flame test using low cost material was enjoyable for them. Overall this was highly appreciated by the pre-service teachers.

Conclusion

Feedback of the pre-service teachers clearly indicates that this method is equally applicable to the traditional method of flame test using platinum wire.This test does not require any specific or sophisticated arrangement and can be demonstrated easily in classroom situation. Thus, such type of low cost experiments should be designed and encouraged in day-to-day practical classes.

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TRANSCENDING DISASTER EDUCATION: A DEVELOPMENTAL APPROACH ENSURING SUSTAINABILITY

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Our earth, with the present population estimate of 7.5 billion humans, has been a cradle to the evolution, transformation and manifestations of many civilizations that ever existed on its surface. The time elapsed and the human society proliferated with the development of science and technology through the modern thoughts brought about by three gigantic revolutions made in agriculture, industrial and information technology sectors of income and human sustainability. The continuance of human life on earth is intricately intertwined with the sustainability of the earth on micro to macro scale. The sustainability of earth bears the imprints of all those catastrophes that affect its ability to guard human life on it. The world with vast continental landmasses and having diversified topographic structures is bound to face multiplicity of natural hazards on local to regional scale. Natural events of such adverse effects on human property and life have led us to conceptualise these as disasters. The trend analysis of last 100 years over the earth reveal the fact that much have been changed by natural disasters with an average occurrence of 7 in 1914 to 341 disasters in 2014 per continent on a global scale. The present study focuses on how frequent the disasters have continued to harm our environment and up to what extent threatened existence of mankind in the last ten decades. The available data on past natural calamities have been studied to gauge the intensity and effects of these hazards and realising a better way to mitigate them by educating all for disasters and disaster management as this will ensure timely disaster preparedness in general. Each disaster occurs at the backdrop of some science in it. This necessitates natural disasters as a probable area of concern which awaits intrinsic study and investigations with enough scientific aptitude and enquiry in science education of our country. Natural disasters though a comprehensive theme to work upon is still a phenomenon least understood in our education system. The origins of such events of unforeseen calamities are originating and set in one country but its effects howsoever mild or severe it may be are widespread across national boundaries. To understand, mitigate and finally to manage them lies with the scientific community at our disposal. Without realising scientific spirit and integrating science behind disasters by each one of us, the goal to manage our earth resource and to prove a nature worthy of being called as sustainable, and hence notion of all round sustainable development remains devoid of reality.

Key words: *Natural hazards, disasters, sustainable development, science education*

Introduction

The sustainability approach over the earth's surface is taken in various forms each having different meanings within a window of some contextual human undertaking. In all its forms it measures a continuing supportive platform where the outputs of the support are always yielding. If the earth is taken as a plain where the human life dwells, evolves and develops then, its ability to provide such a support in a continued state within a time range will give us how sustainable our earth is for the continuance of human life and its development. Over the years, the earth's surface has kept on changing under the varied impacts of natural events occurring on it. These natural events with the passage of time grew in pace and in their impacts which had the ability to completely ruin human society in terms of loss of life and property. They rose from few in number to their frequent occurrences witnessed by different parts of the world in a year.

Initially, considered to be events of divinity occurring under supremacy of the almighty creator the God, they are now found to be embedded in the fabric of science and within the framework of earth's physical phenomenon. Some incipient study would thus, perhaps reveal that their definitions changed as the science progressed and man started to turn to investigations of enquiry into them. They would have been substantially referred to as an event, a chance phenomenon, a physical disturbance, an imbalance in the state of earth's equilibrium, a calamity, a hazard and so on or the most accepted vocabulary of modern times as natural disasters.

Equation of Risk Governs the Concept of Sustainability

The disasters in their scientific constitution follow a worldwide accepted equation of risk, which is given as — Risk = f_n (Hazard * Vulnerability * Exposure) .....Equation (I)

The equation implies that disasters as a natural phenomenon have the dynamics of risk or the danger for the human sustainability which is always dependent on variables of hazards, vulnerability attached with that hazard and the time for which a part of land is exposed to the hazards. A hazard shall mean the potential to disrupt human society and its environment with a magnitude beyond the coping capacity of the affected community. Vulnerability states the extent of getting damaged which can take place in the affected area in terms of social or economical loss or both. However, the severity of such a disaster would be realistically related by the ultimate factor of exposure time in its occurrence period. The aforesaid discussion makes it clear that disasters have an inherent component of risk in the form of danger for human society. The question is how it relates to the concept of sustainability.

How does Sustainability Change with Disasters?

The promise of sustainability finds its root in the fact that earth should provide us our all basic needs in the coming times at the same pace and to the similar extent of requirements existing currently. A disaster is such a huge impact factor of sustainability assessment that it can slow down the pace as well as extent of this proposed sustainability. Human society dwells with a constant equilibrium which he maintains with the environment within a framework of prerequisite ecological inter-relationships. Since the disasters are known to greatly disrupt this steady state of natural equilibrium by their impacting magnitude, exposure time and arrival frequency, the land's carrying capacity is attenuated, and hence forming a limiting factor in sustainable human development.

Studies with Aggregate Data

Any naturally occurring adverse event will be qualified to be called a disaster only if it crosses over a threshold value set by the government of the affected country. Under this definition, we broadly classify three categories of natural disasters namely as geological, hydrological and meteorological disasters. However, the definition also extends to some less discussed disasters of wildfires, health disasters in the case of an epidemic and those rarely seen space disasters created by impact events and airbursts. Many of the disasters in the earth's history are traced through their global evidences

collected by avenues of discoveries where the findings are inappropriate for any quantified assessment. From an available database, the quantifications are met out in the form of aggregate data from the beginning of the last century.

Table 1

Aggregate data of affected persons from disaster

Years	Total number of disasters per continent		Total affected (Number of persons in thousands per continent)	Total deaths (Number of persons in thousands per continent)	Trend in number of disasters (Percentage factor increase or decrease)	
	Global	Asian	Global	Global	Global	Asian
1912	7	4	99.09	52.09	–	–
1922	7	2	11.00	101.24	0.00	-50.00
1932	9	4	36.88	73.29	+28.00	+100.00
1942	9	6	183.10	1608.23	0.00	+50.00
1952	24	9	1001.73	8.95	+1.66	+50.00
1962	28	12	143.26	17.35	+8.33	+33.33
1972	64	30	219154.82	20.03	+128.57	+150.00
1982	160	68	151118.61	13.95	+150.00	+126.67
1992	233	101	68609.27	18.89	+45.63	+48.53
2002	505	175	659261.17	21.32	+116.74	+73.27
2012	369	143	111425.29	11.60	-26.93	-18.29
2015	394	177	104395.00	23.88	+1.36	+23.78

Compiled from EM-DAT international disaster database

The various kinds of disasters of varying magnitudes and each sub-type having distinctive scales of destruction was taken in aggregate form and the data was put under study at an interval of ten years period starting from the year 1912. To yield projected results data pertaining to 2015 was also taken to gauge current state of disasters. With the beginning of twentieth century, we faced 7–9 hazards per continent in a year with no significant rise of world population. However, the reported number of affected people and the resulting deaths were more at the end of 1942 or World War II period. Time scale study revealed that the numbers recorded maxima from 1972–1982 with a gain of 150

percentage points. This period marks the age of sudden population rise and change with more technological upbringings in India and in the world and, therefore, seemed most accountable to more number of people affected and the resulting deaths.

Impact Studies of Natural Disasters

The compiled data on natural hazards provide us the numerical facet of damages with regard to their increase in numbers and frequency with advancement of time. We study through these numbers, their impact over the land in general and on human life in particular. Their impact studies require a deeper approach of assessment and evaluation. From 1912–1915 there was negligible increase in the number of disasters per year per continent up to 1942 and after it, they rose in bigger numbers till 2002 by almost doubling every ten years. The trend was most visible in Asia where our country holds a key position. After 2002, we account for an abrupt drop of 26.93 and 18.29 percentage points in the number of these disasters globally and in Asia, respectively, in the last ten years. The reasons of such timely variations are manifold but culminating at one focal point of study. After 1972, the global population grew enormously with more and more exploitation of resources and the sustainability of the earth has been tested from this time onwards. Better technologies came, more industrial clusters and agglomerations sprawled, industries dominated with persistent agriculture to feed huge population of 7.5 billion humans today. The earth provided the same land earlier with similar dimensions as it is offered today but man as the sole judge of using resources has ultimately disrupted the state of equilibrium of nature seen in more intense and frequent natural hazards.

Measures to Mitigate Natural Disasters: A Governance Issue

It is evident from the fact that with further rising population and greater ecological imbalances, our lands will lie more prone to disasters. For a country like India having sub-continental dimensions feeding 18 per cent of the world's population, India is projected to be the world's most populous country by 2022, surpassing China and is bound to face disasters in the form of catastrophes. This was already felt by us and our government planned to enact Disaster Management Act in 2005, which provided us institutional, legal, financial and coordination mechanisms at the national, state, district and local levels. The Indian government places its vision to build a safe and disaster resilient India by adopting a holistic and integrated approach towards disaster management where community participation, capacity building and cooperation with agencies at national and international levels are sought out. In the formulation of the objectives of such a national policy on disaster management, we have proposed a culture of prevention, preparedness and resilience at all levels through knowledge and education by encouraging prevention from disasters based on technology, traditional wisdom and environmental sustainability.

Science in Disasters: An Essential Feature of Science Curriculum

One major cause of the greatest disasters in the last 30–40 years has been the climate

change phenomenon not by nature itself but by the triggering effect of man's rising population. Therefore, human-induced climate change draws a parallel to the number of natural disasters if human population grows uncontrollably at the present rate with further degradation of environment. Further, any disaster is an event in outcome but its development, progression and dissipation is governed by physical laws just like in other natural and applied sciences. A disaster can never be explained and estimated in its chance probability with a scientific commitment to its study by way of usage of empirical, observational and analytical research methods in it. The scientific community has made several strides to locate the cause of them and have successfully given both quantified and qualitative assessment of disasters. If at one end, lies are the causes of natural hazards, then their assessment, risk evaluation, monitoring, control and preventions are the other major objectives of science at the other end. This sufficiently justifies that disasters have science in them and this science forms a bridge of human response to natural disasters between their causes and measures of mitigation and management.

Disseminating Education of Disaster Science: A Way to a Better Living

A disaster mitigation and management effort aims to achieve its objectives through six levels of imparting education and training namely, prevention, mitigation, preparedness, response, rehabilitation, reconstruction and recovery. What is provided by the earth is destroyed by the disasters affecting sustainable development. Without understanding the essentials of science in disasters we shall not meet effective community participation and their cooperation at all levels in the time of crisis. Just like an elementary knowledge of computer application is essential for every countryman for digital India, a preliminary sound knowledge of disaster science shall render each one of us to act in a timely way in mitigating a disaster by a self-preparatory response. To make our earth a better place to live peacefully on the lines of sustainability goal and development approach, a strategy to educate each one of us in disaster sciences shall yield fruitful results at national level.

Conclusion

Any country runs from a risk of disasters and these disasters are inevitable because they are naturally arriving with great spatial-temporal variability without giving an early warning and range in magnitude from feeble to devastating. Their effects may be completely catastrophic to ruin crores of human property and multitude of life. The progress and the national development of the country will inter-relate to its capability to cope up with the situation when a disaster strikes its land and people. To fight back from any economic pitfalls and environment degradation impacting national sustainable development, disaster education offers us an indispensible scientific tool to mitigate them and standard procedures to manage critical situations. Growth and spread of disaster science as a mandatory part of science curriculum is the need of the hour and an aspiration of the country at the moment.

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QUALITATIVE ANALYSIS OF SCIENCE QUESTION PAPER OF CLASS X BOARD EXAMINATION

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The theory science paper for the Class X board examinations should have carefully designed experiment and technology-based questions, questions testing critical understanding and ability to solve problems. In view of the above, an attempt has been made to analyse the science question paper of Class X (2015) of Rajasthan Board of Secondary Education under a minor research project taken up by the Regional Institute of Education (NCERT), Ajmer. The science question paper of Class X has been analysed considering the design and blueprint provided by the Rajasthan Board of Secondary Education. Emphasis has also been given to identify the strengths and weaknesses of the paper. Tools developed by the Department of Educational Measurement and Evaluation of NCERT, New Delhi were used. Science paper was analysed by a team of experts in workshop mode considering the design and blueprint. Difference has been observed between the ratio of the marks allotted to the objectives (knowledge, understanding, application and skill), as per the design and the analysis of the question paper. The weightage given to the skill (objective) is less in comparison to the other objectives. There is a difference between the marks allotted to the units, as per design and marks allotted as per analysis of the question paper. There is no question from Unit VI. There is no difference between the weightage to forms of questions (i.e., essay or long answer, short answer-I, short answer-II and very short answer) as per the design and as per the analysis of the question paper. Both of them have a perfect match. The difficulty level of most of the questions is average. There is difference between total number of chapters as per the design and as per the textbook. The time required for Unit I is less and for Unit II it is more than the time mentioned in the design.

Key words: *Examination, question paper, design and blueprint*

Introduction

Sincere efforts have been made since long to improve quality of science education considering examination reform as an important part of it. *The National Policy on Education* (1986) and its Programme of Action (1992) envisaged an improvement in the programme of evaluation to make it serve as a powerful instrument of quality improvement in the teaching and learning process in schools. In 1991, the National Advisory Committee appointed by the MHRD under the Chairmanship of Professor Yashpal, highlighted in its report (1993) that the examination system is memory based and it is focusing only on the child's ability to recall facts from prescribed textbooks. Observation and exploration are discouraged; syllabus and textbooks are packed with

facts and information that burden the child, making learning with understanding impossible. Thus, this report recommended re-designing of public exams taken at the end of Classes X and XII, so that questions test not just memory and information, but the understanding and application of concepts (MHRD, 1993). Examination to assess students' learning is an important aspect of curriculum implementation, as it influences what the students learn and the way they learn. Ideally, examination process is meant to guide teaching-learning process and hence considered supportive to it. However, due to importance of marks achieved in our day-to-day life, more particularly in getting admissions to higher level programmes and securing jobs, examination process has gained so much importance that gradually teaching-learning process has become subordinate to it. In other words, in some cases question papers of the last five years become the *de-facto* curriculum, and sometimes, even teachers start teaching as per the question papers of previous years. In such a scenario, there is a need to address the quality of question papers. If quality of a question paper is not good enough, it may lead to improper learning as well as teaching.

It is generally observed that most of the time question papers consist memory-based questions and because of this, students also study accordingly. In this situation many students are able to pass their exams without an understanding of the subject knowledge and ability to apply it in real life situations. It is therefore imperative to ask understanding and application level questions in the question papers. Other problems associated with the question papers are improper coverage of the curriculum, ambiguity in questions, role played by chance or luck factor, subjectivity in understanding the scope of questions by students as well as examiners. According to Gupta (1993) examination results can make or mar the career of students. The entire future of the students depends on how they perform in the board examination. All these problems may be addressed if proper types of questions are selected, proper language is used and proper marking scheme is provided with the questions. Most of the paper setters are good in subject knowledge but they may need training for developing good question papers.

The Position Paper of *NCF-2005* on Examination Reforms (2006) which examined the major shortcomings of the public examinations in our country has recommended for drastic reform in paper setting. It also refers to a detailed study of question papers of the recent Class X board exams. *NCF-2005* (Position Paper, Examination Reforms, 2006) also states that skill of presenting findings coherently, integrating them into a persuasive argument and applying them to real life situations are important which can be best evaluated through essay type questions. It has also discussed on 'What do board exams test?' It remarks, exams, though fairly reliable tests of narrow textbook content, Indian school board exams are rarely valid tests of desired competencies and broader curricular objectives even within cognitive domain. It further states that it is designed to test a detailed knowledge of textbook rather than competencies and concepts. However, the core of examination system is the examination question paper.

Need and Significance

Many tools and techniques have been developed to assess the learning of learners. Some of them are written tests, oral tests, practicals, projects, interviews, etc. However, in science learning assessment process, the activities, experiments and technological modules within the textbook should be assessed internally for Class X board examinations. The theoretical science paper for examinations for the Class X board examinations should have carefully designed experiment and technology-based questions, questions testing critical understanding and ability to solve problems. There may be problems of logistics which will reduce examination related stress to some extent. In a board examination, question paper is the main tool employed to assess students' achievement through a written examination. If the question papers are improved, its impact will percolate down to schools. As mentioned above, about requirement of science question paper, the analysis of existing question papers is the first step towards improving the quality of testing. During analysis one can look for many factors— quality of questions, typology of questions, abilities being tested by different questions, difficulty level of questions, the language of question, etc. What can be a model question paper in any subject is difficult to decide, however, in the light of *NCF-2005*, attempt has been made by NCERT in this regard which have been shared with CBSE. *NCF-2005* emphasises inclusion of different types of questions testing higher order thinking skills rather than mere memorisation with enough scope for a child to construct his/her own correct answer. Department of Educational Measurement and Evaluation, NCERT is working with different boards in this direction. According to Rama and Reddy (2013), more application level questions must be given and utmost care must be taken to see that question papers contain questions from all areas. Therefore, it was felt that there is a need to analyze the question papers of Class X board examination.

Objectives of the Study

The objectives of the study were:

- To analyse the science question paper of Class X in relation to design and blueprint provided by Rajasthan Board of Secondary Education.
- To identify the strengths and weaknesses of the science question paper of Class X.

