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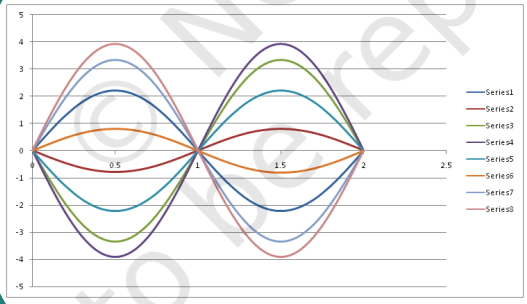

Superposition of eight waves at a time making a loop

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Contents

EDITORIAL

The December 2018 includes an interdisciplinary approach to figure out the inquisitiveness of individual learners, teachers, or teacher- educators regarding different science subjects and domain areas through analysis. The current problems in multidisciplinary scientific, and educational aspects, which consist of physical, chemical, and biological sciences, are addressed. The current issue may raise awareness among teachers, teacher-educators, and students about their different queries.

The article 'Problem-based Learning in Basic Physics – XIII' discusses the usage of minimum mathematical knowledge and logical ability to solve problems in the light of physical laws. In the research paper 'Assessment of Science Laboratory Experiments (Physics, Chemistry, and Biology) in inculcating Science Process Skills at the Higher Secondary Level,' the author concludes that the level of understanding of Physics, Chemistry, and Biology is based on the laboratory skill test among the students.

The article 'Paris Agreement on Climate Change' creates awareness regarding the climatic conditions and discusses the ambitious Paris agreement action plan and the theme of India's 'Sustainable Lifestyle: Positive Climate Action' for COP22. The paper entitled 'Simple Classroom Method to Demonstrate the Law of Conservation of Mass' presents a simpler, safer, less time-consuming demonstration method to verify the law of conservation of mass using eco-friendly and locally available material. In the article 'Management of Biological Disaster,' the author discusses the bio-hazards, which have been assumed to be a serious problem for health and the environment in recent years. The major findings of the article 'Assessment of Students' Understanding of Salt Hydrolysis: Misconceptions and Clarifications' show the importance of a practical approach in learning that teachers can adopt rather than restrict only to theoretical chemistry.

The article 'Computational Physics with Spreadsheet – III' illustrates the importance of MS Excel for better understanding the concepts of the superposition of waves in physics. The authors of 'Analysis of In-service and Pre-service Teachers' Understanding of Some Concepts of Biotechnology in Biology Curriculum" concludes in their present research study that there is a need to emphasise a practical approach on learning biotechnological concepts in the pre-service teacher education programme. Authors also recommend need-based well-designed capacity-building programmes for in-service teachers, which might be helpful to them for better delivery of biotechnological concepts in the biology curriculum during classroom teaching.

The research study on "The Relationship between Psychological stress due to the Socio-economic status (PSSES) of Learners and their Achievements in Science" focuses on the impact of psychological stress due to low socioeconomic background on science learning. On the basis of results, authors have provided. recommendations for policy makers and curriculum developers.

This issue also has the regular features 'Science News' and 'Web Watch' for readers. We wish all readers a fruitful reading. Your kind suggestions are always welcome.

Form IV *(See Rule 8)*

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I, Anup Kumar Rajput, hereby declare that the particulars given above are true to the best of my knowledge and belief.

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PROBLEM-BASED LEARNING IN BASIC PHYSICS - XI

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In this article— thirteenth in the series of articles— we present problems which are non-numerical or the ones which require minimum mathematics but can be addressed by bare minimum mathematics or simple logic. Many are the situations which have to be understood in the light of laws of physics. This involves serious discussion of the phenomenon or the process and logical analysis.

Keywords: Action-reaction pair, centre of mass, moment of inertia, Archimedes principle, surface tension, surface energy, field inside a charged spherical shell, real isotherm, phase isotherm on P-T diagram

1. **Motion relative to an Observer** Consider a passenger travelling by train. S/he performs an experiment of dropping two stones while standing near the door. One inside the train and other outside the train. What would be the trajectory of these stones. Where would be the stone land with respect to the door position where our passenger drops it. What will be the trajectory observed by an observer standing near the track for the stone dropped outside?

2. **Action and Reaction Forces**

   (a) Consider a person standing on the earth's surface and three forces in relation to his/her state of motion: (i) gravity acting on him/her, (ii) force his/her feet exert on the ground and (iii) normal reaction that ground exerts on him. Explain his state of rest and identify which two of the three forces form action-reaction pair.

   (b) Consider a horse cart. Consider the following forces: (i) force exerted by horse on the ground, (ii) force of friction between the diagram horse's feet and the ground, (iii) force exerted by the horse on the coupling between him and the cart, (iv) force exerted by the cart on the coupling and friction between cart wheel and the ground.

   Which of these forces form pair(s) of action and reaction?

3. Consider a bird in a cage hanging from a spring. Inside the cage, the bird is sitting on the swing. What will happen to the spring when the bird jumps off the swing and when it lands on the floor of the cage?

4. Consider two cylinders—one of bigger radius and hollow and the second of smaller radius. Initially the bigger cylinder is resting on the ground and the smaller cylinder is inside the bigger cylinder as Figure 1. Shows side view of cross-section of cylinders the smaller cylinder was released from its initial position. Discuss its subsequent motion.

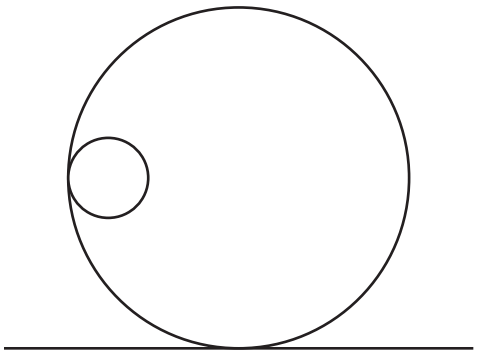

Figure. 1

5. Consider four objects, (i) a ring, (ii) a disc, (iii) a solid sphere, and (iv) a hollow sphere. All four are released from the same height on an inclined surface and they roll down without slipping. Which of them will be the first to reach the bottom of the plane? Why?

6. A vessel filled with water is kept on a weighing pan and the scale is adjusted to zero. A block of mass M and density ρ is suspended by a massless spring of spring constant k. This block is submerged inside the water in the vessel. What is the reading of the scale?

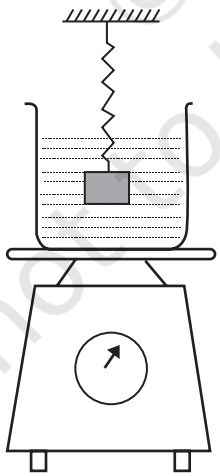

Figure. 2

7. A boat carrying a number of large stones is floating in a water tank that is about to overflow. If the stones are unloaded into the water tank, what will happen to the water level in the water tank? Will water in the tank overflow? Give scientific explanation based on Archimedes principle. (At a scientific meeting, the same question was put to Dr Gamow, Dr J. Robert Oppenheimer, and Nobel Laureate Dr Felix Bloch. All three of them, not thinking too carefully, gave the wrong answer!)

8. Liquid droplets take spherical shape as the sphere has minimum surface area for given volume thereby minimizing surface energy due to surface tension. However, kept on a horizontal surface, water droplets are nearly spherical whereas mercury drops gets flattened. Explain why?

9. Gravitational field inside a spherical shell of uniform mass density is zero. Explain.

10. Isotherms (P vs V curves at constant temperature) for a real substance are as shown in Figure 2. LPG (liquified petroleum gas) cylinders (the one carrying cooking gas for household) have liquified gas that works on the Principle of similar isotherms. which cooking,s when we open the regulator valve, it flows out in gaseous form is almost at a constant rate till all of it is consumed. Explain the working of as LPG cylinder using the isotherms shown below. You may assume that initially you are at the leftmost point of the horizontal section (mixture of liquid and vapour) of the isotherm.

11. Figure 3 shows phase diagram (P vs T behaviour) for water. We want to understand two phenomenon associated with our life using this phase diagram.

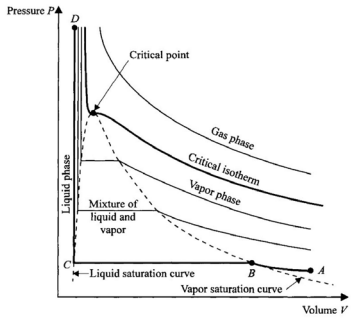

Figure. 3: Isotherms of pure substance such as H_2O

(a) We use water inside pressure cooker for cooking food. Explain how pressure cooker works and what is the advantage of using it.

(b) During summers in India, one of the common practice to keep cool is to make ice balls of crushed ice, dip it in flavoured sugar syrup and sip it. For this a stick is inserted into crushed ice and is squeezed by the palm to make it into the ball. Equivalently in winter, in those areas where it snows, people make snow balls and throw around. Explain the formation of balls out of crushed ice or snow in the light of P–T diagram of water.

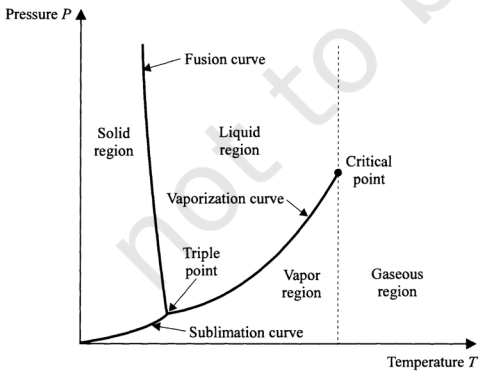

Figure. 4 :Phase diagram for water (H2O)

Discussion/Answers

1. It is our common experience while travelling in a train that any object dropping off our hand falls at our feet. This is what will happen to the stone dropped inside the train. The stone dropped outside likewise should also drop exactly below the feet of the passenger at the door and near the track. For an external observer, when the stone was dropped, it already had horizontal speed (that of the train), and thus would fall vertically like a projectile projected horizontally along a parabolic path.

It is worth noting that water or paper dropped outside from the moving train appears to go backward because as seen from the outside they had horizontal speed and being lighter objects would face air resistance slowing their speed. Thus, for internal observer, they appear to move backward.

Also note here, that during this time, if the train suddenly accelerates or decelerates, these objects will appear to move opposite to acceleration of the train creating need for pseudo force to explain their motion as train accelerating becomes a non-inertial frame.

2. (a) For a person standing on the ground, him/her exerting force on the ground and normal reaction from the ground are action-reaction pairs. As these forces always act on the other body from the pair of bodies interacting with each other.

(b) For the horse and cart, horse pushing the ground backward and friction pushing the horse forward are the action-reaction pairs. Also, horse pulling the cart through coupling and cart pulling the coupling backward are the action-reaction pairs.

3. As the bird jumps off the swing, in trying to preserve position of the centre of mass of bird-cage system, spring will contract. Since bird has jumped on the floor of the cage under the action of gravity, eventually the centre of mass gets lowered.

4. As the smaller cylinder is released, it will roll down due to gravity, but as there is no force in the horizontal direction, horizontal position of centre of mass should remain the same. As the smaller cylinder descends, its centre of mass shifts to the right and the bigger cylinder will roll towards left to preserve position of combined centre of mass.

5. For an object rolling without slipping kinetic energy is given by $\frac{1}{2}\left(1+\frac{1}{R^2}\right)Mv^2$. Since all

start with the same potential energy, which gets converted to kinetic energy, the one with smallest moment of inertia will have largest speed. Since solid sphere has the smallest moment of inertia for same mass and radius, it will be the first to reach the bottom. Same can also be argued based on acceleration.

Let x be the compression on the spring. As the block is in equilibrium $Mg-(K_z+P_wV_g)=0$

where ρ_w is the density of water and *V* is the volume of the block. The reading in the pan is the force applied by the water on the pan i.e.,$M_{vssel}l+m_{water}r+p_wVg$.

Since the scale has been adjusted to zero without the block, the new reading is ρ_wVg^1

6. For a floating object, mass of the liquid displaced is equal to its own weight.

Whereas for a submerged object, volume of the liquid displaced is equal to volume of the submerged object. Stone is much denser than water and thus has much smaller volume compared to the water having same mass. Thus, when stone is in the floating boat, volume displaced is much more (as equivalent mass of water occupies much greater volume) than when it is dropped into the water. Thus, the tank will not overflow. In fact its water level should come down.