Methods and Procedure

Sample: For the study, the question paper of science of Rajasthan Board of Secondary Education of the year 2015 was chosen.

Tools: The proformas for Question Paper Analysis (Proforma-A; Proforma-B and Proforma-C) developed by the Department of Educational Measurement and Evaluation, NCERT, New Delhi were used. The main areas covered in the tools are:

(i) **Proforma-A:** It is used to work out the following information for each individual question, such as, Mental Processes Involved; Content Area Tested; Type of Question; Marks Allotted; Estimated Difficulty Level;

Time Allotted. The observation regarding the language, difficulty level, scope of the question, whether question is within the syllabus or not, quality of diagrams and sketches, about instructions and the comparability of options, etc., will be summarised in the remarks column.

(ii) **Proforma-B:** It is based on Proforma A and is used to calculate percentages of marks and a comparison is made with the weightages decided in the design of question paper. Proforma B in fact deals with all aspects of a question paper and is the basis for making observation about the quality of questions and question paper.

(iii) **Proforma-C:** The observations made in Proforma A and B are consolidated in Proforma 'C'. It takes care of general and specific suggestions also.

Procedure of Data Collection: The Rajasthan Board of Secondary Education, Ajmer was contacted and they supplied design, blueprint, science question paper of Class X of board exam of 2015, along with the textbooks. A workshop was organised for three days from 19–21 January 2016 in which there were five resource persons to analyse science question paper. The resource persons examined the design, blueprint, question paper and also had discussion on tools and their usage. The resource persons filled Performa A, B and C and wrote a detailed report. The experiences of the school teachers who were a part of the workshop were of great help in giving suggestions for improvement of the question paper.

Results and Discussion

As the present study is qualitative in nature, the data collected has been analysed qualitatively and presented in detail in the succeeding pages. The science question paper for Class X was analysed from the following parameters: mental processes tested; types of questions used for testing them; the content areas covered; and the difficulty level.

Weightage to Objectives

Analysis was done in terms of the weightage given to the objectives in the design and the question paper of science. Table 1 below, gives the details of objective-wise weightage.

Table 1

Weightage to Objectives

S. No.	Objectives	Marks allotted as per design	Marks allotted as per analysis	Comments
1.	Knowledge (K)	30.50	27.50	There is difference between the marks allotted as per design and as per question paper analysis.
2.	Understanding (U)	29.00	25.00	
3.	Application (A)	9.50	15.50	
4.	Skill (S)	11.00	12.00	

It has been observed from Table 1 that there is difference between the marks allotted to the objectives as per design and marks allotted as per analysis of the question paper. It is seen that for knowledge domain as per the design out of 80, 30.50 marks have been allotted and 27.50 marks allotted as per analysis of the question paper. For understanding, application and skill domains out of 80, 29.00, 9.50 and 11.00 marks allotted as per design and 25.00, 15.50 and 12.00 marks allotted as per question paper analysis, respectively.

and science question paper. Details are summarised in Table 2.

It has been noted from Table 2 that, there is a difference between marks allotted to the units as per design prescribed by the Board of Secondary Education and marks allotted as per analysis of the question paper. It has been observed that, in the question paper, Unit I, III and IV has been given same weightage (i.e, out of 80, 24 (30%) to Unit I, 14 (17.50%) to Unit III and 10 (12.50%) to Unit IV) as mentioned in the design but Unit II is allotted 20 marks

Table 2

Weightage to Content

S. No.	Name of the Unit	Marks allotted as per design	Marks allotted as per analysis	Comments
1	2	3	4	5
I	Chemical Substances	24.00	24.00	There is difference between the marks allotted as per design and as per question paper analysis Unit VI is not taken into consideration while framing the question paper.
II	World of living	20.00	22.00	
III	Effects of Current	14.00	14.00	
IV	Light	10.00	10.00	
V	Natural Resources	8.00	10.00	
VI	General Awareness	4.00	Nil	

So, it can be inferred that, in the question paper, less weightage has been given to the knowledge and understanding domain in comparison to the weightage assigned for these domains in the design. It has also been noted that application and skill domains are given more weightage in the question paper in comparison to the design presented by the Board of Secondary Education.

Weightage to Content

Analysis was done in terms of the weightage given to the content, unit wise in the design

(25%) in design and 22 (27.5%) marks in question paper, similarly Unit V is allotted 8 marks (10%) in design and 10 marks (12.50%) in question paper. It has also been noted that Unit VI is not taken into consideration while framing question paper.

Weightage to Forms of Questions

Analysis was done in terms of the weightage given to forms of questions in the design and science question paper. Marks allotted to different forms of questions are given in Table 3.

Table 3

Weightage to forms of questions

S. No.	Forms of questions	Marks allotted as per design	Marks allotted as per analysis	Comments
1.	Essay/Long Answer (LA)	30.00	30.00	There is a perfect match between the marks allotted as per the design and as per analysis of the question paper.
2.	(a) Short Answer-I (SA-I)	12.00	12.00	
3.	(b) Short Answer-II (SA-II)	30.00	30.00	
4.	Very Short Answer (VSA)	8.00	8.00	

It has been found from Table 3 that there is no difference between the weightage to forms of questions as per design and as per analysis of the question paper.

All the forms of questions are in the question paper as per the marks allotted in the design.

inferred that the difficulty level of most of the questions is average.

Distribution of Marks over Questions

It is found from the analysis of design and question paper that Q. No. 30 is framed

Table 4

Difficulty level of questions

S. No.	Difficulty Level	Marks allotted as per design	Marks allotted as per analysis	Comments
1.	Difficult (A)	-	8	Design does not indicate the marks allotted to the difficulty level of questions. Most of the questions are of average difficulty.
2.	Average (B)		55	
3.	Easy (C)		17	

Difficulty Level of Questions

Analysis was done in terms of the difficulty level of questions in the design and science question paper and the data is given in Table 4.

It is observed from Table 4 that the marks allotted to the difficulty level of questions are: for difficult questions (A) it is 8.00 (10%), for average questions (B) 55.00 (68.75%) and easy questions (C) 17.00 (21.25%). So it can be

with five (3+1+1) marks, but the total of the distribution of marks in the 'OR' part of the Q.No. 30 is only three as per the question paper. This shows that there is variation in the distribution of marks over questions in the question paper, when compared with the design.

Estimated Time

The estimated time for Unit I as mentioned in the design is 50.96 minutes but according

to the analysis the time required for this unit is 49 minutes which is lesser than what is given in the design. In contrast, for Unit II time mentioned in design is 46.72 minutes but required time is 47.00 minutes which is more than the time given in the design. For Unit III to V the time mentioned in the design (i.e., III Unit=29.73 min, IV Unit=21.23 minute and Unit V=21.23 minute) is sufficient.

Arrangement of Questions and Format in the Question Paper

The arrangement of the questions in the question paper is as per design. Diagrams are at proper place. The quality of printing can be improved.

Translation—Compatibility between English and Hindi Versions of Questions

Translation is found to be satisfactory.

Adequacy and Clarity of Instructions to the Students

Although adequacy and clarity of instructions to the students are satisfactory, word limits can be mentioned for each question in the question paper.

Comments Regarding Quality of Questions— Language, Scope, Relevance to Content

The difficulty level of the most of the questions is average. Questions are based on the content of the textbook. There is ambiguity in the language of Q. No. 19.

Major Findings of the Study

- There is a difference between the ratio of the marks allotted to the objectives (knowledge, understanding, application and skill) as per the design and as per the analysis of the question paper.
- The weightage given to the skill (objective) is less in comparison to the other objectives.
- There is a difference between the marks allotted to the units, as per design and marks allotted as per analysis of the question paper.
- There is no question from Unit VI.
- There is no difference between the weightage to forms of questions (i.e., essay, long answer, short answer-I, short answer-II and very short answer) as per the design and the analysis of the question paper. Both of them have a perfect match.
- The difficulty level of most of the questions is average.
- There is ambiguity in the language of Q. No. 19.
- As per the design Q. No. 30 should carry five marks but in the question paper it is (3+1+1) and shown as three.
- There is difference between total number of chapters as per the design (9) and the textbook (6).
- The time required for the Unit I is less and for Unit II is more than the time mentioned in the design.
- The difficulty level of most of the questions is average.

General Suggestions for Further Improvement

- The weightage given to the skill (objective) in the design can be increased.
- Some more questions of difficulty level can be included in the question paper

for the benefit of gifted children and average may be reduced.

- Unit VI has to be taken into account while framing question paper.
- The quality of the printing of question paper can be improved.
- Word limits can be mentioned for each type of question in the question paper.

Conclusion

The analysis of the question paper has reflected the strengths and weaknesses of the science question paper. Since the study is limited to question paper of only one year, the findings cannot be generalised. However, with more rigor, commitment and monitoring, it is possible to improve the quality of question paper and test what is actually required to be tested. It was also felt during the analysis that some degree of freedom has to be given to the question paper setters though it is their responsibility not to deviate much from the design and blueprint. This would surely ensure improvement in quality of the science question paper.

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TEACHING OF SCIENCE IN UPPER PRIMARY SPECIAL TRAINING CENTRES FOR OUT-OF-SCHOOL CHILDREN

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Delhi State Science Teachers' Forum (DSSTF) is an organisation of science teachers of different management schools of Delhi. DSSTF was conceptualised and visualised with the objective of inculcating scientific attitude, scientific temper in teachers and students, to popularise science subject in schools by bringing quality of teaching science with the help of hands-on activities/science kits, free science teaching camps (for SC/ST and economically backward students) and conducting workshops, seminars, exhibition and celebration of National Science Day and birth days of eminent scientists. For improving and increasing the popularity of science subject in schools of Delhi, science open merit test is introduced by DSSTF in Class X, so that the quality crop of science students could be created to benefit students of Delhi. Among other activities of DSSTF special mention is to be made of training of lab assistants, training of science teachers, preparing manual and material for science teachers teaching at elementary and secondary levels. The main activity of DSSTF is free science teaching camps (for SC/ST and economically backward students) for elementary and secondary classes. The main feature of these camps which are running in government schools of Delhi since 1989 is that more than thousand science teachers, who are life members of the forum, are teaching in these camps voluntarily. These camps are arranged during autumn and winter breaks. All science teachers who offer to teach in these camps are given subjects of their priority including physics, chemistry and biology stream. The topics are assigned to DSSTF members as per their specific interest in theory and practical at the elementary and secondary levels. These teachers are trained for performing practical and scientific activities related to their topics by experts of DSSTF. In the year 2016, DSSTF has launched a new innovative project of science for upper primary students of STCs running in schools of Delhi by SSA to whom even fundamentals of science are not known. These STCs are run by SSA Delhi funded by MHRD, Government of India. The State Project Director of SSA and RMSA was approached by functionaries of DSSTF. The DSSTF members offered to teach science in these STCs all over Delhi and the kits provided by SSA Delhi was made available to these science teachers by State Project Director, SSA. This paper presents a successful intervention and our experience of science teaching with groups of out-of-school children in three government schools of Delhi.

Key words: *Developing scientific temper, popularisation of science, special training centers*

Introduction

The situation of science education at the elementary level all over the country is very alarming. After the implementation of RTE Bill 2009, i.e., no detention policy for the age group 6 to 14 years, even the basics or fundamental concepts of science are not taught. Science is learned by doing. Demonstrations and practicals play a great role for science at the elementary stage. This aspect is being totally overlooked in almost all the government run schools, throughout the country. The portion of elementary education in science is even worse in the special training centres (STC's) for out-of-school children enrolled there. Maximum teachers appointed in STC's are not of science background. So you can visualise the state of science teaching there.

Keeping this in mind, DSSTF has taken the responsibility of creating awareness among teachers and students of special training centres. Interesting and moderating hands-on

activities connected with scientific temper and scientific attitude are shown and practised by STC students. In order to develop and inculcate interest in the subject, scientific activities related to students' day-to-day experiences and burning social problems, the lessons to be taught are articulate. For example, in Delhi the recent disaster was pollution due to crackers. Because of burning of crops in the NCR, pollution caused by vehicles both old and new, industrial pollution, the capital was adjudged as the worst in terms of particulate matter in the world. So to make the students aware of this and showing them to install indoor plants which reduces pollution, at DSSTF level it is in the form of a project in all upper primary STCs. Some plants were shown, distributed and get planted in schools. Students were motivated to keep some of the anti-pollutant plants at home. As far as science curriculum is concerned, activities as suggested by State SCERT and hands-on activities prepared under RAA programme by DSSTF measures were introduced in STCs.

Methods and Procedure

A list of upper primary STCs throughout the capital was procured. Willing science faculty members were identified who could cater to the subject needs of STC students as per locality. A list of STC, teachers, principals along with their contact numbers were also collected. A circular regarding provision of science kits for these STCs was put on the website. Principals and STC teachers were well informed about the DSSTF Investigator who was coming along with his topic. The STC teacher and lab assistant were timely informed to arrange material and apparatus concerned.

It was ascertained that the activity shown by the DSSTF member was practised by every student of STC. After every lesson, feedback was taken from all students and parents, on their hands-on activities, demonstrations and experiments by STC teacher. Video clippings of some of the classes were also prepared by STC teachers on their mobiles. The children were taken out of the classroom to school premises for actual study of scientific facts related to the class room topics. Some clippings in this regard were also designed which were later on shown to the students and parents in the community.

Results and Discussion

Though the time involved in the scientific activities was small because the project was started in late September but even in this short period the results were very encouraging. The students were over motivated about the subject than expected. The parents' response was also very positive. Some interviews of students with or without camera have shown that students of STCs were discussing classroom activities with their parents. In some cases teachers and principals of the school wanted that these activities performed by DSSTF members should also be repeated among regular students of Classes VI, VII and VIII.

The results have been discussed and shared among DSSTF members, with principals, staff and parents. All of them were given relevant suggestions also for capacity building of other teachers and students of the institution. In the discussion of stakeholders, it is concluded that these activities could be increased and STC students and STC teachers should create their own kits. DSSTF has taken note of it and

in the near future STC teachers and students were to be facilitated for preparing small science kits.

Conclusion

This project is gaining momentum and the working retired science teachers of DSSTF are of the view that this pilot project should be taken at the primary level also (from Classes I to V) for the age group (6-11) to create interest in science. Delhi science teachers forum has now taken this project as a mission. This project will run in all upper primary STCs of SSA in Delhi throughout the year. The convenience of the schools, STC teachers who are coming to teach will be kept in mind while deciding and finalising the schedule of science teaching in these special training centres. At present, the following upper primary STCs are functioning:

1. Government Co-ed SS Nangli Sakrawati, New Delhi (South West-B)
2. GSKV Peeraghari, New Delhi (West-B)
3. GSBV Bijwasan, New Delhi (South West-B)

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STUDY OF INDICATORS ON ACIDS AND BASES

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There is a paradigm shift in the traditional role of teachers as well as students in *Constructivist Science Classroom.* The teaching methods used in traditional classroom is based on objectivist view of knowledge which is grounded on the assumption that knowledge is objective, universal and complete and can be transferred from head of the teacher to the head of student. Whereas, in constructivist classroom, the role of teachers' shift from *transmitter* of knowledge to *facilitator* of knowledge. Hence, the role of students changes from *knowledge gainer* to *knowledge constructor.* By taking this approach forward, the same concept was taught in two sections of Class VII. One was considered as the control class of 34 students, where students were taught by chalk and board method and the other one as the constructivist class, where students learnt by doing experiments themselves. In control class the students were taught about the use of indicators on acids and bases by lecture method. They were taught that the colour of an acid and a base changes when an indicator was added. This was done by drawing a table on the blackboard. The definition of an indicator was taught and the students memorised it. In the other class, the teacher was like a facilitator. The class was divided into groups and the material, i.e., an acid, a base and indicators like china rose, phenolphthalein and turmeric was given in test tubes which were distributed to the students. Here the students performed hands-on experiment and saw the change in colour of an acid and a base by using various indicators. By doing hands-on experiments students were able to relate better with the concepts given in the book as the visual impact had a far much better impression.

Fussing with definition: Definition is an integral part of science, therefore, this strategy works beautifully in helping the students understand the key words involved in the definition and help them know it correctly without memorising it. The students were given key words related to the concept and they themselves came up with the definition of indicators. The students were able to evolve the definition themselves by using a constructivist strategy which is given above. When the students performed hands-on experiments the concept was understood very well and the impact was far better. The analytical data was also done which indicated that for every question asked the graph was much higher in the class where constructivist approach was used.

Key words: *Indicators; china rose; phenolphthalein; turmeric; fussing with definition.*

Introduction

"If you want to build a ship, then don't drum up men to gather wood, instead give orders and divide the work. Rather, teach them to yearn for the far and endless sea".

Antoine de Saint – Exupery

There is a growing body of evidence which demonstrates that students' learning of scientific concepts can be improved as a result of implementing research based teaching sequences. In this paper, some of the approaches taken to design and evaluate such sequences offer an alternative perspective which is based on the concept of learning demand and a social constructivist perspective on learning. A variety of teaching methods and their combinations have proved effective in the Constructivist Approach to Learning. One cannot single out a right instructional method for a particular lesson. Often within the same lesson, a particular method will flow into another. The selection of appropriate method/s varies with the students and their associate attributes. Various effective strategies recommended for the constructivist approach in facilitating

learning of science are: Graphic Organisers, Collaborative and Cooperative Learning, QASP, Fussing with the Definitions, etc.