7. When a liquid droplet is on a horizontal surface, the sum of its energy: gravitational potential energy plus surface energy should settle for a minimum. Since mercury is much denser and has greater mass within same volume compared to water. Thus, lowering its centre of mass reduces its gravitational energy much more than that of water droplet. Flattening of the droplet lowers energy of mercury droplet and compensates for increase in surface energy more than water droplet. The flattened droplet is the minimum of total energy for mercury.

8. Refer to the figure below. If the big circle represents thin uniform spherical shell and P a point inside, then the entire spherical surface can be divided into pairs of infinitesimal areas dA_1 and dA2. In this case contribution to the field at P from infinitesimal elements will be proportional to $dA/r^2 = d\Omega$, the solid angle subtended at P,

since mass of each element is proportional to area for a shell. Since, each element subtends same solid angle at P and field

directions are opposite, net field at P or any point inside is zero.

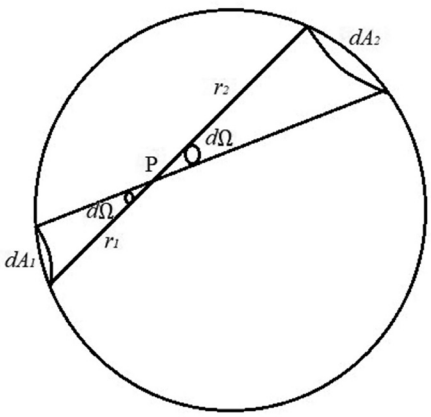

Figure.5

9. Refer to the figure in the question, the horizontal portion represents mixture of liquid and vapour phase. This is the state of LPG inside the cylinder. As we open the regulator, some gas escape could reduce pressure. Simultaneously some liquid evaporates and tries to maintain the pressure. The state point on the horizontal portion shifts to the right. This continues till all of the LPG gets converted to gas. This brings the system to the rightmost point of the horizontal segment. Here onwards, pressure starts dropping indicating we are running out of LPG.

10. Phase diagram problems:

    (a) Refer to the vaporisation curve. To the left is the liquid phase and right is the vapour phase. Initially we start with water-liquid phase and as it is heated, slowly water gets converted to steam and a fraction of the substance shifts horizontally crossing vaporization curve. This results in increasing pressure. So on PT diagram increase in pressure brings us back to liquid phase. This means further vapourisation is prevented unless temperature is increased further, i.e., boiling point is increased due to increase in pressure. How is this advantageous?

For normal cooking, water boils at 100°C, using 540 Cal/gm of energy. If boiling point is raised by increasing pressure, then vapor isation is prevented till further increasing in temperature. Say, If new boiling temperature is 110°C, then we need only 10 Cal/gm before we cross 110°C instead of losing 540 Cal/gm. This is where we not only save our energy but food also gets cooked better. Normally people allow steam to be released (in the form of whistle) which is actually loss of energy as we are releasing steam. Correct thing to do is the just before steam is released, stove should be kept on the minimum flame to prevent loss of heat energy and then food gets cooked better at higher temperature, also preventing loss of 530 Cal/gm. This would also result in saving cooking fuel. This is the advantage of pressure cooker.

(b) Refer to the P-T diagram of water and fusion curve. Say, we are having crushed ice at 0°C and we are on the left of the fusion curve. Increasing pressure at 0°C and 1 atm, we move our state vertically upward and convert ice into liquid state and decreasing

pressure in liquid state at 0°C and 1 atm converts water to ice state. When crushed ice is squeezed, some of it melts filling up the gap between ice flakes. Upon releasing pressure, this water freezes binding all ice flakes making the ball more stable.

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ASSESSMENT OF SCIENCE LABORATORY EXPERIMENTS (PHYSICS, CHEMISTRY, AND BIOLOGY) IN INCULCATING SCIENCE PROCESS SKILLS AT THE HIGHER SECONDARY LEVEL.

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The present research aimed to study the significance of science laboratory experiments in inculcating science process skills at the higher secondary level. Science laboratories play a very vital role in understanding the concept of science to students. Coordination of theory with practical is significant for corroborating concepts and stimulating interest in students' minds. Moreover, when the students handle the equipment themselves, it gives a more profound understanding. The researcher used the survey method for the collection of data. The research tools, i.e., science process skill tests for each physics, chemistry, and biology, were designed and implemented to understand the ground reality. Each process skill in Science (physics, chemistry, and biology) for a particular experiment is assessed by a five-point scale. The process skills are assessed as (i) Beginning stage, (ii) Foundation stage, (iii) Developing stage, (iv)Accomplished stage, and (v) Proficient stage. The scores given for the stages are 1,2,3,4 and 5, respectively. The mean of the process skill test in biology, physics, and chemistry was 11.18. The standard deviation of the scores was 4.459.

Keywords: Science process skills, science laboratory, equipment, schools.

Introduction

Laboratory work can be categorised as a learning resource for science and technology as it runs on the principle of 'learning by doing' and a constructive approach. Performing experiments by themselves or observing the experiments being performed in front of them provides an upper hand experience to students. Laboratory work helps in the development of (i) understanding the nature of science, (ii) building a scientific attitude, (iii) cognitive abilities, and (iv) enhancement of science process skills. *Shahali et al. (2017)* argue that different teachers' knowledge of science process skills is different based on their teaching experiences. Laboratory work allows the teachers to inculcate science process skills, namely, observation and classification skills, inference skills, and communication skills. Lunetta, Hofstein and Clough (2007) explain that the natural sciences' knowledge is constructed to explain objects, phenomena, and their interactions in the natural world. With time, scientific ideas or concepts become connected by wider-ranging theories, and especially since the resurgence, new knowledge and understanding have developed through continual, dynamic interaction between scientific theories, research, and experimental data. Fraiser, McRobbie and Giddings, 1993, conclude that learning science requires many skills; the most crucial are problem-solving, keen observation, drawing, labelling, generation of ideas, and creativity. Higher secondary science education focuses on eliminating the abstractness of science

built-in students who come from a junior level. Handling equipment and performing experiments individually also make the students sound in scientific concepts. Weinberg (1962) argues that the laboratory approaches can be inductive and deductive. In the inductive approach, first-hand experience is given priority, and then students get to learn the theoretical concept. In the deductive approach, the theoretical aspect is explained then the practical is performed.

Methodology

The research was intended to study the assessment of science laboratory experiments (physics, chemistry, and biology) in inculcating science process skills at the higher secondary level. Hence, the survey method was used to research the ground reality. A science process skill test was designed for each Physics, Chemistry, and Biology, and the related skills were scored. The study sample consisted of 11 higher secondary schools of Delhi NCR. The research intended to depict the science laboratory experiences of higher secondary school students and to analyse the difficulties faced by the teachers and students in using science laboratories in the higher secondary schools. In order to attain this objective, we have developed some tools that were discussed and prepared with the experts in a workshop conducted at NIE, New Delhi, from 30 July into 3 August 2018.

The tools used for the study are:

- A questionnaire for each—Physics, Chemistry, and Biology on utilisation of science in learning science (physics, chemistry, biology, respectively) in higher secondary schools of Delhi NCR.
- A classroom observation schedule to observe science laboratories for all the three laboratories— Physics, Chemistry, and Biology.
- A Science process skill test for Physics, Chemistry, and Biology each.

How do these tools help in achieving the objectives of this research?

(i) The questionnaires were prepared to know students' and teachers' difficulties using science laboratories.

(ii) A questionnaire was prepared on the utilisation of science laboratories in learning science.

(iii) The current approach in science teaching is that science should be taught not as unalterable facts, theories, and principles but the teaching of various scientific methods, scientific thinking, and critical thinking to describe various science skills; these skills form the essential qualities of a good scientist, according to AAAS (American Association for the Advancement of Science). Hence we have prepared Classroom Observation Schedule based on science process skills which included (1) Observing skills, (2) Inferring skills, (3) Measuring skills, (4) Communicating skills, and (5) Classifying skills.

Science Process Skill Test

Science process skills are classified as basic skills and integrated skills. These skills can be accessed by applying them to a series of laboratory activities.

Observation means the action or process of closely observing or monitoring something or someone and using your senses to gather information about an object or event. It is a description of what was actually perceived. This information is considered qualitative data. This skill was tested in experiments like recording zero error signs and studying cardiac muscle characters. In these experiments, high observing power is required to observe cardiac muscle characteristics, and one should have excellent observation skills.

Measuring is using standard measures or estimations to describe specific dimensions of an object or event. This information is considered quantitative data. This skill was tested in experiments like determining the least count of measuring devices, recording measurements in proper units, time taken vs colour change (salivary amylase reaction). In these experiments, like in measuring most minor counts, one should have a reasonable estimation of measuring dimensions of the particular device. Hence, we can test measuring skills through these experiments.

Inferring is formulating assumptions or possible explanations based upon observations. This skill was tested in experiments like inferences drawn based on colour change of indicators, plotting graph between current and potential difference, and interpreting the graph. For example, in these experiments, like in the titrations, one should possess the skill to infer whether the given solution is acidic or basic. Hence we can test inferring skills through these experiments.

Classifying is grouping or ordering objects or events into categories based upon characteristics or defined criteria. This skill was tested in experiments like studying different types of epithelial/ muscle/ cartilage/ tissues and their distinguishing features, classifying anions and cations into various groups. In these experiments, one should be able to classify the given information correctly as NH4+ will come under zero group; similarly, other cations and anions can also be classified in their respective groups. Hence we can test classifying skills through these experiments.

Communicating is using words, symbols, or graphics to describe an object, action, or event. This skill was tested in experiments like computing the focal length of the convex mirror and interpreting the graph to determine the minimum angle of deviation. Chemicals and apparatus used in the experiment were appropriately listed. Students can perform these experiments by exhibiting good communicating skills.

The process skills selected for assessment are:

(a) Observation

(b) Classification

(c) Communication

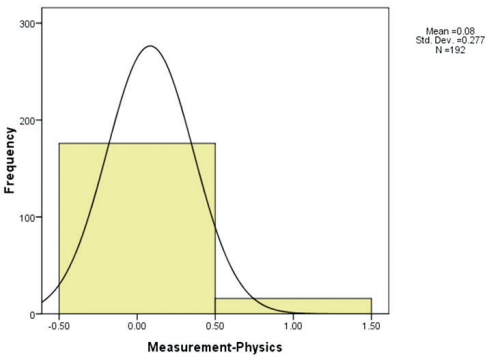
(d) Measurement

(e) Inference

Each process skill in science (Physics, Chemistry, and Biology) for a particular experiment is assessed by a five-point scale. The process skills are assessed as (i) Beginning stage, (ii) Foundation as stage, (iii) Developing stage, (iv) Accomplished stage, and (v) Proficient stage. The scores given for the stages are 1, 2, 3, 4, and 5, respectively.

Data Interpretation and Analysis

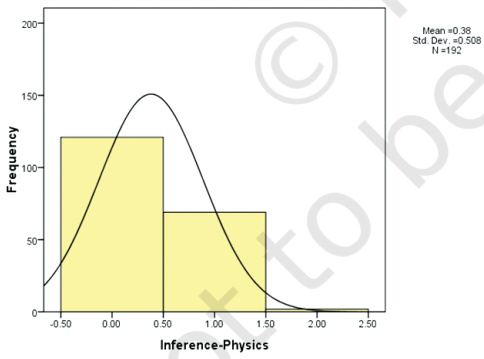
Measurement Skill of Students in Physics



Graph 1: Measurement Skill of Students in Physics

From Graph 1, it is clear that the mean of the process skill test in physics (process skill-measurement) is 0.08. The standard deviation of the scores is 0.277.

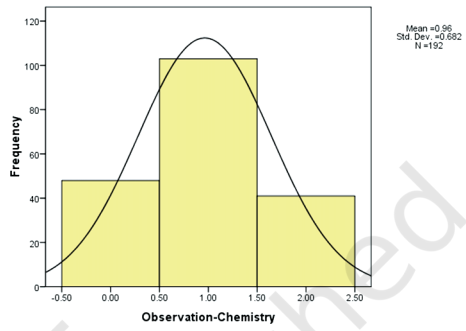
Inference Skill of Students in Physics



Graph 2: Inference Skill of Students in Physics

From Graph 2, it is clear that the mean of the process skill test in physics (process skill-inference) is 0.38. The standard deviation of the scores is 0.508.

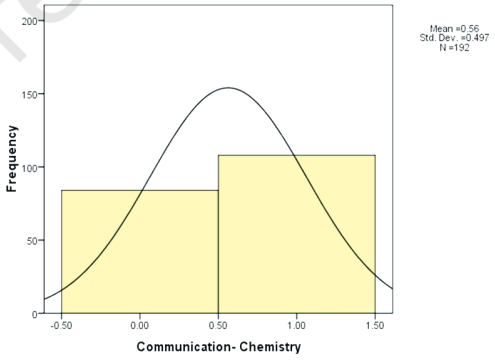
Observation Skill of Students in Chemistry



Graph 3: Observation Skill of Students in Chemistry

From Graph 3, it is clear that the mean of the process skill test in chemistry (process skill-observation) is 0.96. The standard deviation of the scores is 0.682.

Communication Skill of Students in Chemistry

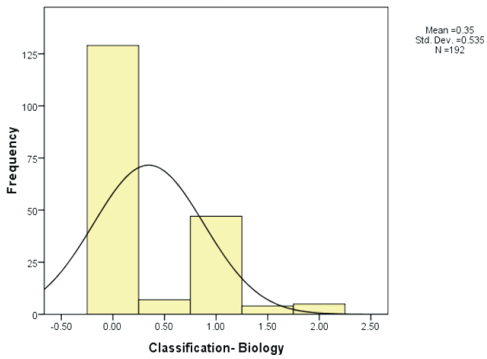


Graph4: Communication Skill of Students in Chemistry

From Graph 4, it is clear that the mean of the process skill test in chemistry (process

skill-communication) is 0.56. The standard deviation of the scores is 0.497.

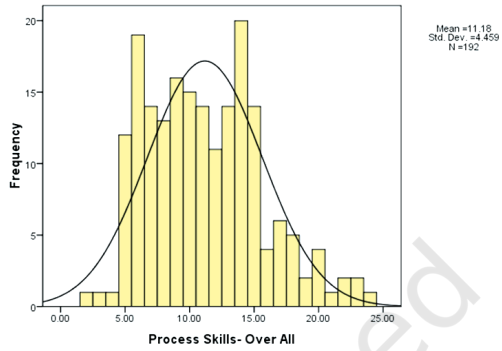
Classification Skill of Students in Biology



Graph 5: Classification Skill of Students in Biology

From the above graph, it is clear that the mean of the process skill test in Biology (process skill-classification) is 0.35. The standard deviation of the scores is 0.535.

Science Process Skill-Overall



Graph 6: Science Process Skill-Overall

From Graph 6, it is clear that the mean of the process skill test in Biology, Physics, and Chemistry is 11.18. The standard deviation of the scores is 4.459.

Table 1: Science Process Skill Test Result

Science Process Skill Test Result					
		Process Skills in Chemistry	Process Skills in Physics	Process Skills in Biology	Process Skills- Over All
N	Valid	192	192	192	192
	Missing	0	0	0	0
Mean		4.44	4.22	3.78	11.18
Std. Deviation		2.02	1.72	1.69	4.46
Variance		4.09	2.95	2.86	19.88
Skewness		-.05	-.02	1.14	.49
Std. Error of Skewness		.18	.18	.175	.18
Kurtosis		-.22	-.60	1.83	-.18
Std. Error of Kurtosis		.35	.35	.35	.35

From the above table, it is evident that the mean scores of 100 students in the process skill test in Chemistry, Physics, and Biology are 4.44, 4.22, and 3.78, respectively, while the standard deviation of the scores is 2.02, 1.72, and 1.69. The skewness of the three scores is -.05, -.02, and 1.14, respectively, which shows that the scores form a normal curve. The kurtosis values of the scores are -.22, -.60, and 1.83, which also proves that the curve is almost normal. The table also shows that the mean score of 100 students in the process skill test, when all the three subjects taken together is 11.18, and the standard deviation is 4.46. The skewness is 0.49, and kurtosis is -.18, which shows that the scores almost follow a normal curve.

Result and Discussion

Regarding the science process skills in Biology, 59.7 per cent of students belonged to the average category, 8.9 students scored low, and 31.4 high. In case of Physics, 76.4 percent of students belonged to the average category, 15.2 students scored low in science process skills, and 8.4 in the high category. In Chemistry, 83.2 percent of students belonged to the average category, 5.8 percent scored low, and 11 percent in the high category.

As the current study was based on the significance of science laboratories in the execution of science process skills at the higher secondary level, it has been established that coordination of theory with practicals is significant for validating concepts and stimulating interest in students' minds. When the students handle the equipment themselves, it gives a deeper understanding. Therefore, there should be proper coordination between theory and practical. When they run parallel to each other, it is helpful in better understanding of the science concepts.

Inference

From the results obtained, we infer the following:

- First, it is observed that nearly all the schools have adequate infrastructure to carry out Physics, Chemistry, and Biology experiments in their laboratories. They had judicious working space, flooring, water supply, ventilation, provision of waste disposal, and electrical connectivity.
- It can be concluded that nearly all the schools under study provided sufficient safety measures for carrying out the experiments in their Physics, Chemistry, and Biology laboratories.
- The study showed that for teaching and dissemination, all the schools under study relied upon blackboard, books, and manuals as teaching aids, and more than half of the schools used e-resources for demonstrating the experiments. Also, more than one-third of the teachers demonstrated the experiments before the practical.
- A limited number of schools made efforts to educate the students about the signs and symbols related to laboratory safety of chemical bottles or any other place.
- Teachers faced difficulty demonstrating biology experiments such as DNA extraction and Salivary Amylase activity due to lack of apparatus. In addition, untrained laboratory staff was also appointed in some schools, and the majority of the staff were not proficient in using the available e-resources.

- Students faced difficulty in performing practicals such as drawing the characteristic curve of the Zener diode and determining its reverse breakdown voltage, finding the focal length of a convex lens by plotting graphs between u and v or between 1/u and 1/v, etc.

Suggestions for teachers and educational planners:

- Information and Communications Technology (ICT) tools should be present in the laboratories. Lack of ICT tools was observed in the schools due to which the teachers were not able to use audio-video materials during practical sessions.
- The laboratory assistants should be given yearly in-service courses to update themselves according to the new techniques in the laboratory.
- There should be proper coordination between theory and practical. When they run parallel to each other, it is helpful in better understanding the science concepts.
- As observed in schools, the equipment was not sufficient for each student to perform the practicals individually, and it is indispensable to have sufficient apparatus and chemicals in providing first-hand experience to the students.
- Schools should have facilities for children with special needs (CWSN) to get good laboratory experiences, ensure better learning of science concepts, and develop science process skills among the students.

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THE PARIS AGREEMENT ON CLIMATE CHANGE

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The impacts of climate change are further exacerbated due to increased frequency and intensity of extreme weather conditions, increase in sea level and acidification of the oceans. The Paris Agreement which lays down an ambitious action plan at limiting global warming to well below 2°C by the end of the century entered into force on 4 November 2016 after its ratification by 103 Parties of 197 Parties to the Convention. Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change. In COP-22, India raised the need to strengthen pre-2020 actions to close the emissions gap and lay down on a timeline for early ratification of the second commitment period of the Kyoto Protocol. India also stressed that climate justice, sustainable lifestyles and poverty eradication should be focused in future discussions.

keywords: Climate change, Kyoto Protocal, Paris agreement, GHGs, UNFCCC, COP, INDCs

The global climate is changing due to emissions of greenhouse gases (GHGs). These changes are expected to result in higher average temperatures, changed rainfall patterns, and increased severity and frequency of floods, droughts and cyclones, which can severely impact livelihoods, especially of the poor in developing countries. The impacts of climate change are further exacerbated due to increased frequency and intensity of extreme weather conditions, increase in sea level and acidification of the oceans. Over the years, the climate change has accentuated large-scale shifts in vegetation that cause major losses of sensitive plant and animal species and significant shifts in the geographic ranges of diseases, their vectors and pathogens.

COP- 21 and the Paris Agreement

The 21st Conference of the Parties (Cop-21) under the United Nations Framework Convention on Climate Change (UNFCCC) was held in Paris, France in the year 2015. It discussed the diverse issues relating to climate change. It adopted the Paris Agreement operating under the framework of the Convention and will succeed the Kyoto Protocol (KP). The Paris Agreement which lays down a motivated action plan at limiting global warming to well below 2°C by the end of the century. It entered into force on 4 November 2016, after its ratification by 103 Parties of 197 Parties. India was the 62nd country to ratify the Agreement with the United Nations on 2 October 2016.

The aim of the Paris Convention is described as "enhancing the implementation" of the UNFCCC through:

(a) Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5°C above pre-industrial levels;

(b) Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions;

(c) Making appropriate finance flows consistent towards low greenhouse gas emissions and climate-resilient development.

The Paris Agreement requires all parties to put forward their best efforts through *Nationally Determined Contributions*.(NDCs) The Paris Agreement strengthens the global efforts in combating climate change. The agreement also provides for enhanced transparency of action. The agreement support through a more robust transparency framework.

The Preamble to the Agreement is significant. It lays emphasis on the principles of Convention including Common but Differentiated Responsibilities and Respective Capabilities (CBRD-RC) and Equity. Hence, safeguarding the interests of developing countries and maintaining differentiation in all pillars of the agreement are the emphasis. It further recognizes the importance of climate justice. It also recognises sustainable lifestyles, as advocated by India, with developed countries taking the lead in addressing the problems of climate change.

One of the important features of the Paris Agreement is that it is not mitigation centric. It covers all pillars of the Durban mandate[1] , i.e., mitigation, adaptation, finance, technology development and transfer, and capacity-building, etc.

India's Expectations on the Outcomes of COP-21, Paris Agreement and Its Decisions

Ensuring fulfilment by developed countries of their existing commitments under the decisions of the UNFCCC and the Kyoto Protocol in the pre-2020 time period:

(i) Many developed countries are yet to ratify the Doha Amendment[2] , which establishes the second commitment period of the Kyoto Protocol (KP). As on date only 73 countries have ratified the Doha Amendment, majority among which are developing countries. Many developed countries, including the European Union, are yet to ratify and implement the Doha Amendment, which commits developed countries who are Parties to the Protocol, to undertake the second commitment period. In fact, the COP-21 decision on enhancing action prior to 2020 urges

[1]The 2011 United Nations Climate Change Conference (COP-17) was held in Durban, South Africa, from 28 November to 11 December 2011 where Parties decided to adopt a universal and legally binding climate agreement by 2015, with work beginning under a new group called the Ad Hoc Working Group on the Durban Platform for Enhanced Action (ADP). The agreement, referred to as the "Durban Platform for Enhanced Action", was notable in that for the first time it included developing countries such as China and India, as well as the US which had refused to ratify the Kyoto Protocol. This apart, Parties also agreed a second commitment period of the Kyoto Protocol from 1 January 2013. A significantly advanced framework for the reporting of emission reductions for both developed and developing countries was also agreed, taking into consideration the principle of common but differentiated responsibilities to establish a new treaty to limit carbon emissions.

[2]COP-18 held at Doha saw the launch of a second commitment period under the Kyoto Protocol, from 1 January 2013 to 31 December 2020, with the adoption of the Doha Amendment to the Kyoto Protocol on 8 December 2012.The amendment includes:New commitments for Annex I Parties to the Kyoto Protocol who agreed to take on commitments in a second commitment period from 1 January 2013 to 31 December 2020; A revised list of greenhouse gases (GHG) to be reported on by Parties in the second commitment period; and Amendments to several articles of the Kyoto Protocol which specifically referenced issues pertaining to the first commitment period and which needed to be updated for the second commitment period.

all Parties to the Kyoto Protocol to ratify and implement the Doha Amendment.