Graphic organisers are valuable instructional tools, which convert complex and disorganised information into easily understood, meaningful displays. They help teachers and students organise ideas and concepts. They are flexible and endless in application. Using a graphic organiser, teachers can represent the entire overview of an issue or a problem and also a closer view of any aspect of it. Graphic organisers are of several types and their usefulness stretches across all disciplines and topics.

Another strategy used was 'Fussing with definition'. So, this strategy worked beautifully in helping the students understand the key words involved in the definition and help them know it correctly and sequentially without memorising it. So, in this paper, I have explained how various strategies used in constructivist approach helped students understand the concept and the teacher is rather not teaching but facilitating to understand a concept.

Material Used: Chalk and blackboard, test tubes, indicators like china rose, phenolphthalein and turmeric, acids, bases

Method and Procedure

1. In control class the students were taught about the use of indicators on acids and bases by lecture method. They were taught that the colour of an acid and a base changes when an indicator was added. This was done by drawing a table on the blackboard. The definition of an indicator was taught and the students memorised it, as shown in the picture below.

2. In the other class, the teacher was like a facilitator. The class was divided into groups and the material, i.e., an acid, a base and indicators like china rose, phenolphthalein and turmeric was given in test tubes which were distributed to the students. Here the students performed hands-on experiment and saw the change in colour of an acid and a base by using various indicators. By doing hands-on experiments students were able to relate better with the concepts given in the book as the visual impact had a far better impression, as shown in the picture.

3. *Fussing with definition*: Definition is an integral part of science. So this strategy works beautifully in helping the students understand the key words involved in the definition and help them know it correctly without memorising it.
4. The students were given key words related to the concept and they themselves came up with the definition of indicators. The students were able

to evolve the definition themselves by using a constructivist strategy which is given above.

Following questions were asked in the control class and the in the class where constructivist approach was used (Experimental Class), respectively.

Q1. What change will you observe if

(a) 'china rose' is added to an acid?

(b) 'phenolphthalein' is added to an acid?

(c) 'turmeric' is added to an acid?

Q2. What change will you observe if

(a) 'china rose' is added to a base?

(b) 'phenolphthalein' is added to a base?

(c) 'turmeric' is added to a base?

Q3. An indicator which is obtained from a flower gives pink colour, if added to a liquid. Is this liquid an acid or a base?

Q4. An indicator which is usually used in our kitchen for cooking gives red colour, if added to a liquid. Is this liquid an acid or a base?

Q5. Two test tubes 'X' and 'Y' filled with acid were taken and two different indicators namely 'A' and 'B' were added to the test tubes. 'A' was added to 'X' and 'B' was added to 'Y'. It was found that there is no change in the colour. Which indicator do you think is added? Identify the two indicators.

Q.6. State the definition of an acid.

Q7. State the definition of a base.

Q8. State the definition of an indicator.

Results and Discussion

Table 1

Number of students who answered correctly in both the classes is shown in the table

S. No.	Control Class (Total students 36)		Experimental Class (Total students 36)	
	Number of students participated	% of students	Number of students participated	% of students
1 (a)	25	69	35	97.22
1 (b)	28	77.7	34	94.44
1 (c)	30	83.3	34	94.44
2 (a)	30	83.3	35	97.22
2 (b)	26	72.22	35	97.22
2 (c)	28	77.78	34	94.44
3	15	41.67	30	83.33
4	12	33.33	32	88.89

5	8	22.22	30	83.33
6	25	69.44	36	100.00
7	28	77.78	36	100.00
8	29	80.56	35	97.22

The table above, clearly indicates the responses from the students. The responses were more accurate in the experimental class as compared to the control class.

Conclusion

When the students performed hands-on experiments the concept was understood very well and the impact was far better. It helped the students in developing a positive change, build scientific attitude ad provide a natural way of learning. The analytical data was also done which indicated that for every question asked the graph was much higher in the class where constructivist approach was used.

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PERIODIC TABLE AS A CONSTRUCTIVIST MODEL OF TEACHING-LEARNING AT THE SECONDARY LEVEL

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The article demonstrates the use of periodic table as constructivist model of teaching-learning to understand the periodic trends among the elements. The focus of the activity is to shift the passive learner from rote memorisation and facilitates them to construct their own understanding of the fundamental concepts such as electronic configuration, atomicity and valency of elements, charges on the ion, recalling the atomic number of elements, etc.

Key words: *Constructivist pedagogy; periodic table*

Introduction

Constructivist teaching is based on the constructivism theory of learning that enhances the active learning of students by creating their own meaning through experiencing things and reflecting on those experiences, instead of receiving knowledge passively through lectures and memorisation [Tan, 2004]. Constructivist teaching uses guided discovery, discussions on thoughts and ideas as well as activities to help students, learning. Using constructivist approach, the teacher fulfils the role of a facilitator to students creating experiences, providing hands-on environment and helps students to better relate the information learned in the classroom to their daily life activities [Huang, 2006 and Mustafa, 2008].

Science is an enterprise of inquiry, knowledge acquisition and exploration. The principal goal of science education is to develop creative and innovative thinking, to inculcate problem solving skills and to acquire understanding of scientific concepts among students. The *National Curriculum Framework-2005* has placed special stress on science education keeping in view its inherent nature. It has emphasised inculcation of learning principles of science through daily life activities and working with hands-on activities and experiments without diluting the conceptual understanding at any stage. It is learner centred rather than teacher centred and promoted teacher as facilitator to inculcate curiosity and creativity among the students to transact the science content effectively through constructivist approach.

Result and Discussion

The learning of chemical elements and their symbols has always been a boring task for students. First, it requires memorisation of a list of over one hundred names and symbols. Secondly, although the learning of the chemical elements and their periodical classification is an important part of the high school chemistry programmes, a practical application for this list of not so well-known terms is not readily found by pupils in their

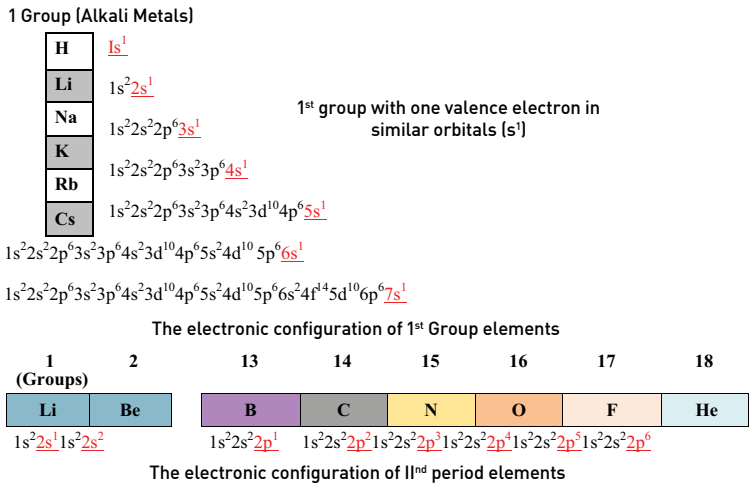
daily life. The periodic system of the elements is a fundamental knowledge at school and for that reason, the students from secondary education should learn the names and chemical symbols of the most important elements [Kathleen, et, al., 2012 and Carla, et al., 2014]. The different teaching methods other than memorisation are not often used in order to learn names and chemical symbols. In this way, educational strategies to help learners in this topic as a historical approach or the use of games have been an area of research nowadays.

The common difficulties among the secondary students are in the understanding of the basic concepts of elements, molecules, compounds, mixtures, atoms and sub-atomic particles and their further application in chemical reactions, stoichiometric relationships, periodicity of elements and transformation of one substance into another. The poor understanding of the fundamental concepts of elemental chemistry has led to the problems in the conceptual learning of related concepts. The difficulties regarding the valency of elements or charges on the ion, recalling the atomic number of elements, writing chemical formula and electronic configuration of elements can be solved by using periodic table as constructivist model of facilitating concepts. To improve the conceptual understanding in elemental chemistry the periodic table has been used as a constructivist model. The elements may be arranged in the periodic manner on the basis of their increasing atomic number, in various periods (rows) and groups (columns) as in the periodic table (excluding the transition elements) and once the elements were arranged, their difficulties can be easily overcome by studying in the constructivist way.

The following concepts may be facilitated.

1. Electronic Configuration and Valence Electrons

The electronic configuration of elements may be written by simply noting the position of element in the periodic table. Each group number of element represents similar orbitals with same valence electrons and the period number of element represents the



energy level for that row. For example Lithium, Li being the elements of first group will have only one valence electron in the last shell, i.e., S^1 and will have the principal quantum number 2 as placed in second period of periodic table. Therefore, the last shell electronic configuration will be $2S^1$

2. Atomic Number of Elements

The atomic number of any element may be predicted by locating its position in the periodic table. While moving from one period to another, the atomic number increases in a particular aspect ratio, i.e.

- From period II to period III: the atomic number increases by a factor of 8.
- From period III to period IV: the atomic number increases by a factor of 8.
- From period IV to period V: the atomic number increases by a factor of 18.
- From period V to period VI: the atomic number increases by a factor of 18 (Except for p-Block elements)

For example, if one wants to predict the atomic number of element iodine (Symbol I). After finding the position of iodine in the periodic table one could predict the atomic number 53, as the iodine is in the 17 group and V period of the periodic table. Therefore, 8+8+18 will be added to the atomic number of fluorine, i.e., 9.

3. Ionic charges on elements, atomicity of elements and writing of chemical formula

The common ionic charges of particular elements can be found out looking its position in particular period of periodic table. For example, elements of Group 1 like Li, Na, K, Rb, Cs and Fr will possess +1 charge. All the elements of a particular group possess same ionic charge.

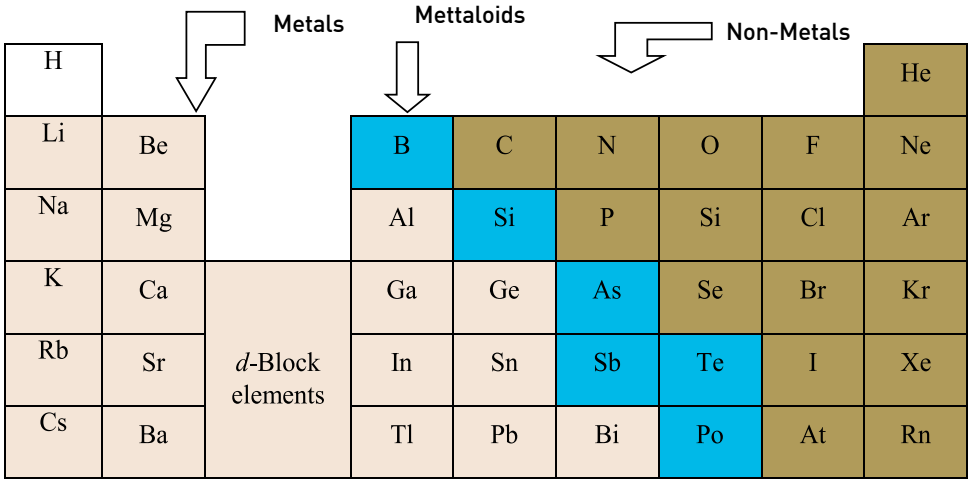
Group →	1	2		13	14	15	16	17	18
Period I	^{1}H								^{2}He
II	^{3}Li	^{4}Be		^{5}B	^{6}C	^{7}N	^{8}O	^{9}F	^{10}Ne
8 III	^{11}Na	^{12}Mg		^{13}Al	^{14}Si	^{15}P	^{16}Si	^{17}Cl	^{18}Ar
IV	^{19}K	^{20}Ca		^{31}Ga	^{32}Ge	^{33}As	^{34}Se	^{35}Br	^{36}Kr
18 V	^{37}Rb	^{38}Sr	*d*-Block	^{49}In	^{50}Sn	^{51}Sb	^{52}Te	^{53}I	^{54}Xe
VI	^{55}Cs	^{56}Ba	elements	^{81}Tl	^{82}Pb	^{83}Bi	^{84}Po	^{85}At	^{86}Rn

Group →	1	2		13	14	15	16	17	18
Charges →	+1	+2		+3		–3	–2	–1	0
	H^+								He
	Li^+	Be^{2+}		B^{3+}	C	N	O^{2-}	F^-	Ne
	Na^+	Mg^{2+}		Al^{3+}	Si	P	Si^{2-}	Cl^-	Ar
	K^+	Ca^{2+}		Ga^{3+}	Ge	As	Se^{2-}	Br^-	Kr
	Rb^+	Sr^{2+}	*d*-Block elements	In^{3+}	Sn	Sb	Te^{2-}	I^-	Xe
	Cs^+	Ba^{2+}		Tl^{3+}	Pb	Bi	Po	At^- ⇕ Diatomic	Rn ⇕ Monoatomic

The common difficulties in writing of chemical formula can also be resolved by looking into the charges of a particular ion

4. Identification of Metals, Metalloids and Non-metals among all the Elements

The metals and non-metals in the periodic table occupy a specific place and separated by a zigzag line. Remembering the position of any element in the periodic table one can identify them as metal, non-metal and metalloid.



Conclusion

The understanding of the basic concepts of elements, molecules, compounds, mixtures, atoms and sub-atomic particles and their further application in chemical reactions, stoichiometric relationships, periodicity of elements and transformation of one substance have been a difficult area for the secondary students. The memorisation based learning of students should be replaced by understanding the fundamentals to assimilate the knowledge. Therefore, taking it as prime concern, the present study was focused on facilitating concepts of science which are traditionally based on the memorising facts and theories and are not involved in the intellectual processes which resulted in the theories. The difficulties regarding the valency of elements or charges on the ion, recalling the atomic number of elements, writing chemical formula and electronic configuration of elements can be solved by using periodic table as a constructivist model of facilitating concepts. The exemplar approach will make the present approach suitable for transiting concepts at the secondary level.

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SCIENCE EDUCATION FOR SUSTAINABLE DEVELOPMENT: A THEORETICAL FRAMEWORK

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Sustainable development is an emerging need of present times. Sustainable development is the development that meets the needs of present without compromising the ability of future generations to meet their own needs. Man is always curious about the world surrounding him and science helps in this domain of knowledge. Science is a dynamic body of knowledge which involves many interconnected steps to solve any problem. Science is knowledge and knowledge is power; power is essential for sustainable development, so science education and sustainable development are interrelated with each other. Science helps people to acquire values, skills and knowledge necessary to build sustainable development. We can say that education for sustainable development is to renew education, teaching and learning and it also provides comfortable life to us. Science education can develop positive attitude towards science as a major factor in the society which leads to the path of sustainable development. For sustainable development there should be a balance between science and humanity, ecology, economy and prosperity and peace. This paper is intended to stimulate discussion about science education and its role in sustainable development. It also elaborates the science education in relation with sustainable development which helps to achieve the Millennium Development Goals (MDGs). It also discusses the challenges for sustainable development.

Key words: *Sustainable development, science education, science teaching.*

Introduction

Science is derived from the Latin word *scientia* which means what is to know, what a fact is—truth or certainty. Science is the bedrock upon which any nation can be built. This means that no country can be globally recognised without talking about its scientific advancements. According to Pember and Humbe (2009), science education is a process of teaching or training, especially in school, to improve one's knowledge about environment and to develop one's skill of systematic inquiry as well as natural attitudinal characteristics. Generally, science education has been recognised as a pre-requisite in technological development across the world. Science education consists of in-depth study of science and by means of which educational knowledge and concepts are learnt and verified. A country can never be globally recognised without giving due importance to its scientific advancements.

Science education identifies not only natural phenomena appropriate to child interest and skills but also equips teachers, learners and the society with knowledge, skills, equipment along with freedom to perform noble task useful for improving socio-economic standard. In addition to this Pember and Humbe elucidate that science education courses are designed to produce capable scientists who contribute meaningfully to academic excellence of the society which in turn can raise the economic level of nations. Sustainable development is directly related to science education as science education is the need of the hour and quite essential for the process of modernisation. It is an issue of

concern that generally the people who are not from science background do not understand it in its pure scientific terms but still they use science in their daily life directly or indirectly.

Sustainable development has been defined in many ways but the most familiar definition is given in the Brundtland Commission's report, Our Common Future (WCED, 1987): "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Sustainable development takes different forms in different societies and environments and is the process whereby societies realise that state of dynamic equilibrium termed sustainability (Reid, 1995).

The Millennium Development Goals (MDGs) were established following the Millennium Summit of the United Nations in 2000. The MDGs are eight international development goals for the year 2015 that follows the adoption of the United Nations Millennium Declaration. All 189 United Nations member states of that time and at least 22 international organisations, committed to help achieve the following MDGs by 2015:

1. Eradicate extreme poverty and hunger.
2. Achieve universal primary education.
3. Promote gender equality and empower women.
4. Reduce child mortality.
5. Improve Maternal Health.
6. Combat HIV/AIDS, malaria, and other diseases.
7. Ensure environmental sustainability.
8. Develop a global partnership for development.

The Millennium Development Goals are the world's time-bound and quantified targets for addressing poverty which helps in its many dimensions such as income, poverty, hunger, disease, lack of adequate shelter, and exclusion in different areas which also promotes gender equality, education, and environmental sustainability. They are also the basic human rights which can be directly elucidated as the rights of each person on the planet to health, education, shelter, and security.

Classroom example: Rain water harvesting is a concept that the students learn in science and which has an important role in sustainable development as it will help in future to conserve water for future generations.

Objectives

The objectives related to the present research article may be formulated as under:

1. To explore the theoretical concepts of science education and sustainable development.
2. To suggest some possible recommendations for channelising science education so that the goal of sustainable education can be attained.