(ii) In relation to the support of financial resources from developed to developing countries, in Cancun in 2010, Parties had agreed that developed countries will mobilise US $100 billion per year by 2020 for developing countries. However, developed countries have fallen short from fulfilling this commitment in totality with only US $9.9 billion contributed to the Green Climate Fund. Through the COP-21 decision, it was agreed that developed countries will "enhance the provision of urgent and adequate finance, technology and capacity-building support in order to enhance the level of ambition pre-2020 actions by Parties" and developed countries were strongly urged "to scale up their level of financial support, with a concrete roadmap to achieve the goal of jointly providing US $100 billion annually by 2020 for mitigation and adaptation while significantly increasing adaptation finance from the current levels and to further provide appropriate technology and capacity-building support." Whether developed countries will provide a concrete roadmap on the provision of the US $100 billion annually by 2020 will be an important indicator to gauge, if their commitments will be honoured.

(iii) The Parties agreed that at COP-22 (in 2016), there will be a "facilitative dialogue" "to assess the progress" in implementing the decisions reached under the Convention. the KP (Bali Roadmap) and to identify relevant opportunities to enhance the provision of financial resources, including the technology development and transfer with a view to identifying ways to enhance the ambition of mitigation efforts. This facilitative dialogue presents insignificant chance to assess progress on whether the existing commitments of developed countries are being fulfilled, as agreed to under the Durban mandate. If there is reluctance on the part of the developed countries to honour their pre-2020 commitment, there will be considerable doubt as to whether they will meet their obligations under the Paris Agreement. In COP-22, our country raised the need to strengthen pre-2020 actions to close the emissions gap and lay down on a timeline for early ratification of the second commitment period of the Kyoto Protocol. India also stressed that climate justice, sustainable lifestyles and poverty eradication should be discussed in future.

(iv) Green Climate Fund (GCF) is a vital mechanism for the developing countries to implement their climate action plans. It is critical for the countries to observe the fulfilment of the GCF's approval of projects for funding this year. The approval of funding proposals is now on hold for completing the remaining policy discussions within the GCF Board in order to meet the goal of disbursements of US $2.5 billion last year. There is a need to obtain clarity on the type of financing that will be available, the balance between

loans versus grants, the balance between funding for adaptation versus mitigation, as well as the process of replenishment of the GCF's funds. This was tentatively targeted to take place by June 2017. If this mechanism is not able to respond sufficiently to the needs of developing countries for the implementation of their current plans and actions, it will be even harder for many developing countries to implement their NDCs under the Agreement post-2020.

Tasks Pending in Preparation for the Paris Agreement

There are several critical tasks that are pending in preparation for the Paris Agreement. Some of the key issues that are critical for developing countries in advancing their commitments under the Paris Agreement are as set out below.

(i) *Warsaw International Mechanism for Loss and Damage*[3] : COP-21 decided that Warsaw International Mechanism for Loss and Damage (WIMLD) is to continue, following its review in 2016. It will be vital to review the working of the WIMLD, to take stock of whether the Loss and Damage Mechanism is able to respond to the needs of developing countries. If it is a token mechanism, then, it will be important to focus on the usefulness of the mechanism from the view point of the developing countries. If developed countries will allow important outcomes on Loss and Damage under the Paris Agreement, including as to how developing countries can secure financial, technological and capacity-building support for this very significant element of the agreement.

(ii) *Process for Identifying Information on Financial Support to be provided by Developed Country Parties:* Developed countries are "to biennially communicate indicative quantitative and qualitative information" on the provision of financial support and mobilisation of financial resources and "the projected levels of public financial resources" to be provided to developing countries. It will be critical to gauge how developed countries engage in relation to this in order to assess their commitments to developing countries.

(iii) *Elaboration of the Technology Framework and Assessment of the Effectiveness of Technology Mechanism:* In Paris, developing countries fought hard to have commitments for developed countries to effectively transfer technology to developing countries. In the COP-21 decision, the Subsidiary Body for Scientific and Technological Advice (SBSTA) has been tasked to elaborate the technology framework under the Paris Agreement. Whether the technology framework will deliver meaningful outcomes for developing countries remains to be seen and will

[3]At the Conference of Parties 19 (COP-19, November 2013) held in Warsaw, Poland, the COP established the Warsaw International Mechanism for Loss and Damage associated with Climate Change Impacts (Loss and Damage Mechanism), to address loss and damage associated with impacts of climate change, including extreme events and slow onset events, in developing countries that are particularly vulnerable to the adverse effects of climate change.

be a hard struggle for the developing countries, given the resistance of developed countries to be serious about effective and meaningful technology transfer. Further, at Paris, Parties agreed that the Subsidiary Body for Implementation (SBI) will initiate the elaboration of modalities for the periodic assessment of the effectiveness and adequacy of the support provided to the Technology Mechanism. This will be another measure of whether there will be any meaningful assessment of the Technology Mechanism.

(iv) *The Paris Committee on Capacity-building:* COP-21 agreed for the establishment of the Paris Committee on Capacity-building (PCCB). This was a hard fight by developing countries to get an effective institution to address the various problems that the developing countries face in relation to their capacity needs. The PCCB's work plan for 2016-2020 is yet to be developed and much remains to be done to evolve this institution into one that works for developing countries.

Securing the Conditions for the Implementation of the Intended Nationally Determined Contributions (INDCs) under the Paris Agreement

Several developing countries have submitted their INDCs prior to the agreement reached in Paris. All parties under the Paris Agreement have agreed to undertake their INDCs. Most of the INDCs of developing countries are dependent on the provision of finance, technology transfer and capacity-building support. Significantly, if these 'enablers' of actions in developing countries are not in place prior to the coming into effect of the Agreement as set out above, it will be very hard for the developing countries to keep to their commitments. Pressure would be brought to bear on developing countries for non-implementation of their actions. It is important for the developing countries to have confidence that they can implement their INDCs with the enabling factors put in place, before their signing of the Paris Agreement.

The UN Climate Change Conference (COP-22)

The UN Climate Change Conference (COP-22) held in Marrakesh from 7 to 18 November 2016, marked the crucial next step for the governments looking to operationalise the Paris Climate Change Agreement. With Paris Agreement already into force, the dialogue and decisions in Marrakesh gained incredible importance and held immense potential to accelerate and amplify the immediate response to the challenge recognised in the Paris Agreement.

COP-22 thus took over the reins from COP-21 during which important progress was made with the adoption of the Paris Agreement on Climate Change. COP-22 was more action-oriented focusing mainly on formalising the Rulebook for the Paris Agreement, especially related to adaptation, transparency, technology transfer, mitigation, capacity building, and loss and damages. At Marrakesh Climate Change Conference (COP-22), nations of the world continued their work on strengthening global response to the threat of climate change, with the central focus placed on enhancing ambition, promoting implementation, capacity building and, providing support— both technological

and financial to the developing countries. While the Paris Agreement gave clear pathways and a final destination in respect to decisive action on climate change, the relevant first step for many of the details regarding how to move forward as one global community in that common direction was initiated at Marrakesh.

First meeting of the Conference of the Parties serving as meeting of the Parties to the Paris Agreement: COP-22 also witnessed the first meeting of the CMA which in the parlance of the UN Climate Change process stands for the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement under the UNFCCC. The CMA has been tasked to take forward decisions on matters assigned to it.

Rule Book: Another key milestone of COP-22 is the initiation on the direction of negotiating the Paris Agreement's implementation rule book. It is the rule book that will make the agreement functional, setting out the detailed requirements under each section.

Enhanced Finance, Technology Transfer and Support for Capacity Building: Another key issue which found focus at COP-22 relates to ensuring the availability of finance committed by developed countries to the developing countries. Finance and technology transfer is key to enabling the developing countries to fulfil their commitments in line with their respective NDCs. COP-22, thus began working on the roadmap for ensuring enhanced finance and technology transfer which is vital to advance the Paris Agreement on Climate Change. India stressed that on both these aspects the basic principle of equity and common but differentiated responsibilities laid down by the UN Framework Convention on Climate Change is upheld. The developing countries, including India demanded suitable high financial flows to both mitigate emissions and prepare communities to adapt to climate change. New and additional funds and technology will enable countries to integrate their national commitments into actual policies and investment plans. Further decisions were also taken to facilitate capacity building of the developing countries.

Managing Rise in Global Temperature: The fact that the average global temperature has already risen somewhere around one degree from pre-industrial times and global greenhouse gas emissions have not yet peaked, underlined the urgency of implementing the Paris Agreement in full and in this light the COP-22 stressed on the governments to take action to achieve the temperature goals enshrined in the Agreement – keeping the average global temperature rise below 2° C and pursuing efforts to limit it to 1.5 degrees.

India at COP-22

India Pavilion at COP-22: Showcasing India's theme 'Sustainable Lifestyle: Positive Climate Action' for COP-22 at Marrakesh, India Pavilion took India's message forward and played a defining role in sharing and disseminating information on India's approach towards combating the grave threat posed by climate change. A number of sessions, in the form of panel discussions, documentaries and presentations, were hosted by the India Pavilion from 8-18 November 2016, which showcased India's initiatives and actions and gave an opportunity to visitors and invited

experts to engage in discussion and think of new solutions and ideas.

Highlighting Impact of Climate Change on Disasters, Biodiversity and Agriculture: India at COP-22 highlighted the impact of climate change on disasters, biodiversity and agriculture. The Himalayas provide water to 1.3 billion people in Asia and though the Himalayan region is warming up faster than the global average, they have been inadequately represented over the past three decades in climate change discussions. Therefore for the emergent need to chart climate change mitigation plan for the region, India hosted a special side event at COP-22 highlighting the impact of climate change on its 12 Himalayan States.

International Solar Alliance[4] *:*The framework Agreement for International Solar Alliance was opened for signature from 15 November 2016 in Morocco. Twenty-four countries have signed the Framework Agreement of ISA since it was opened for signature on 15 November 2016 in Marrakesh, Morocco on the side-lines of COP-22.

Conclusion

Developing countries are most vulnerable to climate change because they have the least capacity to adapt. On its part, India is strongly committed to engage constructively and productively with the international community in the global efforts to preserve and protect the environment. India firmly believes that any future agreement should take into account developing countries' concerns and their developmental requirements fully. Developing countries should have the discretion to fulfil their domestic goals in accordance with their national circumstances through a legally appropriate regime having binding force at the international level.

[4]The International Solar Alliance is a common platform for cooperation among sun-rich countries lying fully or partially between the Tropics of Cancer and Capricorn who are seeking to massively ramp up solar energy, thereby helping to bend the global greenhouse emissions curve whilst providing clean and cheap energy.

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THE SIMPLE CLASSROOM METHOD TO DEMONSTRATE THE LAW OF CONSERVATION OF MASS

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Laboratory methods that are given to verify the law of conservation of mass require an accurate balance and weighed amount of material for performing the activity. Generally, a precipitation reaction is preferred in these activities to show that a chemical reaction has occurred, and verification requires careful mass measurement before and after the reaction. This paper deals with a straightforward and fast method with very low/no-cost involvement and uses environment-friendly materials.

Keywords: Chemical change, Physical change, The law of conservation of mass

Introduction

Most of the teachers use the reaction between barium chloride and sodium sulphate in a closed system as prescribed in the standard laboratory manuals (NCERT, 2008;edu.rsc.org, 2021; Green, 2020; VDOE, (n.d)). An alternative method to verify the law was given in 1943 by Louis Weiss (Weiss, 1943), in which a photoflash bulb was used. Unfortunately, the method could not become popular due to the unavailability of this bulb everywhere. This method also requires an accurate balance. The precipitation reaction is preferred because of its simplicity and safety. The present proposed method is simple and safer than earlier reported methods. The formation of gas in a closed system is used to indicate a chemical reaction.

Materials required

- Empty Plastic bottle of 500 mL capacity
- Vinegar
- Baking Soda
- Rubber balloon
- Thread
- Sketch pen
- Spring balance.

Method and Observations

- Take an empty mineral water/cold drink bottle of 500 ml capacity. Pour about 100 mL of vinegar solution into it. Tag thread at the mouth of the bottle so that it can be hung on a spring balance. Take a rubber balloon, widen its mouth and fill 1-2 teaspoons full of baking soda in it.

- Stretch the mouth of the balloon and fix it at the mouth of 500 mL bottle containing vinegar solution. Do not pull the balloon upward to avoid mixing baking soda powder with the vinegar solution in the bottle.
- Now hang the above arrangement on the hook of the spring balance with thread and mark the position of the pointer of the spring balance with the help of a sketch pen (Fig. 1).
- Now pull the balloon upward and allow the baking soda powder to pour down into the bottle containing vinegar. Carbon dioxide gas will form according to the following reaction.

$$CH_3COOH\ (aq) + NaHCO_3(s) \rightarrow CH_3COONa\ (aq) + CO_2\ (g)$$

- The gas will be released with brisk effervescence and move upward with pressure. This results in the inflation of the balloon (Fig 2), which is the indication of the occurrence of a chemical reaction.
- Record any change in the position of the pointer of the spring balance after completion of the chemical reaction (inflated balloon).
- The same activity may be performed by taking some crushed ice into the bottle and recording any mass change when all the ice melts (for observing any change in mass for the physical change).
- Teachers may use any citrus juice/tamarind juice /amla juice in place of vinegar and washing soda in place of baking soda as per local availability.

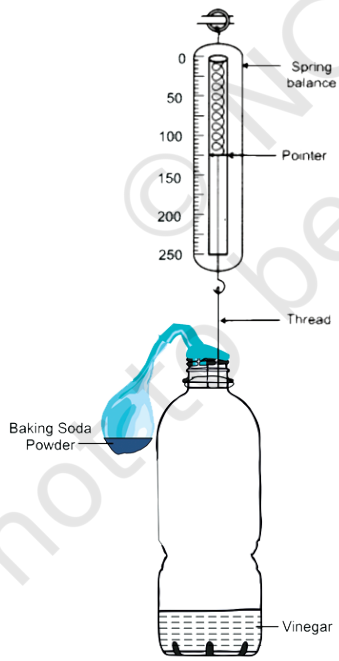

Fig. 1: Before Reaction

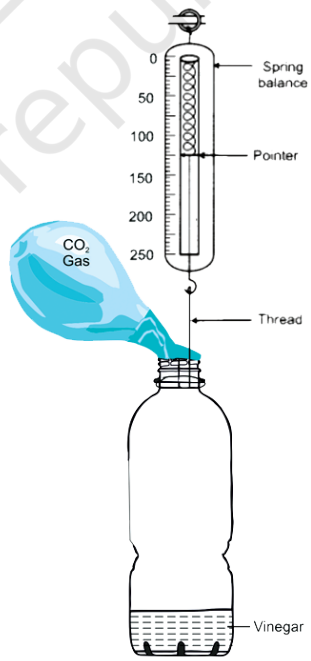

Fig. 2: After Reaction

Result

No change in that the position of the pointer of the spring balance indicates that mass remains conserved during any physical/ chemical change.

Conclusion

This paper presents a straightforward, safer, and less time-consuming classroom demonstration method to verify the conservation of mass. The materials required are eco-friendly and locally available everywhere, so it is a greener method too.

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BIOLOGICAL DISASTERS IN PRESENT PRESPECTIVES

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Biological disasters are organic origin, including pathogenic microorganism, toxins and bioactive substances. In recent years, biological disasters have become a serious problem for health, environment, and national security. These disasters are of organic origin and can include pathogenic microorganisms, toxins, and bioactive substances. Biological disasters can take the form of an epidemic or pandemic level and can be caused by diseases such as plague, cholera, H1N1 (Swine Flu), and influenza outbreaks. The Center for Disease Control (CDC) has categorized biological Disaster into four bio-safety levels (BSL 1-4) to help manage the risks associated with handling biological materials. It is essential to improve the current understanding of health hazards caused by biological disasters. Preventing and preparing for biological disasters requires assessing the risks, medical and public health consequences, medical countermeasures, and long-term strategies. Environmental monitoring can help substantially in preventing outbreaks of waterborne, airborne, vector-borne, and zoonotic diseases. Personal protective equipment like masks, gloves, protective clothing, eye shields, face shields, and shoe covers can help eliminate the source of contamination. Individuals can take steps to prevent disease by eating nutritious balanced food, maintaining up-to-date immunization status, preventing overcrowding, maintaining good ventilation, and protecting themselves from hot and cold weather. Medical treatment for biological disasters may focus on both non-Pharmaceutical and Pharmaceutical approaches. To prevent and control biological disaster, it is crucial to develop capacities, strengthen the existing legislative/regulatory framework, provide mental health support, offer rehabilitation and specialized healthcare, and establish laboratory facilities. Being vigilant and taking proactive measures can help prevent and control biological disasters.

Keywords -Biological disasters, Biological hazards, National Disaster Management Authority (NDMA), State Disaster Management Authority (SDMA), District Disaster Management Authority (DDMA), National Executive Committee (NEC), National Disaster Response Force (NDRF) and National Institute of Disaster Management (NIDM).

Introduction

Biological disasters refer to natural events that cause disability, disease, or death on a large scale among living organisms due to other living organisms and their products. These disasters can occur as epidemics or pandemics. Epidemic-level biological disasters affect a large number of individuals within a population, community, or region at the same time, while pandemic-level biological disasters spread across a large region, such as an entire continent or the world. Examples of epidemic-level biological disasters include cholera, Ebola, dengue fever, malaria, and measles, while examples of pandemic-level biological disasters include H1N1 (Swine Flu) and influenza outbreaks. Biological disasters, such as pandemics and disease outbreaks, have become a major concern in recent years due to the increased globalization, human activity &mobility of people and goods, as well as the emergence of new infectious agents. Human activity causes destruction to people and their way of life, it can be considered a severe and extreme hazard. A biological disaster occurs when harmful agents, such as bacteria or viruses, enter a vulnerable population in an environment that supports their growth and propagation. It is difficult to determine precisely when an outbreak reaches epidemic proportions and when it becomes a full-fledged disaster, as there is no clear

Source:https://freesvg.org/vector-illustration-of-internation-al-biohazard-symbol

consensus on the matter. The movement or migration of people to new locations can lead to a biological disaster. One notable historical example is the Plague or Black Death, which originated in western Asia and spread via Asian brown rats aboard a cargo ship that travelled between Italy and the eastern Black Sea during the middle Ages. Similarly, AIDS (HIV) also spread through the movement or migration of people to and from different places. Recent biological disasters include the Ebola outbreak in West Africa, which resulted in over 11,000 deaths, and the Zika virus epidemic in South America, which caused birth defects in thousands of infants. The COVID-19 pandemic, caused by the SARS-CoV-2 virus, has been the most significant biological disaster in recent times, with millions of people infected and hundreds of thousands of deaths worldwide.

Biological Safety Levels

The US Center for Disease Control (CDC) has categorized biological disaster or biological hazards into four bio-safety levels or BSL 1-4—

BSL-1: At this level, bacteria and viruses including Bacillus subtilis, canine hepatitis, Escherichia coli, varicella (chickenpox), some cell cultures, and non-infectious bacteria are present. Gloves and facial protection are important precautions to take at this level.

BSL-2: In this level, moderate-risk infectious agents or toxins cause only mild disease, such as hepatitis A, B and C, some Lyme disease, influenza A strains, salmonella, mumps, measles, scrapie, dengue fever, HIV. BSL-2 takes extreme precautions for safety purposes including the use of autoclaves for sterilizing and biological cabinets

BSL-3: In this level, biological hazards generally have known vaccines or treatments. Bacteria and viruses that can cause severe to fatal diseases in humans such as anthrax, West Nile virus, Venezuelan equine encephalitis, Severe Acute Respiratory Syndrome (SARS) virus, Middle East Respiratory Syndrome (MERS), corona virus, hantaviruses, tuberculosis, typhus, Rift Valley fever, Rocky Mountain spotted fever, yellow fever, malaria, and trypanosomiasis come under this level.

BSL-4:At this level, effective treatment or vaccines are not available for viruses that pose a potentially fatal threat to humans, such as the Marburg virus, Ebola virus, Lassa fever virus, Crimean-Congo hemorrhagic fever, and other hemorrhagic diseases. To ensure maximum safety and prevent transmission, strict protocols are necessary, which may involve the use of a positive pressure personnel suit. This suit comes with a segregated air supply and provides a barrier between the wearer and the virus. Additionally, an ultraviolet light room, multiple showers, and an autonomous detection system may be included in the protocols to further minimize the risk of infection.

Legal /Institutional and Policy Framework

Legal Framework

- The state government has the primary responsibility of tackling biological disasters according to the Indian Constitution. Health is a state subject. Several legislations control and govern the nation's health policies. Our government can enforce these legislations to contain the spread of diseases. Some of the commonly used legal instruments are discussed below;--

Legislation that supports health Action at Grass-Root Level

- The Panchayati Raj and Municipal Acts provide legislation to support health action at the grass-root level, including provision of safe drinking water, hygiene and sanitation, food safety, notification and control of diseases, and public health concerns, including containment of outbreaks.

State and District Level

The Epidemic Diseases Act (Act 111 of 1897) empowers the states to take measures for the prevention and control of dangerous epidemic diseases, thereby improving their ability to contain and prevent the spread of such diseases. This Act allows the states to designate specific officers or agencies to carry out these measures.

National level

There are several legislations that control and govern the nation's health policies. The government can enforce this legislation to contain the spread of diseases. The Water (Prevention and Control of Pollution) Act, 1974, The Air (Prevention and Control of Pollution) Act 1981, provide prevention and control of Water and Air pollution. The Environmental (Protection) Act, 1986 protect the environment and empowers the government to take all measures as it deems necessary or expedient for protecting and improving the quality of the environment and, controlling, preventing and abating environmental pollution. This Act also provides for the Biomedical Waste (Management and Handling) Rules, 1998 to control the indiscriminate disposal of a hospital/biomedical wastes

The Disaster Management Act (DM Act) provides an institutional and operational at all levels for disaster prevention, mitigation, preparedness, response, recovery and rehabilitation This includes National Disaster Management Authority (NDMA), State Disaster Management Authority (SDMA), District Disaster Management Authority (DDMA), National Executive Committee (NEC), National Disaster Response Force (NDRF) and National Institute of Disaster Management (NIDM).

International Level

International Health Regulation (IHR2005) was adopted by the World Health Assembly on 23 May' 2005 that came into force on 15 June' 2007. The purpose of this regulation is to control, prevent, and provide a public health response to the international spread of disease and to avoid unnecessary interference with international traffic and trade.

Biological and Toxin Weapons Convention (BTWC)

The Biological and Toxin Weapons Convention (BTWC) is an international treaty that was established on March 26th ,1975. Its main objective is to prohibit the development,

production, stockpiling, and use of biological and toxin weapons, and to promote their destruction. The treaty has been signed by 183 countries and is considered a crucial component of international efforts to prevent the use of biological and toxin weapons in warfare.

The BTWC is designed to prevent the use of biological and toxin weapons, which can have devastating effects on human populations and the environment. The treaty requires signatory states to destroy any existing stockpiles of these weapons and to refrain from developing or acquiring them in the future. The BTWC also includes measures to monitor compliance and ensure that countries are adhering to its provisions.

Institutional and Policy Framework

The National Disaster Management Authority (NDMA) was established under the Disaster Management Act 2005 to provide effective management of disasters. The NDMA works closely with national, state, and district-level authorities to plan, prepare, and ensure a rapid response to both natural calamities and man-made disasters/accidents. Here's how the NDMA's structure and functions have been designed to achieve this:-

National Disaster Management Authority: The NDMA is the apex body responsible for formulating policies, plans and guidelines for disaster management at the national level. It consists of a Chairperson, Vice-Chairperson, and members appointed by the central government.

National Executive Committee: The NEC is responsible for implementing the policies and plans formulated by the NDMA. It consists of the Union Home Secretary, Secretaries of various ministries, and experts in the field of disaster management.