Science Teacher and Teaching

Science is a subject which is directly related with the creativity and scientific attitude of students. So, science teaching should be innovative and arouse interest in students. The main qualities of science teacher should be as follows:

S - Scientific Attitude
C - Creative
I - Innovative
E - Energetic
N - Noble
C - Critical Thinker
E - Enthusiastic
T - Torch Bearer
E - Eager
A - Affectionate
C - Content Expert
H - Honest
E - Efficient
R - Reliable

The role of science teachers should be:

- The teachers should teach their students how to think in scientific ways.
- They should actively involve students in teaching-learning process.
- They should help students to develop a conceptual framework as well as to develop problem solving skills.
- They should promote student discussion and group activities.
- They should help students experience science in varied, interesting, and enjoyable ways.
- They should assess student understanding at frequent intervals throughout the learning process.

Use of science education in achieving sustainable development: The science education can be used in achieving sustainable development and can be discussed in the following points:

1. *By inculcating responsibility in citizens:* When the students are educated and well informed they can become responsible citizens and science education can help them in it as they can understand the scientific processes easily and can also become enlightened consumers. Science education can also create diligence and a sense of caution in them while leading their daily life.
2. *By building a strong economy:* Students who have a solid knowledge base of science can help in inculcating ideas, technologies and businesses that can stimulate the economy of a country. Better skills and training of the individuals for the career development can also be enhanced by building a strong base of economy.
3. *By giving emphasis to health globally:* Science education has paved the way for better physical and mental health. Modern scientific inventions and discoveries have led to find out the cure of many diseases and have increased the life-span of humans.
4. *By taking fruitful decisions:* Science explains the interaction and interdependency of nature with humans. It helps them in fostering the fruitful decisions which can help to create better future life.
5. *By giving utmost importance to scientific research and advancements:* Science education also provides the students with knowledge about research, reviewing, reporting, analysis, etc., which can in turn help in new inventions, discoveries and research.

Challenges for sustainable development in science education: Science teachers face numerous challenges while imparting education among students. Sustainable education in science can help students in creating awareness about environmental and educational needs.

1. *Teaching methodology:* Teaching methods help the teachers in presenting their lessons in a more concrete way. In fact, it is the methodology which makes a teacher professional and helps him/her in imparting knowledge fruitfully among the students. In the changing times, it is necessary for a teacher to devise new teaching methodology and change it according to the learning pace of the students.
2. *Lack of instructional materials:* Instructional materials are materials, facilities and equipment that emphasise, illustrate and explain lesson to the students for better understanding of the students. Some abstract concepts of science need instructional materials for better explanation and understanding by the students.
3. *Large class size:* Teacher-pupil ratio is a very big challenge for science educators and poses to be a problem for them.The Teacher becomes incapcitated to handle many students, which further increases the gap in the interaction between students and teachers.
4. *Remuneration and improved work conditions of science teachers:* It is necessary for the government to rehabilitate and improve the working conditions of science teachers to boost up their moral and standards. This could also be done by enhancing teacher's packages and special allowances.
5. *Lack of funds:* Funding is one of the major aspects for the success of research in any field. Lack of funds pose a threat to advanced research and quality of education gets affected which also demoralises the students as they are unable to carry out innovative research.
6. *Political instability:* Democracy is the sole criteria to suppress political instability in the country. Sustaining the democracy of a country also helps in consolidating the market economy, sustaining the confidence of the international investors in the economy of the country and strengthening its position as an emerging economy.

Recommendations: After the above discussion, we can give the following recommendations through which science education can help in achieving sustainable development:

1. Easily accessible and quality science education should be made accessible to all.
2. Both government and private sectors should join hands in making efforts and providing resources for developing the science education.
3. Proper research equipment and facilities should be provided to the research institutes so that they do not face any problem while conducting their research work.
4. The teachers should be paid well so that they can elicit best results according to their capabilities.
5. Modern learning aids such as computers, overhead projectors,

internet, etc., should be provided to develop better understanding of the science concepts.

Conclusion

Science can play a truly liberating role in any progressive society. It works for poverty eradication, skill development, conservation of nature, etc., which are key features of sustainable development. Sustainable development works in four dimensions, i.e., environment protection and preservation, sustainable economic growth and conservation of natural resources, poverty alleviation and to strengthen mutual knowledge. In the MDGs many issues are given importance but the issues related to education and sustainable development are the burning issues of humans for the coming era. If we analyse these two Millenium Development Goals (i.e., to achieve universal primary education and to ensure environmental sustainability) then we can understand that the one (education) is the medium to achieve the other (sustainable development). As far as we are concerned about the sustainable development then we can interpret that among all the streams of education, science education is directly related to sustainable development because science and environment are inter-connected.

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HANDS-ON ACTIVITIES VS MULTIMEDIA CONTENT IN SCIENCE IN DEVELOPING PRE-SERVICE TEACHERS' COMPETENCE

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This paper reports the finding of our study with the use of hands-on activities and multimedia science content in training of pre-service teacher trainees of elementary level. A pre- and post-test design was chosen for the study. Two groups of trainees formed the experimental group 1 (PTHA, N=39) and group 2 (PTMC, N=34). The experimental groups were oriented on some selected chemistry related content of NCERT science textbooks. The interventions were made by the first Investigator on second year trainees of District Institute of Education and Training of East and North East districts of Delhi. The pre- and post-test scores of both the groups were compared by subjecting the data with appropriate statistics. The analysis of data indicates that the post-test gain scores of both the experimental groups were improved. However, the group treated with hands-on activities showed a marked and significant improvement in their pedagogical content knowledge of the topics covered in the intervention.

Key words: *Hands-on activities, multimedia science content, pre-service teachers*

Introduction

The development and application of ICT has affected all aspects of human life and education is no exception. Thoman E. and Jolls T. (2004) have rightly pointed out that: "the convergence of media and technology in a global culture is changing the way we learn about the world and challenging the very foundations of education". Laurillard, D. (1993) in Taylor, J. (1997) stated that: "various educational media (print, audio, video, computers, etc.) can be compared and contrasted for the contribution they each make to supporting different aspects of teaching-learning process. Roschelle, et al., (2000; p. 79) have also explored the use of multimedia in education. Elliot, et al., (2014) affirm that "multimedia technology has transformed science learning ...radically different learning experiences ensued."

Barnett et al., (2005, p. 351) reported that Computer-based modelling tools "create exciting opportunities for students to create, manipulate, and interact with their own constructions, which in turn support them in developing understandings through their first-hand experience". Similarly, Kozma and Russell (2005, p. 411) argued for use of Multimedia Learning of Chemistry and they said that "in addition to allowing students to mirror the processes that scientists themselves engage in, these representations enable students to explore and discuss phenomena and objects that may otherwise be intangible, such as the molecular structure of a reagent". However, Roger (1991) advocated that "Properly designed educational MULTIMEDIA on Multimedia computers supports active participation and puts the student in control". Tony, et al., (2010) in their study found that "not only was

scripted collaborative multimedia ESCoM mapping more effective than the traditional teaching approach, it was also more efficient in requiring far less teacher guidance." The authors (Singh and Husain, 2015) have also reported the effectiveness of multimedia in enhancing the achievement of elementary level students.

As far as use of hands-on activities are concerned, all along these have been emphasised for all quality initiatives particularly in teaching-learning of science education ever since Piaget, the great educationist has also stressed the importance of learning by doing, especially in science. David and Peter (1994) argued that: "Teachers who embrace hands-on learning in science seem to recognise certain desirable outcomes and endorse student-centered instructional approaches." Brian J. Foley and Cameron McPhee (AERA 2008) have reported 'Students' Attitudes towards Science in Classes Using Hands-On or Textbook Based Curriculum.'

Several attempts are being made world over for improving the effectiveness of teachers' preparation. The use of ICT and multimedia in training of teachers, and hands-on activities have their own place in such endeavors. The present paper reports a comparative account of the two approaches in developing elementary teachers' competence.

Objective of the Study

1. To compare the two approaches—hands-on activities vs multimedia content in science in enhancing conceptual understanding and pedagogical skills of pre-service elementary teacher trainees.

Hypotheses 1 (H1): There is no significant difference in the level of competence of pre-service elementary teacher trainees trained through hands-on activities and multimedia science content.

Methods and Procedure

Material: For the intervention, multimedia science content developed by Dove Multimedia Pvt. Ltd., Mumbai, Tirumala Softwares, Delhi and CAL unit of Sarva Shiksha Abhiyan, Delhi, were procured and used for organising the teaching-learning of the selected topics /units. For the hands-on activities low-cost kits were developed and used while orienting the trainees.

Sample: The sample consisting of two groups of trainees were formed for the intervention from the DIETs located in District East and District North East of Delhi. Two groups of trainees formed the experimental group1 (PTHA , N=39) and group2 (PTMC, N=34).

Tools: The achievement test containing 35 items was developed in consultation with the practising teachers of sample schools. The test was administered as pre-test and post-test to the sample of trainees.

Procedure: After formation of two groups the pre-test was conducted followed by teaching sessions with both the groups. The selected topics were taught to the groups by hands-on activities, and by using multimedia content and also to a control group by the investigator himself. At the end of series of sessions the same tool was administered as post-test and scores were subjected to statistical treatment.

Result and Discussion

The performance of both the experimental groups (the one exposed to a set of hands-on activities and the other exposed to multimedia content) was also compared by analysing their mean scores obtained through pre- and post-test. The pre- and post-test data analysis are given in Tables 1 and 2, respectively.

P value and statistical significance (pre-test): The two-tailed P value equals 0.4978. By conventional criteria, this difference is considered to be not statistically significant. The t value (0.955) was also non-significant at all levels between .20 to.001 (two-tailed), which confirmed that the two groups were at par in the beginning of interventions.

Table 1

Pre-test data of both the experimental groups — hands-on activities and multimedia content

Statistics	Exp. Gp.1: PTHA (N = 39)	Exp. Gp.2: PTMC (N = 34)
Mean	16.97	16.32
SD	3.74	4.42
SEM	0.60	0.76
df	71	
t	t = 0.6814	
SED	0.955	
P value (two tailed)	0.4978	

Table 2

Post-test data of both the experimental groups

Statistics	Exp. Gp.1: PTHA (N = 39)	Exp. Gp.2: PTMC (N = 34)
Mean	23.15	19.03
SD	4.50	3.65
SEM	0.72	0.63
df	71	
t	t = 4.2615	
SED	0.968	
P value (two tailed)	←0.0001	

P value and statistical significance (post-test): The two-tailed P value is less than 0.0001. By conventional criteria, this difference is considered to be statistically significant. The t value (4.2615) is also highly significant at even at .001 level which confirms that difference in the achievement of both the groups as a result of intervention.

The performance of the group exposed to hands-on activities showed more enhancement than that of the group exposed to multimedia content during the course of the training. Thus, on the basis of this observation one can conclude that in comparison to the use of multimedia content, hands-on activities seems to be more effective in enhancing the conceptual understanding and competence of pre-service teacher trainees. The mean scores of both the groups as obtained through pre- and post-test are also presented in Fig. 1.

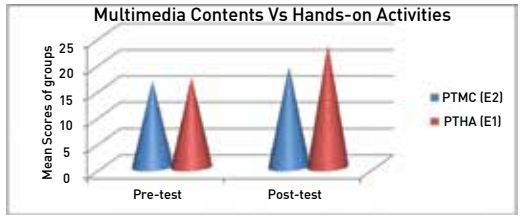

Fig. 1: Mean scores of both experimental groups on pre- and post-test

Comparison of performance of the three groups, Control group and both the experimental groups of Pre-service Teacher Trainees – (ANOVA)

In order to compare all the three groups (control Gp., Exp. Gp. 1 (PTHA) and Exp. Gp. 2. (PTMC), the Analysis of Variance (ANOVA) of the pre-test scores and post-test scores of the trainees was carried out and the statistical analysis is summarised in Tables 3 and 4, below.

Table 3

Analysis of variance of pre-test score of control and the treatment groups- ANOVA summary

Source	SS	df	MS	F	P
Treatment (between groups)	16.33	2	8.17	0.55	0.5785
Error (within groups)	1656.03	111	14.92		
Total	1672.36	113			

Tukey HSD test: This test is not applicable because the analysis of variance did not yield a significant F-ratio. The analysis of variance of the pre-test scores and the smaller F –ratio and higher p←0.5785, indicate that the performance level of all the three groups was similar, in the beginning of the treatment.

Table 4

Analysis of variance of post-test score of the three groups- ANOVA summary

Source	SS	df	MS	F	P
Treatment (between groups)	463.77	2	231.88	13.88	←.0001
Error (within groups)	1854.49	111	16.71		
Total	2318.2544	113			

Tukey HSD Test

HSD [.05]=2.24; HSD [.01]=2.8

M1 vs M2	P<.01
M1 vs M3	non significant
M2 vs M3	P<.01

M1= Mean of Sample 1-Control (TLM); M2= Mean of Sample 2- Exp. Gp. 1 (PTHA); and M3= Mean of Sample 3- Exp. Gp. 2 (PTMC)

HSD = the absolute [unsigned] difference between any two sample means required for significance at the designated level.

HSD [.05] for the .05 level; HSD [.01] for the .01 level. (http://vassarstats.net/anova1u.html)

The analysis of variance also confirmed the effectiveness of teaching through hands-on activities (PTHA) over the teaching through lecture method (PTLM) and teaching through multimedia content (PTMC). The analysis of variance of the post-test scores and the larger F –ratio and P<.0001, indicate that the three groups showed marked difference after treatment which could be attributed to the effectiveness of the treatments.

On the basis of analysis of data as presented in Tables 1,2,3 and 4, Hypotheses1 (H1.: There is no significant difference in the level of competence of pre-service elementary teacher trainees trained through hands-on activities and multimedia science content) is rejected. The statistical results suggest that use of hands-on activities in training and development of teachers is more effective than the lecture method or multimedia method. Thus this methodology of using hands-on activities could bring a significant difference in the competence of pre-service teacher trainees.

Conclusion

On comparing the effectiveness of hands-on activities and multimedia science content with traditional method of training of pre-service elementary teacher trainees, it has been observed that the performance of the group exposed to hands-on activities showed greater enhancement than that of the group exposed to multimedia content during the course of the training. Thus, on the basis of this observation one can conclude that in comparison to the use of multimedia content, hands-on activities seem to be more effective in enhancing the conceptual understanding and competence of pre-service teacher trainees. The analysis of variance also confirmed the effectiveness of teaching through hands-on activities (THA) over the teaching through traditional method (TTM) and teaching through multimedia content (TMC). The analysis of variance of the post-test scores and the larger F –ratio and P<.0001, indicate that the three groups showed marked difference after treatment which could be attributed to the effectiveness of the treatments.

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SUSTAINABLE PRACTICE OF KNOWING MEDICINAL PLANTS THROUGH ENVIRONMENTAL EDUCATION THEME PARK AT RIE, AJMER

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Medicinal plants belong to the earliest known health care products that have been used by mankind. In India, the earliest reference to the medicinal value of plants is found in *Rig-Veda*, in which a brief reference to the healing property of plants has been made. Most of the drug plants are found in the tropics growing in wild condition and are mainly used by Ayurvedic doctors, who refer to them as *Jari-Butis*. We observe that in the absence of proper knowledge related to the identification of medicinal plants, many plants remained either unidentified or wrongly identified. As a result, many important and precious medicinal plants are often considered as weeds and disposed off as waste. Wrong identification even lead towards more serious repercussions as they may be used wrongly in preparing medicines for which they are not recommended. In this paper, an attempt has been made to fill the above identified gaps. Medicinal plants like arborea with locally available medicinal plants will be very useful for Ayurvedic experts, teachers, students and scientists.

Key words: *Medicinal plants, sustainable development, Jari-Butis.*

Introduction

Medicinal plants belong to the earliest known health care products that have been used by the mankind. In India, the earliest reference to the medicinal value of plant is found in *Rig-Veda*, in which a brief reference to the healing property of plants has been made. Most of the medicinal plants are found in the tropics growing in wild condition and are mainly used by Ayurvedic doctors, who refer to them as *Jari-butis*.

The study of Indian medicinal plants was first started in the early part of the century by many researchers. Prominent amongst them were Dastur (1962). Maheshwari and Singh (1965), Jain (1968), Atal and Kapoor (1977), Kirtikar and Basu (1935), etc. In the present paper we try to domesticate, introduce 20 medicinal plants used by the people of Rajasthan in medicinal plant arborea of EE Theme Park which in future will be useful for gathering sustainable knowledge of medicinal plants. Singh and Pandey (1998) and Joshi (1995) have, however, provided comprehensive data on the ethno botany of Rajasthan covering different aspects, including ethno medicines.

Methods and Procedure

The present study is based on the material and information gathered with the help of

two local communities, *Kaviraj* and *Vaidas*. Plantation materials collected carefully and planted season wise. Proper signage board maintained for each plant is helpful for students and researchers for identification.

Result and Discussions

Out of the 20 plants having medicinal importance, the description of only eight plants is given in Table 1.