State Disaster Management Authority: Each state has its own SDMA, responsible for implementing disaster management policies and plans at the state level. It consists of a Chairperson, Vice-Chairperson, and members appointed by the state government.

District Disaster Management Authority: Each district has its own DDMA, responsible for implementing disaster management policies and plans at the district level. It consists of a Collector or District Magistrate as Chairperson, and other members appointed by the district government.

In the context of biological disasters, the National Crisis Management (NCMC), National Disaster Response Force, Ministry of Home Affairs, and Ministry of Health and Family Welfare play a key role in controlling the spread of diseases. The Ministry of Health and Family Welfare is the nodal ministry responsible for decision-making and managing epidemics, providing advisory services, and emergency medical relief. The National Institution of Communicable Diseases (NICD) is the primary agency responsible for investigating outbreaks, while the Indian Council of Medical Research (ICMR) provides laboratory support, teaching, training, and research

The World Health Organization (WHO) The WHO is crucial in enhancing global health security by focusing on outbreak alerts and response through activities such as information collection and dissemination, verified information dissemination, technical support provision, and strengthening national surveillance programs. These activities help detect and respond to disease outbreaks,

ultimately contributing to global health security.

Prevention and Preparedness of Biological Disasters

Prevention and preparedness shall focus on the assessment of bigheads, medical and public health consequences, medical countermeasures, and long-term strategies. They are useful in reducing vulnerability and mitigating the post-disaster consequences. The important components of prevention and preparedness include:-

Pre-exposure immunization (preventive): Vaccination is an essential component of biological disaster prevention. It can prevent individuals from contracting a disease, thereby reducing the spread of infection.

Epidemiological intelligence gathering mechanism: The collection and analysis of epidemiological data can help identify potential outbreaks and assess their potential impact.

Robust surveillance: Robust surveillance system can detect early warning signs is critical for preventing and responding to biological disasters. It can help identify outbreaks before they become widespread and allow for a more effective response.

Capacity building for surveillance, laboratories, and hospital systems: Capacity building is critical for developing the infrastructure necessary to detect, investigate, and manage outbreaks. It includes training for healthcare professionals, development of laboratory capacity, and the establishment of appropriate hospital systems.

Environmental Management: Epidemics can often be caused by diseases transmitted through water, air, vectors, or zoonotic sources. Effective environmental monitoring is crucial in preventing epidemics. One approach to preventing epidemics is through integrated vector management, which involves the use of environmental engineering, chemical interventions, and biological methods to eliminate breeding places and control vectors. In the event of a biological disaster resulting in mass casualties, proper disposal procedures for dead bodies are necessary. To prevent waterborne diseases such as cholera, hepatitis, diarrhea, and dysentery, safe drinking water is essential. Promoting personal hygiene by educating the community about washing, cleaning, bathing facilities, and avoiding overcrowding in sleeping quarters can also be effective. Vector control is another important aspect of epidemic prevention, which includes environmental engineering and genetic integrated control measures, as well as evacuating breeding places through water management and regular spraying of insecticides.

Overall, the prevention of biological disasters requires a multifaceted approach that includes vaccination, epidemiological data collection and analysis, a robust surveillance system, capacity building for surveillance, laboratories, and environmental management and hospital systems.

Prevention of Post-disaster Epidemics

To prevent the outbreak of epidemics in the aftermath of disasters, it is critical to implement preventive measures such as Disease Surveillance Systems. These systems involve teams monitoring potential sources of infection, investigating the spread of epidemics, and identifying modes of transmission to quickly respond and

mitigate potential outbreaks. Ensuring the proper disposal of dead bodies is a crucial component of these measures, as it can help prevent the spread of disease and reduce the risk of post-disaster epidemics

Preventive and Control Measures of Biological Disasters

To prevent and control biological disasters, it is essential to target the source of contamination. Here are some effective measures that can be taken to prevent such disasters:-

Engineering controls are measures that are put in place to reduce exposure to hazards in the workplace by modifying the physical environment or tools. These controls are critical in preventing the spread of infections or contaminants in the workplace. The main goal of engineering controls is to address the source of the hazard, prevent it from being released into the environment, and control its transmission.

Implementing engineering controls is an important aspect of a comprehensive approach to managing the spread of infectious diseases and other hazards. While administrative controls such as policies and procedures and personal protective equipment such as masks and gloves are essential, engineering controls are also necessary to minimize the risk of exposure to hazards in the workplace.

By using engineering controls in combination with other measures, employers can help to create a safer working environment for employees and the public. This can lead to improved health outcomes, reduced absenteeism, and increased productivity.

Maintaining good personal hygiene is crucial in preventing infections, and one of the most fundamental ways to achieve this is by washing your hands with liquid soap. It is recommended that everyone should make it a habit to wash their hands before and after work or before and after wearing protective clothing to minimize the risk of transmitting germs and harmful bacteria, which can cause illnesses and diseases. By doing so, you can keep yourself and others healthy. Therefore, it's important to incorporate hand-washing with liquid soap into your daily routine.

Personal protection is important to regularly practice good personal hygiene habits such as frequent hand washing, covering one's mouth and nose when coughing or sneezing, and avoiding touching one's face. By doing so, individuals can reduce the transmission of germs and viruses, which can lead to illnesses and infections.

When choosing personal protective equipment, it is important to consider the features and level of protection offered by each item. For instance, protective clothing should be made from waterproof and impervious materials to prevent the transmission of harmful pathogens. Safety goggles and face shields can protect the eyes from splashes and airborne particles, while gloves can protect the hands from contact with contaminated surfaces. Shoe covers can also help prevent the spread of pathogens from contaminated floors and surfaces.

It is also crucial to properly sterilize and maintain personal protective equipment to ensure its effectiveness. Sterilization methods may include disinfecting surfaces with appropriate cleaning agents or using specialized sterilization equipment such as autoclaves.

In the face of a biological disaster, it is crucial to have adequate respiratory protective

equipment to safeguard oneself against the disaster. There are several types of protective equipment available, each serving a unique purpose. These include surgical masks, N95 or higher-level respirators, powered air-purifying respirators, and air-supplying respirators.

Aside from personal protective equipment, education and awareness campaigns can also play a critical role in preventing and controlling the spread of diseases. Research on infectious diseases can lead to a better understanding of their transmission and provide insight into effective prevention and control strategies. Effective surveillance systems can also help identify potential sources of contamination and enable prompt action to prevent further spread of the disease.

Ultimately, promoting good personal hygiene practices and adopting personal protective measures can help create a clean and healthy environment and reduce the spread of harmful germs and viruses..

Medical treatment is an essential part of emergency care, but it is not always the first option to consider. Instead, it is important to prioritize preventive measures that can help reduce the likelihood of needing medical treatment in the first place. Some of these measures include:

Eating nutritious and balanced food: Proper nutrition is important for overall health and can help boost the immune system, making it more resistant to disease.

Maintaining up-to-date immunization status: Vaccines are a highly effective way to prevent the spread of many communicable diseases and can help protect both individuals and communities.

Preventing overcrowding: Overcrowding in public places can increase the risk of communicable disease transmission. Limiting the number of people in a given space can help reduce this risk.

Maintaining good ventilation: Good ventilation can help reduce the concentration of airborne pathogens, reducing the risk of disease transmission.

Protecting from hot and cold weather: Extreme temperatures can increase the risk of heat or cold-related illnesses. Taking steps to protect oneself from these conditions can help prevent the need for medical treatment.

When medical treatment is necessary, both non-pharmaceutical and pharmaceutical interventions can be used. Non-pharmaceutical interventions include measures such as social distancing, isolation and quarantine, and biosafety and biosecurity. These measures can help prevent the spread of disease and protect public health. Pharmaceutical interventions include chemoprophylaxis, immunization, and other preventive measures. These interventions can help prevent disease and reduce the severity of illness in those who do become infected. It is important to use these interventions in a targeted and evidence-based manner to maximize their effectiveness.

Overall, a comprehensive approach that includes both non-pharmaceutical and pharmaceutical interventions is needed to promote public health and prevent the spread of disease. By prioritizing prevention and early intervention, we can reduce the need for medical treatment and improve overall health outcomes.

Conclusion

While biological disasters such as pathogenic toxins, microorganisms, and bioactive substances are naturally occurring, they pose a serious threat to health, environment, and national security. In recent years, the frequency and severity of these hazards have increased, leading to devastating consequences including mass mortality. To address these challenges, it is essential to enhance our current understanding of the health risks associated with biological disasters and adopt a comprehensive, proactive, and technology-driven approach to their management. This requires a focus on preparedness activities, biosafety and biosecurity measures, and vigilant prevention and control efforts through capacity development, strengthened legislative and regulatory frameworks, mental health support, rehabilitation, and specialized healthcare and laboratory facilities. By taking a holistic and coordinated approach, we can minimize the impact of biological.

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ASSESSMENT OF STUDENTS' UNDERSTANDING OF THE SALT HYDROLYSIS: MISCONCEPTIONS AND CLARIFICATIONS

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Salt hydrolysis is an important concept in acid-base chemistry. Students are often given a qualitative idea at the secondary level and quantitative information at the college level in the curriculum. In literature, this concept is reported to be vague for students at all stages of education. Hence, the present study is undertaken to integrate both theoretical and practical aspects of this complex phenomenon. The microscale chemistry technique is used in place of a traditional chemistry laboratory to reach a large number of students as it is SEAT friendly, i.e., S (Student), E (Environment), A (Administrator), and T (Teacher). The investigation is conducted in three parts, a pre–laboratory interactive session followed by experimentation and a post–laboratory discussion. The outcome of the study is very encouraging, as revealed by students' feedback. Participants could understand the phenomenon of salt hydrolysis, obtain hands-on-experience, and could predict hydrolysis behaviour of salts of various types (strong acid–strong base; strong acid–weak base; weak acid–strong base; weak acid–weak base It is felt that in dealing with the concepts of chemistry, wherever feasible, teachers can adopt an integrated approach involving experimentation rather than restricting themselves only to descriptive chemistry.

Keywords: Salt hydrolysis, acids, bases, neutralization, constructivist approach, microscale chemistry technique, microscale chemistry laboratory kit, integrated approach, pH value, universal indicator solution

Introduction

Hydrolysis is a chemical reaction in which water breaks the bond between the compounds and makes bond between the compounds and changes its makeup. Both organic and inorganic compounds undergo hydrolysis. In most instances of organic hydrolysis, water combines with neutral molecules; while in inorganic hydrolysis, water combines with ionic molecules such as acids, bases, and salts. In the science curriculum, hydrolysis is an important concept in chemistry and biology. This phenomenon is taught in the chemistry curriculum from secondary to college level. Hydrolysis, being an interdisciplinary topic, finds significance in daily life also, as evidenced by mention in ATP hydrolysis (Biology), digestion process (Biochemistry), Saponification, conversion of ester into acid and alcohol (Chemistry). Hydrolysis is not taught as a separate unit/theme in the curriculum despite its biological and industrial importance. Only qualitative aspects are dealt with in undergraduate courses, and quantitative descriptions and related mathematical relations are discussed at the college level. The concept of 'Salt' introduced in Bronsted-Lowry acids and bases, is erroneously understood and limited to reverse of neutralization. Salt hydrolysis is a reaction when a salt completely dissociates in an aqueous medium, and its anion/cation reacts with water to produce hydroxide ions or hydronium ions that affect the pH of a

solution. A hydration reaction is a chemical reaction in which a substance is surrounded by water molecules. Often the terms 'hydration' & hydrolysis' apparently cause misconceptions among students.

Aqueous phase reactions constitute an essential chemistry component at the secondary, senior secondary, and college or upper senior secondary stages of the science curriculum. Unfortunately, few studies have examined students' understanding and have identified misconceptions or alternate ideas in some concepts, especially those that are multidisciplinary. For example, acids and bases (Cooper 2016, Pan and Henriques 2015, Boz 2009, Kousathana, et al., 2005), Chemical equilibrium (Hackling 1985), Electrochemistry (Anita and Lee 2016), Chemical bonding (Vrabec and Proksa 2016), Atomic structure (Papageorgiou et al., 2016), Nuclear Chemistry (Usta and Ayas, 2010) are a few which are of interest to investigators.