Table 1

Description of the selected medicinal plants

S. No.	Common Name	Botanical Name	Family	Description
1.	*Madar/Aak*	*Calotropis procera*	*Asclepiadaceae*	The milky juice of the stem is used in leprosy, taenia, dropsy, rheumatism, etc. It is also used in typhus and syphilis. The dried latex is antispasmodic and an efficient nerve tonic. The latex also bears the properties of curing ringworm of scalp and relieving toothache.
2.	*Neem*	*Azadirachta indica*	*Maliaceae*	Juice of leaves with honey or salt cures jaundice and intestinal worms. Decoction of fresh leaves is used in malarial fevers. External application of leaf-paste cures boils, ulcers, skin eruptions swellings and wounds. Mixed with camphor, the leaf juice is applied to fractures. Warm decoction of leaves is used as douche after childbirth.
3.	*Ashvagandha/ Asgand*	*Withania somnifera*	*Solanaceae*	The roots of this plant have been recommended for high cough and in female genetic disorder. It is also useful in all types of skin lesions, ulcers and in reducing pus formation. It is an important drug in the treatment of rheumatic pain, inflammation of joints and certain paralytic conditions. It is also known to stimulate sex impulses and improve sperms.

4.	Sandal wood/ *Safed chandan*	*Santalum album*	*Santalaceae*	The tree is a sedative and bears cooling effects. It is given to relieve thirst and with milk in gonorrhoea and bilious disorders. Mixed with rice and honey, it relieves dysentery and excessive thirst. The paste bears cooling effects and cures boils, sores and skin eruptions. The application of paste in also relieves headache.
5.	Datura/ *Dhatoora*	*Datura stramonium*	*Solanaceae*	Dried leaves of Datura smoked in pipes cure asthma, whooping cough and bronchitis. Juice of leaves with curd is given in gonorrhea. A paste of leaves is a cure for swollen joints, inflammations and tumors. Fresh leaf juice is also used in mumps and gouts. Roasted leaves cure enlargement of testicles.
6.	Curry leaves/ *Mithaneem*	*Murraya koenigii*	*Rutaceae*	They are much valued as an anti diabetic, antioxidant, anti microbial; anti-inflammatory and hepato protective. They also contain iron. Although most commonly used in curries, leaves from the curry tree can be used in many other dishes to add flavor.
7.	Mint/*Pudina*	*Menthea mentha*	*Lamiaceae*	It was originally used as a medicinal herb to treat stomachache and chest pains. Powdered mint leaves were used to whiten teeth. Mint tea is a strong diuretic. Menthol from mint essential oil (40%- 90%) is an ingredient of many cosmetics and some perfumes. Mint oil is also used as an environment friendly insecticide for its ability to kill some common pests like wasp, hornets, ants and cockroaches.
8.	Indian gooseberry/ *Amla*	*Emblica officinalis*	*Euphorbiaceae*	The fruits are richest source of vitamin C and are considered to be a good liver tonic. The fruit is useful in the treatment of hemorrhage, leucorrhoea, menorrhagia, diarrhea, toothache, sores, fever, anemia, epilepsy, pimples, fistula, gonorrhea and dysentery. The leaves are a cerebral and gastrointestinal tonic. The root bark is astringent and is useful in ulcer.

Conclusion

We observe that in the absence of proper knowledge related to the identification of medicinal plants, many plants remained either unidentified or wrongly identified. As a result, many important and precious medicinal plants are often considered as weeds and disposed off as waste material. Wrong identification can lead towards more serious repercussions as they may be used incorrectly in preparing medicines for which they are not recommended. In this paper, an attempt has been made to fill the above identified gaps. This type of medicinal plant arborea with locally available medicinal plants will be of immense use to Ayurvedic experts, teachers, students and scientists.

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LIQUID HYDROCARBON FUEL COLLECTED FROM WASTE PLASTIC BY USING $CUCO_3$ CATALYST

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Plastics have many properties like light weight, high durability, so demands increase in every sector. Plastics include carbon, hydrogen, nitrogen, oxygen, sulfur and halogen atoms. The main thing which makes plastics waste valuable is longer carbon chains than those in gasoline and diesel fuels. Therefore, it is possible to convert waste plastic into liquid hydrocarbon fuels. This research paper aims to solve the twin problem of environment pollution due to plastics and the need for an alternative liquid hydrocarbon fuel source. Pyrolysis of the waste plastic bag (hdpe) was carried out with catalysts. The collected liquid hydrocarbon fuels were characterised by FT-IR spectroscope, NMR spectroscope and conversion was very good.

Key words: *Pyrolysis, liquid hydrocarbons green fuel, catalysts, conversion, glass reactor*

Introduction

In daily life, polymer products are used for different plastics which consist of low density polyethylene (ldpe), high density polyethylene (hdpe), polyvinyl chloride (pvc), polypropylene (pp), polystyrene (ps), polyamides (pa), polyethylene terephthalate (ptet), bakelite, dacron, and natural rubbers. Similarly, synthetic rubbers consist of neoprene rubber, styrene rubber, nitrile rubber, butyl rubber, polysulphide rubber, polyurethane rubber, etc. Due to its lightweight, high durability, sustainability and a faster rate of production and design flexibility demands for plastics have increased in every sector[1-2]. Since 1950, the plastic production also increased on an average to 10 per cent every year around the globe[3]. Plastic production growth of 2006, 2007 was around 1.3-245 million tonnes[4-5]. In India, during 1998 around 800,000 tonnes representing 60 per cent of plastics wastes generated in India were recycled involving 2000 units. This recycle rate is the highest in the world[6]. The plastic consumption worldwide was around 150 million tonnes in the year 2000. It is estimated to be around 258 million tonnes in 2010[7]. The plastic industries are making a significant contribution to the economic development and the growth of various key sectors in the country, such as automotive, construction, electronics, healthcare, textiles, and FMCG, etc. Its demand is rapidly growing at ~10 per cent CAGR to reach 10 MnTPA by FY13. Further India observes a significant regional diversity of the consumption of plastics, in western India its consumption is 47 per cent, in Northern India, it is 23 per cent, and in Southern India it is 21 per cent. The bulk of the consumption of Northern India is from end-use industries of auto, electronic appliances packaging (including bulk packaging), plasticulture applications, etc., which are concentrated mostly in UP and Delhi-NCR →50 per cent[8]. Increase in

the economic growth rate is unsustainable without the saving of fuel energy like hydrocarbons[9]. High durability causes great threat to the environment system and it results from landfill release of toxic gasses like CO, CO_2, SO_2, NOx and contributes to the global warming, acidic rain, and depletion of ozone layer. Leaching of chemicals cause the emission of CO, CO_2 and pollutes the environment. Polymers release flue gases after burning[10-19]. Further, the dumped polymers also cause risk of the environment, human health and public amenities[20]. The research paper exhibits concentrating on polymer practical, its formation and conversion into hydrocarbon as it will serve to present chemistry in a way which is both entertaining and educational to the students.

Materials and Method

Waste plastic bags were collected from the local markets. Collected waste plastic bags were washed with liquid soap and then dried in the sunlight. Dried waste plastic bags were cut into small pieces using grinder machine. These grounded wastes were placed into the glass reactor.

The dried waste plastic bags with $CuCO_3$ catalyst material were placed into a round shaped glass reactor. Then the round shaped glass reactor was put into an insulated furnace which protected the loss of heat and gave heat. Then the glass reactor was put inside the furnace. Further, a condenser unit was set up with the reactor and the other end with the fuel collection device. The furnace also had a temperature controller. Then the temperature was increased slowly. Inside the glass reactor, the solid waste plastic was converted into vapors and then passed through a glass pipe to a condenser and distillate and then liquid hydrocarbon is collected.

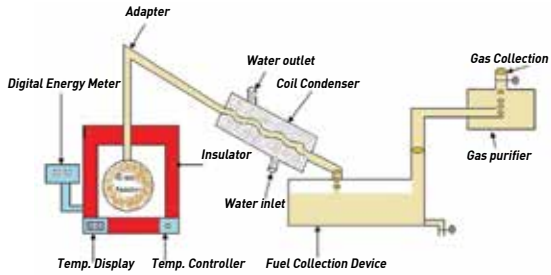

Fig. 1. Waste plastic bag into liquid hydrocarbons production process diagram

Result and Discussions

Liquid hydrocarbon fuel analysis: FT-IR analysis of liquid hydrocarbon fuel (Figure 2 and Table 1) according to their wave numbers and spectrum band following types of functional groups were appeared in the analysis. We noticed that in the spectrum field wave numbers 2921.91 cm^{-1} and 2855.42 cm^{-1} functional group is C-CH^3, wave number 1642.50 cm^{-1} functional group is conjugated, wave numbers 1458.21 cm^{-1} and 1374.87 cm^{-1} functional group is CH_3, wave number 992.41 cm^{-1} and 908.21 cm^{-1} functional group is -CH=CH, wave number 724.55 cm^{-1} functional group is -CH=CH-(cis).

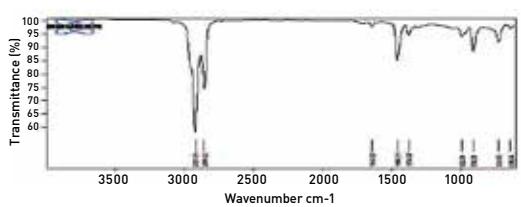

Fig. 2. FT-IR Spectrum of waste plastic bag into liquid hydrocarbons

Table 1

FT-IR spectrums waste plastic bags into liquid hydrocarbons functional group name

Number of Peak	Wave Numbers (cm^{-1})	Functional Group Name
1	2921.91	C-CH_3
2	2855.42	C-CH_3
3	1642.50	Conjugated
4	1458.21	CH_3
5	1374.87	CH_3
6	992.41	-CH=CH
7	908.21	-CH=CH
8	724.55	-CH=CH-(cis)
9	638.04	

TGA shows that the waste plastic bag was placed in quartz crucible for thermo-gravimetric analysis. The waste plastic bag degrades to 500 °C temperatures without any catalyst but in the presence of $CuCO_3$ catalyst it degrades to 390 °C temperatures. 13CNMR shows that more peaks due to mixture of different types of hydrocarbons.

Fig. 1. Collected liquid hydrocarbon fuel from waste plastic

Conclusion

In the present investigation the successful catalytic pyrolysis conversion of waste plastic bag was studied. Under this experimental condition, a waste plastic bag was degraded in the presence of $CuCO_3$ catalyst which resulted in fraction. The collected liquid hydrocarbon fuel was analysed by FT-IR, 13CNMR and 1HNMR. Analysis result indicates that mainly lots of hydrocarbons, long straight chains break down into shorter hydrocarbon chain by using pyrolysis conversion process. Applications of gaseous and solid residue for use as fuel or as a source of chemical were also obtained. Liquid hydrocarbon fuel has a high flammable capacity and its contents are highly combustible.

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SCIENCE EDUCATION AND SUSTAINABLE DEVELOPMENT

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Often people think that the problems which pertain to the environmental issues such as climate change, global warming, ozone depletion, different type pollutions, deforestation, biodiversity loss are to be solved by government or scientists of the world. However, we need to realise that these issues are emerging due to the activities and exploitation of natural resources by the human being. Thus each of us is involved in creating or enhancing these problems as part of the problems. The time has come to take necessary measures to save our future. We should understand the reasons and factors that are responsible for these issues. This paper critically analyses the factors causing environmental issues— imbalance, disturbance like climate change, global warming, ozone depletion, different types of pollutions, biodiversity loss, etc.

Key words: *Science education, sustainable development, environmental issues*

Introduction

Our environment is getting disturbed adversely by the human activities including rapid growth of industries and depletion of the natural resources. For the sustainable development of our environment only science education can provide the crucial solution to address the environmental issues and concerns. For this our target age group should be 5 to 30 years representing the young population of the country. The target population should be oriented in such way that they are aware about the problems which are emerging day by day, such as, high population, biodiversity loss, global warming, ozone depletion and different types of pollutions. The target population can understand and correlate the issues by science education and they may adopt alternatives and make efforts to reduce factors which cause all the problems.

Let us check the data presented in the following tables.

Table 1

Population Growth of India per Decade

Census Year	Population	Change (%)
1951	361,088,000	–
1961	439,235,000	21.6
1971	548,160,000	24.8
1981	683,329,000	24.7
1991	846,387,888	23.9
2001	1,028,737,436	21.5
2011	1,210,726,932	17.7

Source: Hosamane and Desai (2013)

As evident from the above data, the population is growing alarmingly in India and it is causing a lot of environmental issues such as; deforestation; drinking water crises; urbanisation; waste management; excess use of fossil fuel; climate change; Loss of biodiversity; and global warming.

The biodiversity status of India as in 2009 is presented in Table 2 below.

Table 2

Biodiversity Status of India

Group	Estimated number of species	Rank amongst mega diverse countries
Higher plants	18664	IX
Mammals	390	VII
Birds	458	IX
Reptiles	521	V
Amphibians	231	IX
Fish	5749	I

Source: *India's Fourth National Report to the Conservation on Biological Diversity (2009)*

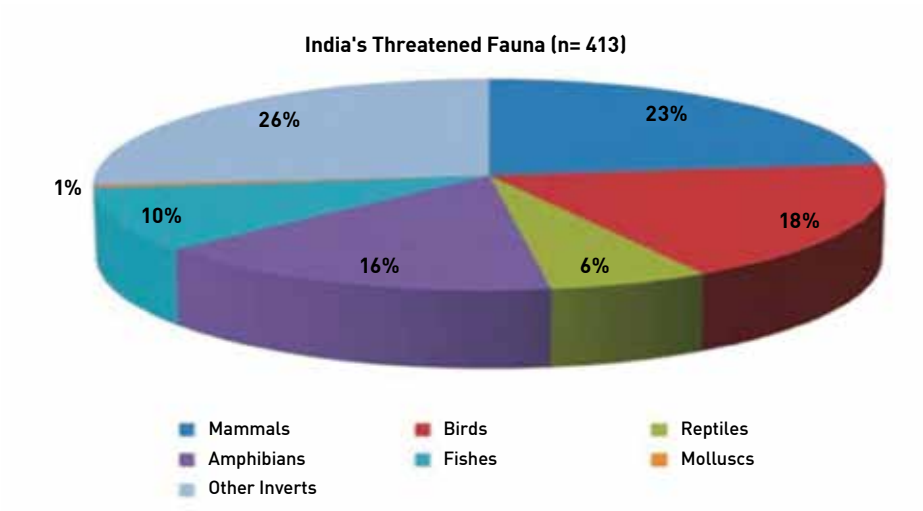

Fig. 1. India's Threatened Fauna

Dicliptera abuensis

Indian Vulture

Great Indian Bustard

One Horned Rhinoceros

Fig. 2. Some of the endangered species in India

Pollution—a serious concern: With rapid growth of population, industrialisation and other changes in life style of people the quality of air is deteriorated and it has reached at dangerous levels in some of the cities like Delhi. Table 3, presents the pollution level classification of air.

Table 3

National Ambient Air Quality Standard (NAAQS)–Pollution Level Classification

Pollution level	Annual Mean Concentration Range (ug/m^3)					
	Industrial, Residential, Rural and other areas			Ecologically Sensitive Area		
	SO_2	NO_2	RSPM	SO_2	NO_2	RSPM
Low	0-25	0-20	0-30	0-10	0-15	0-30
Moderate	26-50	21-40	31-60	11-20	16-30	31-60
High	51-75	41-60	61-90	21-30	31-45	61-90
Critical	→75	→60	→90	→30	→45	→90

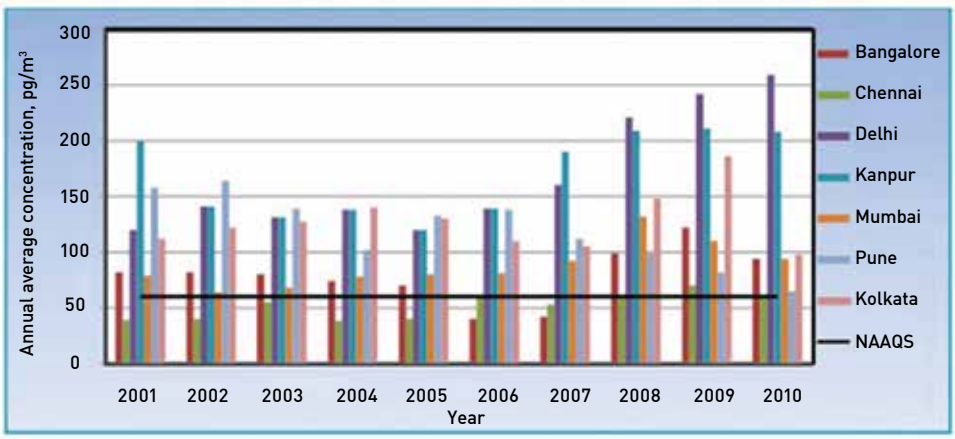

Fig. 3. Concentration of RSPM in residential and industrial areas in major cities

Discussion

- The National Capital Territory of Delhi is concerned with air pollution and public health. The pollution issue of Delhi has been in focus among the national as well as international media.
- Organisations like Centre for Science and Environment (CSE) and Indian Council of Medical Science (ICMR) have given data for air pollution. The report said air pollution is coming out as one of the key sources of growing diseases among the people in Delhi.
- The main sources of air pollution are dust, soot, fly ash, diesel exhaust particles, and gases like nitrogen dioxide, sulphur dioxide, etc.
- The people of the national capital have suffered so many problems like asthma, burning in eyes, inflammation of mucus membranes and skin. The problems are day by day increasing. In recent years due to high pollution and fog the government had to close public as well as private schools.
- The temperature of our environment is continuously increasing and the weather has become unpredictable nowadays. The concentration of green house gases in the environment has been increased, that is why the temperature of our environment is increasing.
- In most of our big cities, the temperature has crossed over 40°C. Phalodi and Churu in Rajasthan had recorded a maximum temperature above 50°C. Figure 4 presents the temperature of some places in India on 25 May 2016 at 03:43 PM.

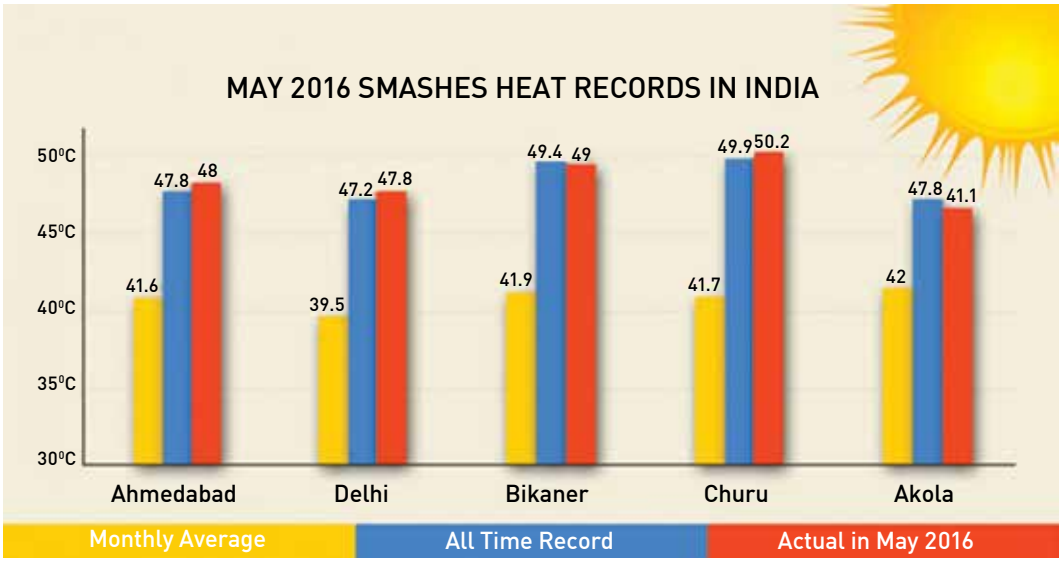

Fig. 4. Temperature recorded on 25 May 2016 at Ahmedabad, Delhi, etc.
accessed from ©Skymet Weather Sciences Pvt. Ltd. 2016

Importance of ozone layer: The ozone layer of the atmosphere is found approximately 15 to 40 km above earth. It absorbs harmful ultra violet rays of sun that can damage the genetic materials in living cells . Hence ozone layer acts as an umbrella of the earth.

Conclusion

To overcome these problems, our education policies should be such that we create an environmentally conscious society by inculcating the scientific temperament among children. This paper presents an overview of the emerging scenario and the critical observations and comments on the various data collected by the environmental and scientific organisations. An effort has also been made to correlate the data with the health related problems in human beings. It is also recommended that the data, its interpretation and discussion should be included in the course curriculum of science at the school level so that scientifically informed and environmentally conscious future citizens are developed in schools. Such an effort will be helpful in understanding the science for sustainable development.

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ORIENTING SENIOR SECONDARY PHYSICS STUDENTS, ABOUT MEASURING CONDUCTIVITY OF A NEW MATERIAL AND ITS APPLICATIONS

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Plasticizer (Propylene Carbonate, PC) is enhancing the conductivity of a polymer electrolyte PEO: NH_4ClO_4 (85:15 wt %) prepared by solution cast method. Preliminary IR and XRD studies suggested that the above said polymer electrolyte is a result of complexation of polymer PEO and salt NH_4ClO_4. Two types of charge carriers are shown to be present in this polymer electrolyte by using transient ionic current measurements. The ionic conductivity of the polymer electrolyte with different amounts of plasticizer PC has been measured by Impedance Spectroscopy and it is shown that the maximum conductivity occurs for 5 wt% of PC which is 10-4 S.cm-1 (approximately 10 times higher than the conductivity of polymeric membrane without PC). The plasticised stable film has been used as an electrolyte in fabrication of a rechargeable polymeric solid state proton battery. The fabricated polymeric re-chargeable batteries uses PEO: NH_4ClO_4 (85:15 wt %) + PC 5wt % as the electrolytes with $Zn+ZnSO_4.7H_2O+MHx$ as anode and intercalating layered cathode material (PbO2+V2O5). The discharge characteristics have been studied at different loads. It is found that the addition of metal hydride (as hydrogen supplying anode) improves the time of stable performance, current drain and rechargeability as it ensures a continuous supply of H+ ions. It may be remarked that the use of H+ intercalating/de-intercalating layered material cathode (viz. $(PbO_2+V_2O_5)$ is essentially responsible for the rechargeability of the cells over many cycles.

Key word: *Polymeric proton battery; polymer electrolyte*

Introduction

The interest in the important ion conducting solid polymer electrolytes (or polymer-salt complexes) began after the pioneering studies of materials based on alkali salts complexed with polyethylene oxide (PEO) reported first by Fenton, et al., 1973; Wright, 1975 and Armand, et al., 1978; 1979. Polyethylene oxide (PEO) in particular is an exceptional polymer which dissolves high concentrations of a wide variety of salts to form polymer electrolytes (Armand, 1987). In such polymer complexes, the cations of the salts coordinate with the hetero-atom (polar group) of the polymer (such as oxygen, in the case of (PEO) as follows:

$$—(CH_2\text{-}CH_2\text{-}O)_{-n} + MX \rightarrow -(CH_2\text{-}CH_2\text{-}O).MX- \quad (1)$$

Polymer Salt Polymer Complex

Proton transport in polyethylene oxide complexed with NH_4ClO_4 has been earlier studied by Hashmi, et al., 1990. They found that polymer complex having configuration PEO:NH_4ClO_4::85:15 wt% possesses maximum conductivity ~ 10^{-5} S.cm^{-1} which is nearly 4 decades higher than pure PEO. They also observed that apart from H+, the anions (i.e., ClO_4^-) are also mobile in the bulk material.

The present study is also related with PEO:NH_4ClO_4 (85:15 wt%) polymer complex with the aim of further enhancing its

conductivity by adding suitable plasticiser which is expected to amorphicise the lattice. This polymer complex of appropriate composition has been prepared by us by solution cast method which has ~ 10^{-5} S.cm^{-1} at room temperature. Complexation has been confirmed by IR and XRD studies. Two types of charge carriers are present in the bulk material. This has been confirmed by transient ionic current measurements. Dependence of it's conducting with temperature has also been studied. As pointed out earlier, in an effort to enhance its conductivity at room temperature for device purposes, we added plasticizer, propylene carbonate (PC) to it. The added wt% of plasticizer has been optimised to get maximum conductivity ~ 10^{-4} S.cm^{-1} which is approximately 10 times higher than the conductivity of polymeric membrane without PC. The plasticised stable film has been used as an electrolyte in fabrication of a re-chargeable solid state proton battery.

Methods and Procedure

Material Preparation

Polymer Complex: Polymer complex film of composition PEO:NH_4ClO_4 (85:15 wt%) was prepared by using high molecular weight polyethylene oxide (PEO) (Aldrich, MW = 5x106) and NH_4ClO_4 (VEB Laborchemie Apolda, Germany) by solution casting technique using methanol as solvent. Solutions of weighed amounts of PEO and NH_4ClO_4 were prepared in methanol. These solutions were mixed and stirred for 5 hours. The resulting viscous solution was poured into petri-dishes. After ambient drying for 2-3 days a thin polymer film or membrane was obtained. This was further vacuum (10-4 Torr) dried to eliminate remaining methanol.

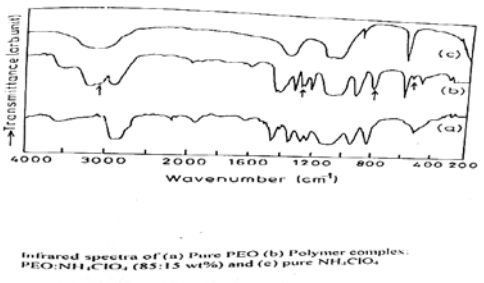
Plasticised polymer complex: The required amounts of plasticiser propylene carbonate and above prepared polymer complex electrolyte were put together and dissolved in methanol to get a clear solution. It was well stirred to get a viscous solution. This solution was poured into petri dishes and dried as above for few days in ambient and in vacuum to get thin plasticized polymer electrolyte films having composition [PEO:NH_4ClO_4 85:15 wt%] + 5 wt% PC and 10 wt% PC. For higher PC content, stable films could not be obtained as the material was becoming soggy.

Results and Discussion

Structural Studies

Infrared spectroscopy: The infrared spectra of (a) pure PEO, (b) polymer complex: PEO:NH_4ClO_4 (85:15 wt%) and (c) pure NH_4ClO_4 .

A comparison shows that the IR spectrum of the complex material is different than the spectra of constituent materials PEO and NH_4ClO_4. Some new peaks (marked by) appear in the new complex spectrum. Appearance of these peaks proves with complexation occurs between PEO and NH_4ClO_4 to yield the polymer electrolyte.

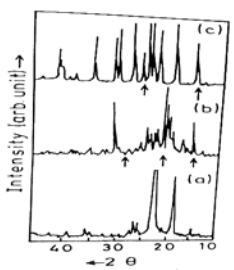


Infrared spectra of (a) Pure PEO (b) Polymer complex: PEO:NH_4ClO_4 (85:15 wt%) and (c) pure NH_4ClO_4

Fig. 1. Infrared spectroscopy

X-ray diffraction: XRD patterns of (a) pure PEO (b) polymer complex PEO:NH4ClO4 (85:15 wt%) and (c) pure NH_4ClO_4.

On careful examination of the XRD patterns, it is clear that some new peaks have appeared in the complex. The intensity of the X-ray peaks are also modified in the complex. Hence this confirms that the complexation of the system has taken place. It may be noted that the distinct peaks are over-riding a 'broad hallow' between two values of 15-30°. The broad hallow is indicative of amorphous phase. Therefore, it can be concluded that complexation has increased the amorphicity of the PEO-lattice.



X-ray diffraction patterns of (a) pure PEO, (b) polymer complex: PEO:NH_4ClO_4 (85:15 wt%) and (c) Pure NH_4ClO_4

Fig. 2. X-Ray diffraction pattern

Ion Transport Studies: Hashmi, et al. (1990) in their studies have shown that in polymer complex PEO:NH_4ClO_4 (85:15 wt%) the charge transport in the material mainly occurs due to motion of H^+ ions (tH^+ 0.85) but to some extent, it is also due to motion of ClO_4^- ions ($tClO_4^-$ 0.08). In order to provide an experimental evidence to the motion of these ions in the complex system, we have carried out transient ionic current (TIC) measurements by the methods proposed by Chandra, et al. (1988). The plot of TIC Vs time.

Two peaks are observed in the i Vs time curve. The first peak at t = 0.35 sec corresponds to the motion of H^+ ions whereas second peak at t = 0.68 sec. corresponds to the motion of ClO_{4-} ions. This identification is 'tentative' and guided by the fact that we have presumed that the lighter species (i.e., H^+) is likely to move faster than ClO_{4-}.

Conclusion

Polyethylene oxide (PEO) complexed with ammonium perchlorate (NH_4ClO_4) having composition PEO: NH_4ClO_4 (85:15 wt%) is found to be predominantly an ionic conductor. Transient ionic current measurements indicate that both cations and anions are mobile. The electrical conductivity at room temperature is of the order of 10^{-5} $S.cm^{-1}$. The plasticised polymer electrolyte having composition [PEO: NH_4ClO_4 (85:15 wt%) + 5 wt% of PC] shows maximum conductivity ~ 10^{-4} $S.cm^{-1}$ at room temperature in ambient. Hence, it can be a good material for the fabrication of a re-chargeable solid state proton battery.

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LEARNING SCIENCE BY USE OF INNOVATIVE HANDS-ON ACTIVITIES

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Science is learning by doing. Learning by doing is a concept within economic theory by which productivity is achieved through practice, self perfection and minor innovations. Science is not just something taught in the classroom; our ordinary moments are full of science. Aim is to develop interest so that students know what, how, when and why of things happening around us. Hands-on science activities are essential components of any early childhood setting, and they lay the foundation for lifelong learning, enhancing ability to think critically and healthy development. Students learn and understand best from what they see, touch, feel and manipulate. No classroom teaching is complete without a live demonstration. It is a challenge, a teacher must face. We can also involve some students they really enjoy learning by doing. Besides routine experiments which are knowledge oriented we can have some simple low cost demonstrations which are motivation oriented. These low cost experiments do not require any routine instructions and can be performed by anyone and with easily available materials. I have designed many hands-on activities using low cost materials, their apparatus and manual covering topics like Mechanics, Properties of Matter, Optics, Sound, Electricity, Magnetism, Heat, Electronics and Chemistry. In my paper I will be demonstrating and explaining some of these activities. Statistical analysis was done covering a topic with simple learning and then with the use of low cost teaching materials. It was found that students retained and gave better result when topic was covered using hands-on activity. Most of the experiments have open ended questions which arouses curiosity in the minds of students. They would try to perform these experiments on their own in order to find the answers. These experiments require materials which are easily available and cost-effective. By studying these simple experiments, they will get an idea of how to develop some more new experiments.

Key word: *Innovations, productivity, enhancing, inspire, demonstration, curiosity, motivation.*

Introduction

Teaching science is a big challenge today. Experiments done in laboratory are mechanical and they appear trivial. We have to improve science education. Hands-on activities and demonstrations play a very important role. They are most valuable tools in the hands of competent and innovative teachers to inspire and excite the fertile mind of a student. Besides routine experiments, we can have some simple low cost classroom demonstrations to explain various concepts in science as when they will work with their own hands, they will gain confidence and develop an insight into fundamentals. By devising such interesting and challenging hands-on activities, we can bring the best students in science.

Why should we use innovative laboratory practices for teaching science?

Hands-on Low Cost Experiments vs. Traditional or Routine Experiments

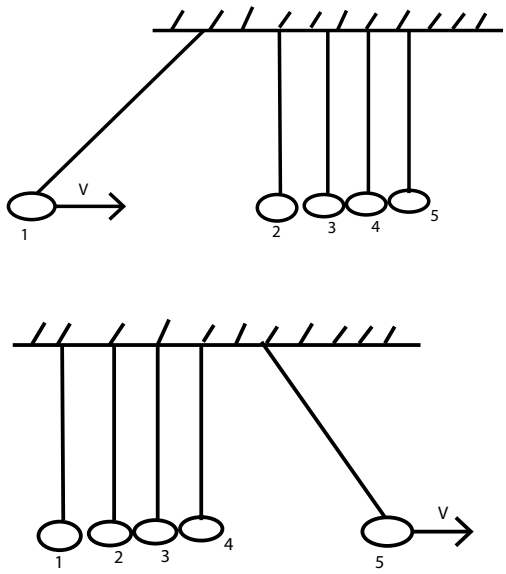
Experiments are an integral part of science teaching; they are broadly classified as traditional or routine experiments and hands-on low cost experiments. Traditional experiments are performed with a set of instructions under the guidance of a teacher with specially designed apparatus, that are part of the curriculum. Traditional

experiments are cognition oriented, i.e., supporting knowledge. On the other hand, low-cost hands-on experiments are motivation oriented. They do not require any special apparatus; materials required are low cost, easily available, no specific instructions are required and can be performed easily. Negative criticism is that it affects the seriousness of the subject but if some play or fun loving activity helps in gaining knowledge then it is surely useful. Thus, in my opinion, hands-on activities are essential components for learning science. My work is on designing low cost hands-on experiments for teaching science mainly for Classes XI and XII students as these days they are under a lot of stress. These will ignite their mind, relieve stress, develop interest and clear their concepts. Students will enjoy science, study with aim and curiosity and design their own activities.

Methods and Procedure

1. Designing low cost experiments by attending several workshops and seminars.
2. Designing low cost experiments of activities mentioned in NCERT textbooks.
3. Collecting ideas from students in live demonstrations in science club.
4. Transformation of some simple numerical problems into experiments.
5. Designing apparatus of science activities shared by interacting with other teachers.

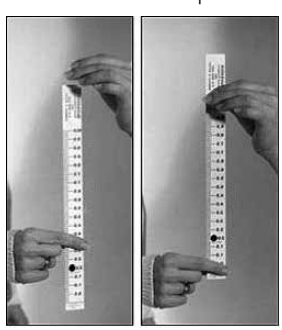
Hands-on Activities: The researcher has designed many hands-on activities using low cost materials, their apparatus and manual covering topics like Mechanics, Properties of Matter, Optics, Sound, Electricity, Magnetism, Heat, Electronics and Chemistry. In this paper



he has demonstrated and explained the details of some hands-on activities.

Activity 1: To demonstrate law of conservation of momentum

Take two plastic scales of equal sizes and



place them diametrically opposite parallel and place marbles of equal sizes between the two scales, with no gap. Now when you hit one marble, one will move, if we hit two marbles two will move and so on.