Salt hydrolysis is an essential concept in acid-base chemistry. Incidentally, this is recorded as one of the topics well known to cause many misconceptions among students. (Demircioglu 2009, Secken 2010, Putri 2014). These studies are based on testing students' knowledge using a questionnaire/test consisting of open-ended and multiple-choice items, correlating textbook information with students' responses, by the tasks assigned to write chemical equations/products obtained after salt hydrolysis, stating acidic/basic nature of salt solutions, etc. Orwat et al. (2017) suggested that laboratory exercises can help understand the phenomenon of salt hydrolysis. However, no concerted efforts are reported in this direction.

Experimentation is an important means of combining knowledge, creativity, and skills to examine hypotheses. In addition, this approach provides hands-on experience about all steps of a scientific process. The crucial role of practical work and experimentation in science is universally appreciated. This is more so in chemistry, an experimental science. Most of the concepts in this area are developed by laboratory exercises. Considering the merits of the laboratory method, the present work is undertaken with the following objectives:

1. To find out and enrich student's knowledge about salt hydrolysis through an interactive pre-laboratory session.
2. To study hydrolysis behaviour of selected salts of various types (Strong acid – Strong base; Strong acid–Weak base; Weak acid- Strong base; Weak acid-Weak base) to account for the acidic/basic nature of products obtained after hydrolysis.

To facilitate laboratory experience, Microscale Chemistry Laboratory developed by NCERT is used. In addition, conventional experiments are restructured to suit the study. This follows the National Curriculum Framework (NCF – 2005) recommendations designed by NCERT.

Selection of Sample

The research was conducted during the odd semester of the 2017-2018 academic year. The research sample consisted of 100 students segregated into 50 batches of two students each. They have completed their Senior Secondary course at various schools of Southern States (Karnataka, Kerala, Andhra Pradesh, Telangana, Tamil Nadu, Pondicherry, and Lakshadweep). Some (about 8%) have studied in their respective

mother tongue like Kannada, Telugu, Tamil, Malayalam, and Hindi. The majority of learners have studied the CBSE syllabus, while a few have opted for respective senior secondary state syllabus prescribed by the Board of Pre-University Education. Qualitative aspects of salt hydrolysis were dealt with in the chemistry syllabus at the secondary and senior secondary stages. Detailed qualitative and quantitative information about salt hydrolysis forms a part of course work for Semester IV (second year) of M.Sc.Ed. and B.Sc.Ed. courses offered by the Regional Institute of Education (NCERT) Mysuru, Karnataka state.

Methodology

The study is undertaken in three parts. The first component consisted of a pre-laboratory session followed by experimentation.

In the first session, some relevant questions on salt hydrolysis were raised.

Focus questions follow the below-mentioned sequence:

1. What is salt?
2. Write formulae of salts considered in the present study.
3. Indicate names of parent acid and parent base constituting these salts.
4. Can these salts be classified into different categories?
5. What is salt hydrolysis?
6. Which type of salts undergo hydrolysis?
7. Whether hydrolysis products are acidic, basic, or neutral?
8. How to identify products? What are the available, feasible, easy, and quick methods?

Participants were categorised into 20 groups; each group consisted of 5 learners. In this session, a student-centred or constructivist approach is followed. Students worked in groups, from their previous knowledge of textbook information, classroom teaching, laboratory experience, peer group discussion, responded for questions posed, and presented their answers/responses. The investigator enlisted plausible answers on the blackboard; necessary corrections were made and supplemented. Wherever necessary, the constructivist approach is used. Students were imparted/enriched with basic information about salt hydrolysis with this exercise. This step is believed to provide a guideline for other parts of the investigation.

The first question raised was to define the term 'salt.' Varied statements and ideas obtained from different groups were noted systematically. The definition suggested by Secken (2010) is quoted in this context: "Salts are electrically neutral substances formed by cation and anion". Among these cations and anions, H^+ and OH^- are exceptions. The bonds formed between those entities are ionic. All compounds with this type of bond are salts without any exception. Salts should be listed under two groups: (a) Inorganic salts (b) Organic salts. In inorganic salts, the cation is generally made of metals, and the anion is generally made of non-metals or their oxides. In the present study, only inorganic salts were selected (Annexure-I).

In writing formulae of the selected ionic compounds (Salts), Cris-Cross method or Cross-over method was used. This is based

on the Zero-sum rule, which states that— For neutral chemical formulae containing ions, the sum of the positive and negative ions must be equal and their sum is equal to zero.

The following steps were followed in finding formulae of ionic compounds.

Step 1: Assign charge to each element.
Step 2: Cris-Cross the charges to find subscript; charges must add to zero.

Example: To write the formula for Sodium Sulphate (Na_2SO_4),

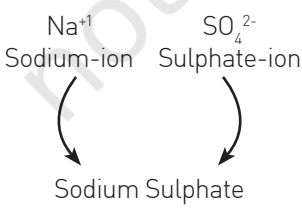
Assign charge to each element / ion: Charge for Sodium ion is +1, charge for Sulphate ion is -2

The sum of positive and negative ions will become zero when two sodium ions and one sulphate ion is considered, i.e., 2 Na^+ and 1 $(SO_4)^{-2}$

Na^{+1}	$(SO_4)^{-2}$
2	1

Cris-Crossing, the formula assigned is Na_2SO_4. This method is based on the valency of atoms and ions. Therefore, the same procedure can be adapted for any given ion, enabling writing the salt formula. In addition, the steps followed above also familiarise learners about the nomenclature of ionic compounds.

In the same example, Na_2SO_4, writing names of the ions,



The next task assigned was to write the names of parent acids and parent bases constituting salts. Salts can be the products of different kinds of acids and bases, both weak and strong. The strategy followed in writing parent acid and parent base is mentioned below:

Starting with an electrolyte formula, first, identify positive and negative ions formed when an electrolyte dissociates in water. If the positive ion is H^+, the compound is an acid. If the negative ion is OH^-, the compound is a base. Generalization is that anion and cation of salt can come from any acid or base (strong and/or weak). Following relationship was also suggested to participants for consideration whenever required:

Example: Potassium Carbonate, K_2CO_3

Parent acid = H^+ and anion of the compound

Parent acid: $H^+ + CO_3^{2-} \longrightarrow H_2CO_3$
Anion is CO_3^{2-} , Carbonate-ion

Acid is H_2CO_3, Carbonic acid

Parent base = OH^- and cation of the compound

Parent base: $OH^- + K^+ \longrightarrow KOH$
Cation is K^+, Potassium ion

Base is KOH, Potassium hydroxide.

Participants were asked to define and explain the term 'Salt hydrolysis.' This question forms the focus question for the present study. Students were expected to express their understanding in a statement /short answer. They were instructed to use previous knowledge, interact with their peer, and refer to text/reference books or any other source of information. At this stage, an inductive process, concept attainment, is utilized,

allowing learners to construct concepts by searching for common characteristics.

Illustration: Students can compare ' yes ' examples of salt hydrolysis with' No ' examples of salt hydrolysis.

Students were presented with six testers to either classify as being ' yes ' or ' no ' examples of salt hydrolysis. This enabled them to differentiate between hydrolysis and other chemical reactions. The main idea was to bring about characteristics of salt hydrolysis.

(a) Hydrolysis of Amides

(b) Mixing dilute solutions of Sodium Hydroxide and Nitric acid

(c) Hydrolysis of triglyceride with Sodium Hydroxide to Glycerol.

(d) Conversion of Cellulose to Glucose

(e) Dissolution of Ammonium Carbonate in water

(f) Production of ADP from ATP

'Yes' examples	'No' examples Testers
Dissolution of Ammonium chloride	**Mixing solutions of KOH and H Cl**
Dissolution of Sodium acetate in water	$CH_3COOH + H_2O \rightleftharpoons H_3O^+ + CH_3COO^-$
Conversion of starch into glucose	$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$
$NH_3^+ H_2O \rightleftharpoons NH_4^+ + OH^-$	$H_2O + H_2O \rightleftharpoons OH^- + H_3O^+$

The question is now focused on identifying salts exhibiting hydrolysis behaviour. At this stage, the investigator displayed names of strong acids and strong bases as enlisted in the textbook (Table 1)

Learners were asked to identify ions that react with water and those which act as spectator ions when ionic salts are put into water. An illustration is given in Table 2.

In writing product/products of salt hydrolysis, participants were unambiguous that products are acids and bases only, maybe by nature, weak or strong. However, when they wished to name parent acids and bases, it hinted that these are the only hydrolysis product. To identify resulting acids and bases produced on hydrolysis, quick, simple methods were tried as it was required to handle several samples simultaneously. In the present study, phenolphthalein, litmus solution, pH paper strips (both wide range and narrow range) and universal indicator solution were chosen as indicators. Well Plate employed by each group enabled a comprehensive, simultaneous observation of 96 samples.

The focus of the second component of the investigation was experimentation. In this part, chemicals/apparatus mentioned below were used.

Table 1
Names of strong acids and strong bases

Acids	Bases
Hydrochloric acid (HCl)	Lithium hydroxide (LiOH)
Hydrobromic acid (HBr)	Sodium hydroxide (NaOH)
Hydroiodic acid (HI)	Potassium hydroxide (KOH)
Nitric acid (HNO_3)	Rubidium hydroxide (RbOH)
Sulphuric acid (H_2SO_4)	Cesium hydroxide (CsOH)
Chloric acid ($HClO_3$)	Magnesium hydroxide [$Mg(OH)_2$]
Perchloric acid ($HClO_4$)	Calcium hydroxide [$Ca(OH)_2$]
	Strontium hydroxide [$Sr(OH)_2$]
	Barium hydroxide [$Ba(OH)_2$]

Table 2
Summary of Acid-Base properties of salts

Salt Solution (example)	P^H	Nature of ions	Ion that reacts with water
Neutral (NaCl, KBr)	=7.0	Cation of strong base (group IA, group.2A but not Be^{2+}) Anion of strong acid (Cl^-, Br^-, I^-,NO^{3-}, ClO_4^-)	None
Acidic NH_4Cl, NH_4NO_3	<7.0	Cation of weak base(NH_4^+, Al^{3+}, Fe^{3+}) Anion of strong acid (Cl^-, Br^-,I^-,NO_3^-, ClO_4^-)	Cation
$AlCl_3$, $FeBr_3$	<7.0	Small highly charged cation The anion of strong acid	Cation
Basic CH_3COONa	>7.0	Cation of a strong base The anion of a weak acid (F^-, NO_2^-, CN^-, CH_3COO^-)	Anion

Chemicals: Ammonium Sulphate, Zinc Sulphate, Aluminium Sulphate, Ammonium Carbonate, Sodium acetate, Ammonium acetate, Sodium chloride, Potassium nitrate, Ammonium fluoride, Sodium bicarbonate, Potassium nitrate, Sodium carbonate.

All chemicals were of A.R. grade purchased from Sd. Fine Chem. Limited., Mumbai, Maharashtra, India. 0.1 M solution of salts was prepared using de-ionized water, stored in

stopper bottles.

Indicators:Phenolphthalein (0.5% solution (w/v) in ethanol (1:1), blue litmus solution, red litmus solution, universal indicator solution. These indicators were procured from Nice Chemicals Private Ltd., Edapally, Kochi - 682024, Kerala State, India.

Microscale chemistry Laboratory Kit

Microscale chemistry laboratory kit developed by Workshop Department of NCERT, New Delhi was used. The kit consisted of a wooden box to accommodate about 45 items (glass/ plastic ware, apparatus) required to perform basic chemistry experiments. In the present work, Well Plate (Acrylic tissue culture plate, TARSON), plastic graduated droppers to dispense test solutions/indicators), screw-capped plastic vials (to store solid substances), plastic dropper bottles (to hold liquid reagents) were used.

Well Plate: This consisted of 96 wells or reaction vessels. Each well is labelled, can hold 0.3 ml volume per well. Salt solutions/ indicators were added using graduated droppers; mixing was done using small, thin plastic colourless sticks. Three drops of test solution are mixed with a drop of the indicator.

Application of salt solution: Salt solutions were added to wells in the order mentioned below (Table 3).