Activity 2: To measure reaction time

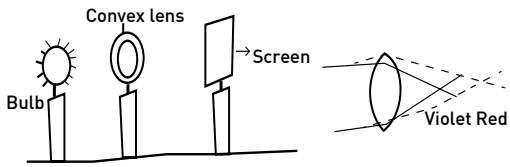
When a situation demands our immediate action, it takes some time before we really respond. Reaction time is the time a person takes to observe, think and act. For example, if a person is driving and suddenly a boy appears on the road, then the time elapsed before he applies brakes is called reaction time. It depends on the situation and on the individual. Take a ruler and ask your friend to drop it vertically through the gap between your thumb and forefinger. After you catch it, find the distance travelled by the ruler (h). Reaction Time t = (2h/g) 1/2

Activity 3: Collision ball experiment

Take a basket ball and a tennis ball and hold them in your hands— one over the other, with the heavier ball below the lighter one. Drop them together taking care that they remain together while falling and observe. When the balls hit the ground, the lighter ball on top will shoot off very high. The heavier ball on the bottom falls dead when it hits the ground. The bottom heavier ball has transferred its energy to smaller ball and will have small bounce.

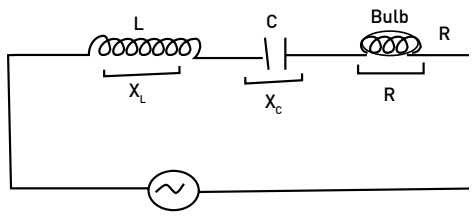
Activity 4: Watch Chromatic Aberration

Theory: White light is made up of seven colours; these colours have different values of refractive index. If light falls on a lens violet will focus nearest and red the farthest.



Take a convex lens with large aperture leaving few millimetres at periphery blocked by pasting an opaque sheet on it. Take a torch bulb and connect it to a battery and keep the bulb and screen proper so that the image is formed on the screen. Move the screen a little. If the screen is moved towards the lens you will see an image like a ring with inner rim violet and outer rim red. If we move the screen away from the lens the inner rim is red and the outer rim is violet.

Activity 5: To study resonance phenomenon in LCR circuit

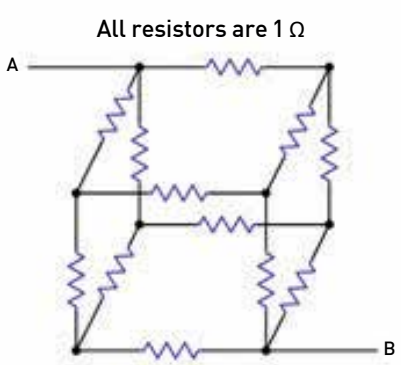


Theory: When XL = XC then impedance, Z is minimum current and glow will be maximum.

Set up an LCR circuit as shown using an AC transformer. Calculate values of XL and XC. Experiment with different values of L and

C so that XL becomes equal to XC. Take different values of capacitors and see that for which value of C, glow is maximum. We can decrease XC by increasing C or increase L by inserting spokes.

Activity 6: To verify Kirchhoff's law using network of resistances using a cube



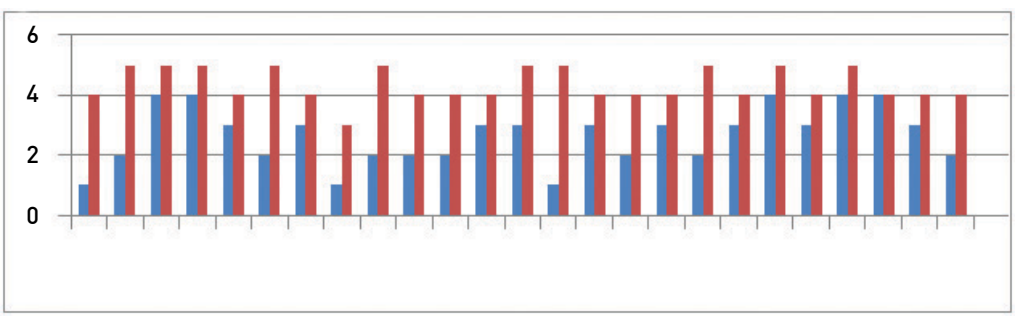
Take twelve wires of equal resistance R and join them to form a skeleton cube and connect multimetre across the diagonally opposite ends of the cube and measure resistance. Verify that value is (5/6) R, same as theoretical value. Verify by connecting across the edge of cube (7/12) R.

Results and Discussion

Statistical analysis was done on understanding and evaluation of a topic covered with simple learning and the same topic covered with the use of activities. It was observed that students retain topic shown with experiments much better and secure more marks than with rote learning. Red bar graph shows with activity and blue without activity on a 5-point scale.

Conclusion

Students can add further suggestions in these experiments. Hands-on activities help to ignite the minds of the students, develop interest in science among the students and invoke scientific ideas in them to bring the best students in science. These students with scientific minds will help in the growth of technology which will help in the advancement of the nation. These innovative methods of using hands-on activities make the learning and understanding of science simple and easy.



Students' performance on some topic taught with activity (Red bar) and without activity (Blue bar)

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EMBEDDED, LAMINATED AND MOUNTED SPECIMENS OF PLANTS AND ANIMALS

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I am a science teacher. While conducting experiments with my students in the lab, one of the specimens fell down from the student's hands and broke. So I enquired about the price and found it very costly. I found some interesting methods to preserve the plants and animals by putting my innovation. Embedded specimen is the replacement of traditional dry and soak specimen because of its advantages: no poison, no smell, easy to transport, not easily broken, can be preserved forever. This is unique real acrylic resin insects or the laminated. It can be an educational specimen for school, museum, and home. The outside material is safe for human. A herbarium specimen is a pressed plant sample deposited for future reference. It supports research work and may be examined to verify the identity of the specific plant used in a study. Specimens are pressed by placing the specimen between the papers under the weight. The objective of pressing plants is to extract moisture in the shortest period of time. My process was laminating herbarium specimen and dried insects ironing the lamination papers by ordinary iron box adjusting the temperature. We have many plants and animals which are explained in the textbooks from Classes V to X. I had collected many of the plants and insects which were available and tried to laminate, embed and mount.

Key word: *Herbarium, embedded specimen, laminated, acrylic, preservation*

Introduction

Science learning is more effective when it happens through participation in activities by the learners. For understanding the biodiversity of flora and fauna, we need to learn the art and techniques of preservation of leaves, plant parts and whole plants and animals for keeping them for long for facilitating teaching-learning process in science classroom. In my efforts I have used various techniques, such as, embedding, lamination and mounting for preserving the specimen of plants and animals. I have also oriented students about these techniques and the usefulness of preservation in learning of biology. In the present paper I intend to present various methods of preservation which I have used during my teaching.

Methods and Procedure

The preservation method included the following steps:

1. Collection of samples
2. Specimens are pressed by placing them in between papers under the weight, and
3. Laminating herbarium specimen and dried insects by ironing the lamination papers by ordinary iron box adjusting the temperature

Herbarium and Lamination Plants Sample

A herbarium specimen is a pressed plant sample deposited for future reference. It supports research work and may be examined to verify the identity of the specific

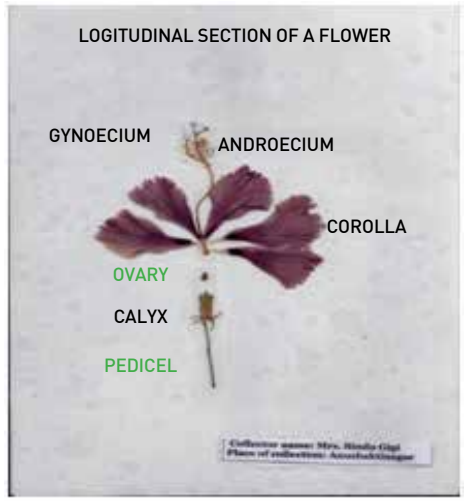
plant used in a study. Specimens are pressed by placing the specimen between papers under the weight. The objective of pressing plants is to extract moisture in the shortest period of time.

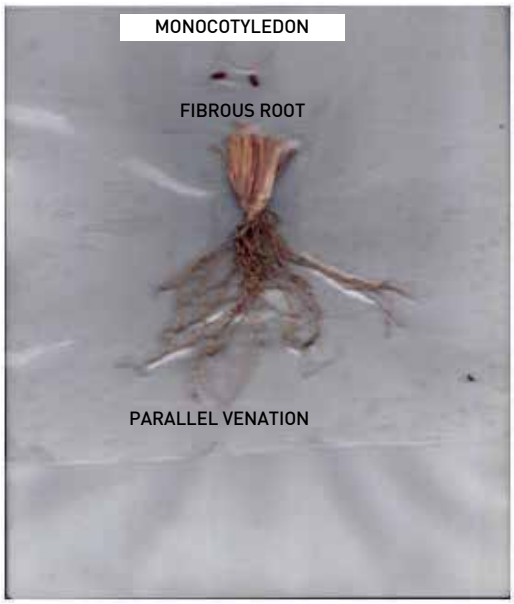
Herbarium Specimen Labels

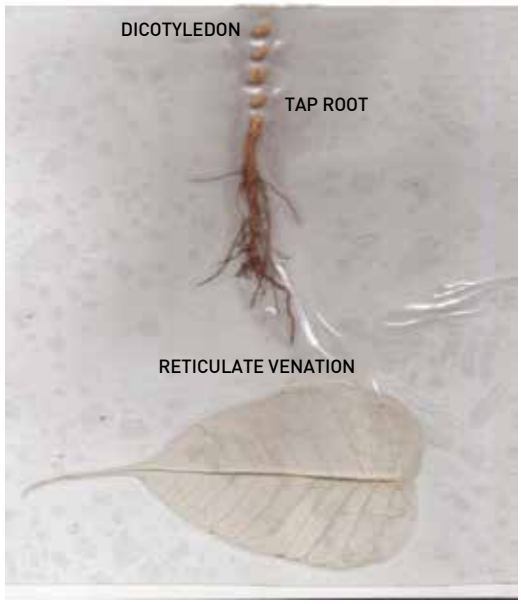
A plant specimen is incomplete without label data. Label data is a form of field data and must be accurate. The following are important elements: scientific name, genus, species, authority, collector's name and date of collection.

Students study about many kinds of plants and animals in the textbooks of Classes V to X. So the author collected many of the plants and insects which were available and tried to laminate, embed and mount them.

Few samples are given below.







Acacia auriculiformis

Scientific classification

Kingdom:	Plantac
Order:	Fabales
Family:	Fabaceae
Genus:	Acacia
Species:	A. aurlculiformis

Binomial name

Acacia auriculiformis

Collector name: Mrs. Bindu Gigi

Place of collection: Anushaktinagar

Papaya

Scientific classification

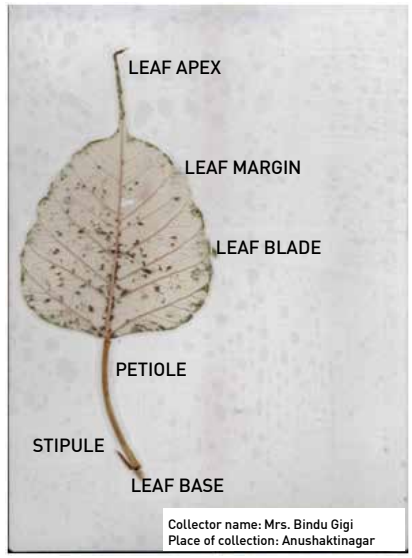
Kingdom:	Plantac
Order:	Brassicales
Family:	Caricaceae
Genus:	Carica
Species:	C. papaya

Binomial name

Carica papaya

Collector name: Mrs. Bindu Gigi

Place of collection: Anushaktinagar



I tried to laminate the parts of the flower because the appropriate flower may not be available all times. Similarly the parallel venation, reticulate venation, parts of stem, fibrous roots, tap roots, germination of seeds, etc., are laminated so that, the children can directly explore the nature. It leads them to know more about the environment and get an active participation in studies.

As children showed interest, I collected many samples and made a herbarium book for future reference. The herbarium contains the leaves, their biological names, scientific classification and uses of those plants.

Conclusion

I would like to conclude this paper by saying that the lamination or embedding can be done by students and teachers. By doing this they will become more familiar with the environment. The children will acquire a better knowledge and better understanding. The herbarium book will improve the students' knowledge and interest. I found it very interesting. Lamination paper is very cheap. Every school can afford it. I have also preserved some insects and fish in 10 per cent formalin solution. They are kept in good quality plastic bottles, so that it can be easily taken to the classrooms. I hope that we can even encourage children to do such activities. We can try another option such as using transparent plastic, cello tape, etc.

Acknowledgements

I am thankful to my colleagues and friends who have directly or indirectly helped me in preparing this project.

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INNOVATIVE HEAVY METAL WASTE DISPOSAL SYSTEM: MODULAR APPROACH FOR SENIOR SECONDARY CHEMISTRY TEACHERS

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Handling and disposal of waste generated during laboratory experiments is prime concern to school education. Most of the waste chemicals generated from laboratories are hazardous so their disposal waste must be given special consideration. This innovative disposal system guides for proper waste management and also helps in minimising the risk of exposure to maintain a safe school environment. The several experiments at school laboratory waste contain heavy metal ions. After completion of experiment the segregation and safely disposal of waste containing heavy metal ions is the main challenge. The readily available glassware was utilized to have easy, fast, cost effective and safe laboratory practice for heavy metal disposal.

Key word: *Lab practices, waste disposable, lab safety*

Introduction

Handling and disposal of waste generated during laboratory experiments is prime concern to school education (Barakat, 2011). Most of the waste chemicals generated from laboratories are hazardous so their disposal must be given special consideration (Akpor, et al., 2010). In several school laboratory experiments, the generated waste contains heavy metals in solid form. This waste mixture has immiscible components having difference in gravity. It is in common practice that waste is generally disposed through sink (Sonali, et al., 2013). This waste not only causes choking of sink but also causes environmental pollution.

An effort can be made to overcome such a problem by the use of this innovative waste disposal system (Figs. 1a and 1b). This system is developed with the basic principle of science, i.e., gravity. When there is a difference in the gravity of the component of mixture, heavier component settles down at the bottom and lighter component comes to the top. In this system the readily available glassware was utilised to have an easy, fast and cost effective laboratory

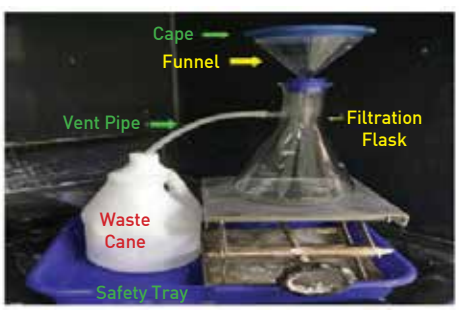


Fig. 1a. Innovative waste disposal system before use

Fig. 1b. Innovative waste disposal system after use

practice for waste disposal. This innovative disposal system guides for proper waste management and also helps in minimising the risk of exposure to maintain a safe school environment.

Methods and Procedure

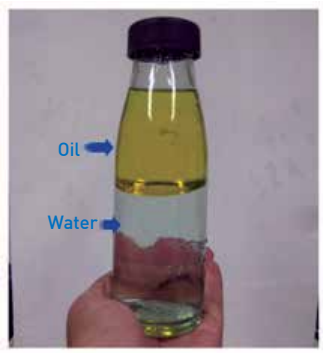
A funnel is fitted in filtration flask and the vent of the flask is connected to waste can via vent tube. This setup is kept in a way that top liquid can flow via vent tube to waste can. A safety tray arrangement is also made so that in case of any overflow, waste will not spread. Waste mixture generated after laboratory experiments is slowly transferred through funnel followed by fresh water to the filtration flask and then funnel is covered by cap to avoid escape of fumes or smell. After some time, a heavy part of the waste mixture settles down at the bottom and the lighter part comes to the top and goes to the waste can through the vent pipe. In this way solid-liquid or liquid-liquid waste get separated. This waste can now be disposed off as per their nature.

Set up Requirements: Filtration flask, funnel and its cover, stop cock, waste can, tray

Use: This idea may be implemented for handling and disposal of the following type of laboratory waste:

1. Immiscible solid-liquid mixture
2. Immiscible liquid-liquid mixture

Fig. 1c. Immisible solid-liquid mixture



Immisible liquid-liquid mixture

Results and Discussion

To keep the school laboratory's environment safe and clean, laboratory waste generated after various experiments should be handled and disposed off safely, easily and in a cost-effective manner. This innovative disposal system guides for proper waste management and also helps in minimising the risk of exposure to maintain a safe school environment. Students will be able to know the use of the concept of gravity and immiscibility and they may also utilise this idea for separating immiscible mixtures without the use of the separating funnel. This system may also be used for miscible metal solutions but for this we have to add some amount of basic solution so that metal precipitates in solid form.

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USING AFFINITY CHROMATOGRAPHY AND WESTERN BLOTTING – THE PURIFICATION OF POLYCLONAL ANTIBODY FROM RABBIT ANTISERA

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Antibodies are considered to be as antigen binding proteins that are present on the B-cell membrane and secreted by plasma cells. They are also called glycol-proteins. The main objectives of the work are: (1) Affinity purification of Anti E.Coli lysate antibody using Protein A Resin. (2) Affinity purification of partially purified Anti E.Coli lysate antibody using CNBr activated Sepharose 4B resin. (3) To check the purity of purified Anti E.Coli lysate antibody using SDS PAGE and Western Blot. (4) FITC labeling of purified antibody and removal of unbound FITC through GFC. Protein A is a wall component of Staphylococcus aureus that binds to Fc portion of IgG. The methods adopted are: (1) Pack the column using Protein A Resin; (2) Boric acid is used to equilibrate the column (10 column volume); (3) Then apply a small sample (1 ml) of Antisera; (4) Wash the column with 5 column volume of buffer A; (5) Elution was done using Buffer B. Collect the fractions into titrating diluent (e.g 1.0M Tris-Cl) and take the O.D. at 280 nm; (6) Pool the sample which shows the maximum O.D. and concentrated it in 10 k D centricon. In the present work, the author has successfully purified unlabelled as well as labelled protein (antibody) by Affinity Chromatography. The immune-activity of the purified antibody was confirmed by Western Blotting. Students of senior secondary level have been oriented using chromatographic techniques.

Key word: *Protein A, affinity chromatography, western blotting, SDS PAGE, boric acid.*

Introduction

Antibodies are hetero-dimers. It has a structure of four peptide chains having two identical light (L) chains of molecular weight 25,000Da and two identical heavy (H) chains of molecular weight 50,000Da. H and L chains are also regarded as immune-globulins. Light chain is linked to heavy chain by a disulphide (-S-S-) bond and by non-covalent structures such as salt linkages, hydrogen bonds and hydrophobic bonds to form a hetero-dimer (H-L). Similarly, two identical H and L chain linked by non-covalent interactions and disulphide bridges to form basic four chain (H-L)2 structure, i.e, a dimer of dimers. There

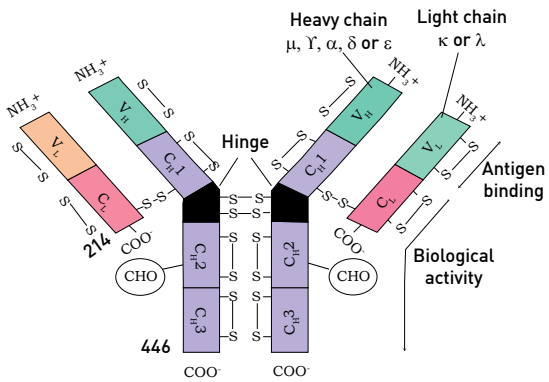

Fig. 1. Diagram of structure of immunoglobulin

are segments of highly variable sequence called V regions in both light (VL) and heavy chains (VH) respectively. Complimentary determining region (CDR) constitutes the antigen binding site of antibody molecule.

The above Fig. 1 is a diagram of structure of immunoglobulin derived from amino acid sequencing studies. Each heavy and light chain in an immunoglobulin molecule contains an amino-terminal variable (V) region (aqua and tan, respectively) that consists of 100–110 amino acids and differs from one antibody to the next. The remainder of each chain in the molecule—the constant (C) regions (purple and red)—exhibits limited variation that defines the two light-chain subtypes and the five heavy-chain subclasses. Some heavy chains (γ, δ, and α) also contain a proline-rich hinge region (black).

When the antibody IgG is treated with the enzyme papain it produces three fragments, two of which are regarded to be as identical fragments and the third is quite different. The fragments that are identical has the capability to bind to the antigens and are called Fab fragments (fragment antigen binding). The third fragment plays no role in antigen binding activity. It was found that the fragments crystallise during cold storage and regarded as Fc fragment, i.e., fragment crystallisable. When the IgG molecule is treated with mercaptoethanol, it breaks into heavy and light chains that are linked by a disulphide bond. The enzyme pepsin cleaves the IgG molecule below these bonds and the enzyme papain cleaves the bonds linking heavy chains.

The fragments produced by various treatments are also indicated. Light (L) chains are in gray and heavy (H) chains in blue.

Methods and Procedure

Affinity Purification of Anti E.Coli Lysate Antibody using Protein A Resin

1. Pack the column using Protein A Resin.
2. Boric acid is used to equilibrate the column (10 column volume).
3. Then apply a small sample (1 ml) of Antisera.

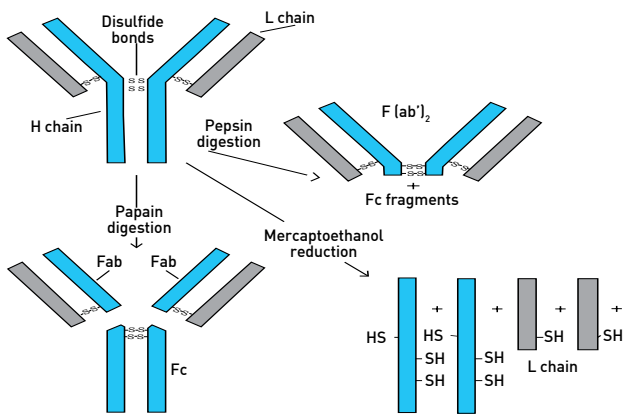

Fig. 2. Prototype structure of IgG, showing chain structure and inter-chain disulfide bonds

4. Wash the column with 5 column volume of buffer A.
5. Elution was done using Buffer B. Collect the fractions into titrating diluent (e.g., 1.0M Tris-Cl) and take the O.D. at 280 nm.
6. Pool the sample which shows the maximum O.D and concentrated it in 10 kDcentricon.

Affinity purification of partially purified anti E.Coli lysate antibody using CNBr activated Sepharose 4B resin

It is a medium used for the immobilisation (the covalent attachment of an enzyme on to the solid matrix) of ligands that contains primary amines. The resulting coupling reaction is spontaneous, rapid and easy to carry out.

To check the purity of purified Anti E.Coli lysate antibody using SDS PAGE and western blot

1. Take glass plate, notch plate and gasket and they should be properly wiped with methanol.
2. Put the notch plate down, cover the plate with the gasket on the walls of notch plate and properly put glass plate to it and fix it with clamps.
3. Perform leak test by pouring WFI between the glass plate and notch plate. Discard and soak it with Whatman filter paper.
4. Add resolving gel between the plates and a layer of saturated butanol so that the gel should not dry.
5. After 20 minutes, discard butanol, add stacking gel (4% acrylamide) and immediately place a comb over it so that the wells should form properly in which we are going to load the protein samples.
6. Take the running unit and in the lower and upper chamber add running buffer to it. Now load the protein samples into the wells and allow for electrophoretic run. The time taken by the gel for complete elution is 11/2 or 2 hrs. When the gel elutes, place it in the staining solution and perform silver staining.

FITC labelling of purified antibody and removal of unbound FITC through GFC.

Mix 500 mcl of Protein A purified antibody (Concentration 2mg/ml) and add 500 mcl of bicarbonate (HCO3) buffer, pH 9.0. So, this gives us the final pH 9.0 of the solution.

Making 20mg/ml solution of FITC in ethanol: Weigh about 2.0 mg of FITC and add 100 mcl of ethanol to it and cover the eppendorf with aluminium foil as FITC is light sensitive.

Labelling of Protein A purified antibody with FITC: Add 52.6 ml of above FITC solution (20 mg/ml) to 1.0 ml of Protein A purified antibody, pH 9.0 in a 2.0 ml eppendorf and cover it with aluminum foil as it is light sensitive and this will make 2.5 mM concentration of FITC in the final system. Incubate it for one hour at room temperature.

Results and Discussion

Affinity Purification of anti-lysate Antibody using Protein A Resin

Purification was based on affinity chromatography and Protein A was used

as a ligand which binds to Fc portion of immunoglobulin.

It was observed in Table 1 that out of the 19 fractions, fractions of the purified antibody that lies between 6-10 gives maximum absorbance at 280nm and those fractions were pooled and protein sample was concentrated using 10 kD centricon.

Table 1

Absorbance at 280 nm for Eluted Fraction of Protein A Purified Antibody

Fraction No	Absorbance at 280 nm	Fraction No	Absorbance at 280 nm
1	-0.011	11	0.027
2	-0.005	12	0.067
3	-0.002	13	0.093
4	-0.01	14	0.075
5	-0.006	15	0.04
6	0.08	16	0.024
7	1.229	17	0.012
8	1.385	18	0.004
9	0.223	19	-0.011
10	0.035		

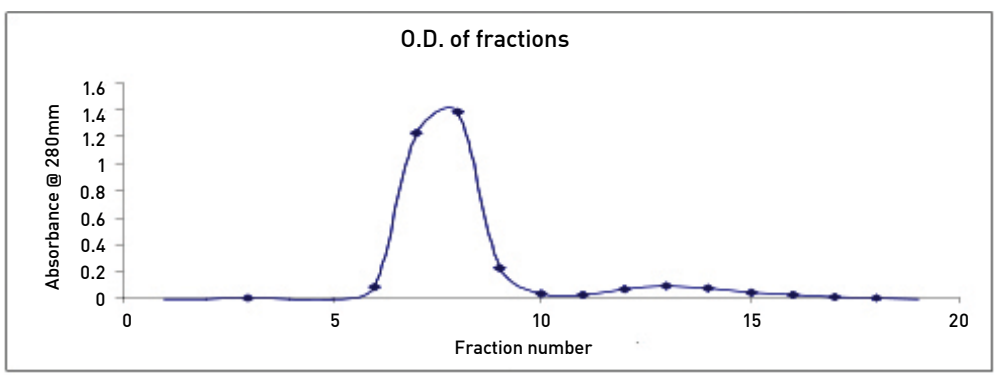

Fig. 3. Graphical representation of absorbance of protein A purified antibody

Affinity Purification of partially purified anti-lysate Antibody using CNBr activated Sepharose 4B.

Table 2

Absorbance at 280 nm of Eluted Fraction of CnBr Purified Antibody.

Fraction No	Absorbance at 280 nm	Fraction No	Absorbance at 280 nm
1	0	14	0.56
2	-0.003	15	0.54
3	-0.005	16	0.05
4	0.008	17	0.049
5	-0.002	18	0.047
6	0	19	0.043
7	0.046	20	0.042
8	0.096	21	0.046
9	0.125	22	0.045
10	0.113	23	0.04
11	0.092	24	0.039
12	0.072	25	0.04
13	0.57		

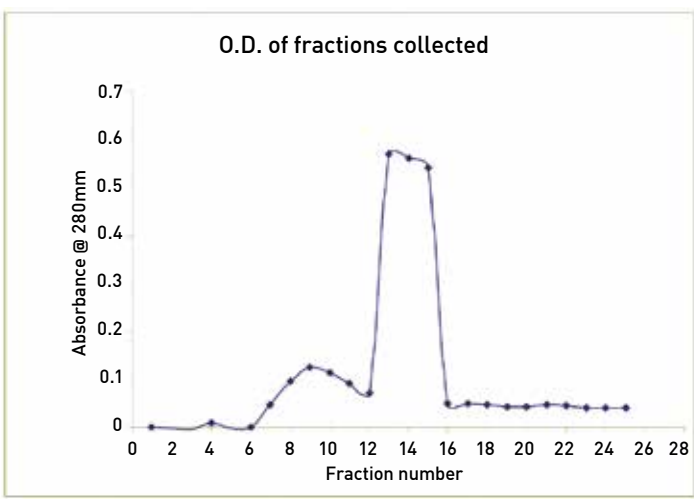

Fig. 4. Graphical representation of absorbance of CNBr purified antibody

To enhance the further purification of antibody that was obtained using Protein A, we followed the purification using CNBr Sepharose 4B as a resin. HCl was added to clean the resin. PBS was used to equilibrate the column. Stringency washes were done using 0.1M acetate, 0.1M Tris-Cl and 0.5M NaCl. Antiserum (1.0ml) was loaded and diluted it with 1X PBS. 0.1M Tris-Cl, 0.5M NaCl having pH 6.0 and 8.0, respectively, was used to remove non-specific binding of other proteins present in serum. Elution was done using 0.1M Glycine-HCl. Fractions 7-12 were pooled (mixed) as these fractions give maximum absorbance at 280nm and the protein sample was concentrated using 10 kDcentricon.

SDS PAGE and Western Blot to check

Purification achieved at each step: Purification was achieved in six steps. Antiserum loaded in the first well, then PBS wash-1 and PBS wash-2 in second and third. Fifth well consists of prestained marker. In sixth and eighth, CNBr purified antibody (NR) and CNBr purified antibody (R), respectively. When antibody is treated with non reducing agent, it gives the purified form of antibody because when it treated with reducing agents like DTT it dissociates into two heavy and two light chains which give the different bands on SDS-PAGE gel.

Purified antibody by western blot and silver staining: To check the effectiveness of the purified antibody, we use western blot.

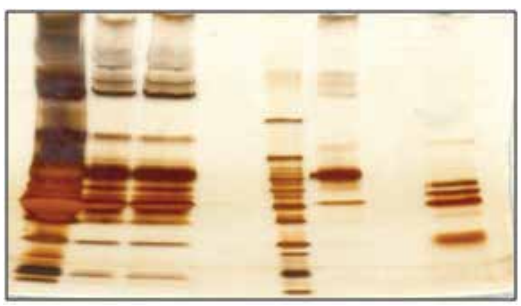

Fig. 5. SDS-PAGE Profile of Samples from Purification Process

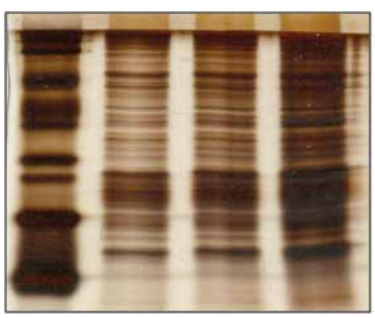

Fig. 6. SDS-PAGE Profile of E.coli lysate

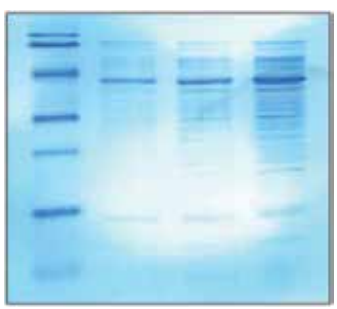

Fig. 7. Western profile of E.coli lysate

Table 3

Loading amount of SDS-PAGE and Western blotting

Lane	Sample ID	Sample buffer.	Loading Amt. (µg)
1	Prestained Marker	–	7µl
2	E.coli lysate	5X R	2.5µg
3	E.coli lysate	5X R	5µg
4	E.coli lysate	5X R	10µg

Primary antibody purified anti-lysate antibody and the secondary antibody was goat anti-rabbit HRP labelled antibody and was used to check the purity and the identity of the purified antibody.

As observed in Fig. 5, CNBr purified antibody was capturing the whole range of band which was detected in SDS-PAGE silver staining (Fig. 4), so this purified form of antibody is against this E.Coli lysate.

FITC labelling of purified antibody and removal of excess FITC using GFC

Labelling of purified antibody using FITC: Protein of interest is labelled using FITC. FITC has an absorbance at 495nm and protein has an absorbance at 280nm. Only those fractions were collected in which the protein bound to FITC, means that gives absorbance at 495 and 280nm, respectively, and the fractions were 3-7 and the protein sample was concentrated using 10 kDcentricon.

Removal of excess FITC using GFC: O.D. of FITC and protein gives maximum absorbance at fraction 5. When we overlap the fractions of proteins and FITC, the combination of it gives the maximum absorbance at fraction 5. As the number of fractions increases (Fraction no. 15–17), the O.D. at 280 nm was increasing slowly while O.D. of 495 was increasing very fast so this fraction contains only FITC molecule.

Table 4

Absorbance at 280 nm and 495 nm of Eluted fraction of GFC

Fraction No	O.D at 280 nm	O.D at 495 nm
1	-0.074	-0.044
2	-0.074	-0.04
3	-0.073	-0.043
4	0.819	0.88
5	1.988	2.106
6	0.305	0.348

7	0.016	-0.013
8	0.173	-0.03
9	0.242	-0.038
10	0.122	-0.041
11	0.005	-0.034
12	-0.058	-0.032
13	-0.076	-0.008
14	-0.056	0.074
15	0.105	0.555
16	0.184	0.873
17	0.291	1.246

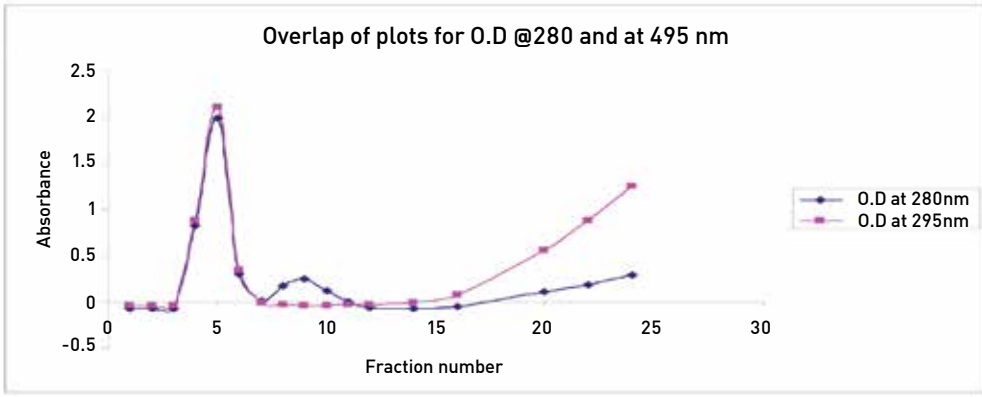

Fig. 8. Graphical Representation of Absorbance of O.D. 280 and 495 value of fraction of GFC

While fraction 8-11 has absorbance at 280 nm only so it may contain unbound protein or any other impurity.

Conclusion

In the present work we successfully purified unlabelled as well as labelled protein (antibody) by affinity chromatography. The immunoactivity of the purified antibody was confirmed by western blotting. The techniques used in the antibody purification can be correlated with the students of senior secondary level which can be studied.

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