Table 3

Mode of application of salt solutions

Sl. No.	Name of Salt	Formulae	Well number
1	Sodium chloride	Na Cl	A_1, C_1, E_1, G_1
2	Sodium acetate	CH_3COONa	A_2, C_2, E_2, G_2
3	Potassium nitrate	KNO_3	A_3, C_3, E_3, G_3
4	Sodium carbonate	Na_2CO_3	A_4, C_4, E_4, G_4
5	Sodium bicarbonate	$NaHCO_3$	A_5, C_5, E_5, G_5
6	Ammonium chloride	NH_4Cl	A_6, C_6, E_6, G_6
7	Aluminium sulphate	$Al_2(SO_4)_3$	A_7, C_7, E_7, G_7
8	Ammonium acetate	CH_3COONH_4	A_8, C_8, E_8, G_8
9	Ammonium sulphate	$(NH_4)_2SO_4$	A_9, C_9, E_9, G_9
10	Ammonium fluoride	NH_4F	A_{10}, C_{10}, E_{10}, G_{10}
11	Ammonium carbonate	$(NH_4)_2CO_3$	A_{11}, C_{11}, E_{11}, G11
12	Zinc sulphate	$ZnSO_4$	A_{12}, C_{12}, E_{12}, G_{12}

The addition of indicators in rows of Well Plate follows the pattern presented in Table 4.

Table 4

The pattern of addition of indicator solutions

Sl. No.	Indicator	Row
1	Phenolphthalein	A
2	Blue litmus	C
3	Red litmus	E
4	Universal indicator	G

To facilitate laboratory work for all groups, 20 well plates were used. Participants worked in a group of 5 and collected the data.

The final part consisted of compiling the data, analysing the observations on the response of salt solutions towards different indicators, drawing inferences based on observations, and correlating laboratory data with textbook information. In addition, the focus was also

to get feedback about the adoption of the microscale chemistry technique and its relevance as an alternative to the traditional laboratory.

Results

In the pre-laboratory session, some relevant primary data about salt hydrolysis was sought, and enrichment was done accordingly.

Initially, when students were probed to define 'Salt,' various responses emerged.

Some relevant statements are mentioned below:

(i) When an acid reacts with a base, a compound formed is called Salt.

(ii) It is a naturally occurring substance.

(iii) Salt is something soluble in water.

(iv) Salt is made up of an anion and a cation.

(v) When strong acid and strong base solutions are mixed, salt is produced.

(vi) It is a substance that could separate into ions when kept in water.

(vii) Salt is formed when the neutralisation reaction takes place.

(viii) Salt is a product of the reaction of an acid and any base in an aqueous solution.

(ix) Salt is a neutral compound.

(x) When an acid and a base react, salt is produced. It is in equilibrium with the reactants.

In writing chemical formulae of salts, about 80% of them were comfortable writing formulae of those salts as exemplified by NaCl, KNO_3, CH_3COONa, CH_3COONH_4. However, the majority of the participants (about 90%) faced difficulties in writing formulae like $(NH_4)_2CO_3$, $Al_2(SO_4)_3$. When both anion and cation were univalent, the mistakes committed were lesser. However, when anion, cation, or both possess more than one valency, the probability of writing incorrect formulae was more.

In identifying parent acid and parent base constituting salts, all of them were comfortable with salts made up of strong acid and strong base. For example, for NaCl, students were unanimous in identifying that HCl is parent acid and NaOH its parent base.

Students were asked to evolve a classification scheme of salts belonging to Strong Acid - Strong Base; Strong Acid-Weak Base; Weak Acid-Strong Base; Weak Acid-Weak Base. In arriving at this design, participants were contingent on either textbook/reference book or the investigator. A compiled data was also presented to them. Many were astonished as there can be many salts in contrast to their belief that salt is constituted invariably by strong acid and strong base.

In defining 'Salt hydrolysis,' the general idea was to consider it a reverse of a neutralisation reaction. Some students were trying to apply literature interpretation of the term. Accordingly, in Greek, 'hydro' means 'water' and ' lysis ' means ' loosening 'or 'disengagement. ' With this, about 25% of them assumed that hydrolysis is a dissociation reaction with their previous knowledge. The general opinion was that it is a chemical transformation involving water.

Given several salts and finding whether it will undergo hydrolysis or not (from the

nature of parent acid and parent base) was the next task assigned to them. At this stage, hardly any predictions were made by participants. Taking individual names of salt, the investigator had to provide the required information. This unexpected poor response may be because salt hydrolysis is treated briefly and qualitatively as a part of acid-base chemistry. Compiled data of Part-1 is presented in Table 5.

Table 5:
Composition of some selected salts

Sl.No.	Salt	Parent acid	Parent base	Type of acid	Type of base	Hydrolysis yes / no
1	Sodium chloride	Hydrochloric acid	Sodium hydroxide	Strong	Strong	no
2	Sodium acetate	Acetic acid	Sodium hydroxide	Weak	Strong	yes
3	Potassium nitrate	Nitric acid	Potassium hydroxide	Strong	Strong	no
4	Sodium carbonate	Carbonic acid	Sodium hydroxide	Weak	Strong	yes
5	Sodium bicarbonate	Carbonic acid	Sodium hydroxide	Weak	Strong	yes
6	Ammonium chloride	Hydrochloric acid	Ammonium hydroxide	Strong	Weak	yes
7	Aluminium sulphate	Sulphuric acid	Aluminium hydroxide	Strong	Weak	yes
8	Ammonium acetate	Acetic acid	Ammonium hydroxide	Weak	Weak	yes
9	Ammonium sulphate	Sulphuric acid	Ammonium hydroxide	Strong	Weak	yes
10	Ammonium fluoride	Hydrofluoric acid	Ammonium hydroxide	Strong	Weak	yes
11	Ammonium carbonate	Carbonic acid	Ammonium hydroxide	Weak	Weak	yes
12	Zinc sulphate	Sulphuric acid	Zinc hydroxide	Strong	Weak	yes

Based on the above observations, a classification scheme for salts was arrived at. (Table 6)

In part-2, participants worked in groups of 5, performed the experiment, recorded diverse colors developed by salt solutions

Table 6
Classification of salts

Sl. No.	Type of Salt	Name of salts	Other examples
1	Strong acid, Strong base	NaCl, KNO_3	$Ba(NO_3)_2$, KBr, K_2SO_4
2	Strong acid, Weak base	NH_4Cl, $Al_2(SO_4)_3$, $(NH_4)_2SO_4$, NH_4F, $ZnSO_4$	NH_4Br, $FeCl_3$,$CuSO_4$
3	Weak acid, Strong base	CH_3COONa, Na_2CO_3, $NaHCO_3$	KNO2, NaNO2, Na F
4	Weak acid, Weak base	CH_3COONH_4, $(NH_4)_2CO_3$	$HCOONH_4$, NH_4HCO_3 NH_4F

Provision was also made to write other examples of salts belonging to four types mentioned in Table 6. Discussion with a peer, reference books, and previous knowledge, textbook data helped them elaborate the list and insert some more examples like Barium nitrate Ba $(NO_3)_2$ and Potassium bromide (KBr) in the first category.

with selected indicators. Data is presented in Table 7.

Abbr: H Ph: Phenolphthalein; BL: Blue litmus; RL: Red litmus; UI: Universal indicator; NC: No color

GN green; PE purple; BE blue; GY green-yellow; PK pink; PH peach; YG yellow-green

Table 7
Response of Salt solutions to different indicators

Indicator	Row ---→	1	2	3	4	5	6	7	8	9	10	11	12
H Ph	A	NC	NC	NC	pink	pink	NC	NC	NC	NC	NC	pink	NC
BL	B	blue	blue	blue	blue	blue	blue	red	blue	blue	blue	blue	blue
RL	C	red	red	red	blue	blue	red	red	red	red	blue	blue	red
UI	D	GN	GN	GN	PE	PE	GY	PK	GN	PH	GN	BE	YG

Note: Rows 1 to 12 indicate names of the salts as in Table 4

pH values of salt solutions were found using pH paper strips (both wide and narrow range), Universal indicator solution, and pH meter. Observations are compiled in Table 8.

When phenolphthalein is used, Sodium carbonate, Sodium bicarbonate, and

Table 8
pH values of salt solutions using different indicators

Sl. No.	Salt	pH paper*	Universal indicator	pH meter
1	Sodium chloride	7.2	7	7.49
2	Sodium acetate	7.4	8	7.18
3	Potassium nitrate	7.2	7	7.58
4	Sodium carbonate	10.2	10	11.38
5	Sodium bicarbonate	9.6	10	9.97
6	Ammonium chloride	5.6	5	5.20
7	Aluminium sulphate	3.2	3	2.80
8	Ammonium acetate	7.2	7	7.55
9	Ammonium sulphate	4.6	5	4.92
10	Ammonium fluoride	6.4	6	6.88
11	Ammonium carbonate	9.2	9	9.06
12	Zinc sulphate	6.2	6	6.40

*both wide range and narrow range

Ammonium carbonate exhibit pink colour with different intensities while other salt solutions remain colourless. The blue colour of the litmus solution lasts unchanged with all salt solutions except Aluminium sulphate. Upon adding a drop of blue litmus, an instant red colour appeared. Response of salt solutions towards red litmus was unlike. Solutions of Sodium carbonate, Sodium bicarbonate, Ammonium fluoride, and Ammonium carbonate turned blue instantaneously. Universal indicator solution could display an intermixture of colors with salt solutions as its working range is capacious. The colour paragon observed was diverse (pink, green, yellow, blue, violet) depending on the archetype of salt (Table 7). The nature of the hydrolysis of salts, their pH ranges, and eventuate colour developed are represented in Table 9.

Table 9
Nature of products obtained from salt hydrolysis

pH range	Description	Colour
Less than 3	Strong acid	Red
3 to 6	Weak acid	Orange or Yellow
7	Neutral	Green
8 to 11	Weak base	Blue
More than 11	Strong base	Violet or Indigo

Discussion

The research confirms that students are hindered in understanding aqueous-phase chemical reactions in general and the phenomenon of salt hydrolysis in particular. In defining the term 'salt' itself, assorted statements were made by participants. For most of them, salt is meant solely as a product when an acid reacts with a base. This response may be for reasons that, in the curriculum, 'Salt,' the entitle finds its significance either while dealing with nature and properties of metals/non-metals or in acid-base chemistry. Another reason for misconception is that while teaching neutralization reaction, usually, examples are chosen from the strong acid-strong base category. Other possibilities that salt can also be a product when Weak Acid-Weak Base/ Weak Acid-Strong Base/Strong Acid-Weak Base interact chemically is not emphasised in the curriculum.

Chemical formulae is a descriptive and heuristic tool in the field of science, especially in chemistry. In writing formulae of salts, most participants (about 80 %) were comfortable with those familiar with daily life situations and /or mentioned in the textbook. When a clue about applying knowledge of valency to facilitate the task is given, they could present correct formulae for ionic compounds. However, when the investigator used the word' metal salt' in one context, many got bewildered. After careful examination of formulae, they realised that the cation of salt could be metal like Sodium, Potassium, or Zinc in many cases.

In writing names of parent acids and parent bases constituting various salts, again, participants could offer correct names to only those compounds learnt by them. For unfamiliar/less familiar salts, the investigator had to interact with groups to elucidate the correct names of acids and bases. Difficulties in correctly identifying products of hydrolysis are observed by K. Orwat et al. (2017). In a study conducted for upper secondary students, pupil imbibed with alternative conceptions of salt hydrolysis, could not predict the products obtained when some salts (Sodium Carbonate, Zinc Chloride, Magnesium Chloride, and Chromium Sulphite) were put into water and made to react with it. The error was also made in writing chemical equations, showing the direction of arrows, whether it is a reversible/ irreversible change. This situation may probably be overcome if exemplar salts of different prototypes (Strong acid-Strong base, Strong acid-Weak base, Weak acid-Strong base, Weak acid-Weak Base) are dealt with in a classroom. In another study, Naah (2012) observed that representation of subscripts in writing chemical formulae can influence students understanding of solubility of ionic compounds in water. Such observations were more conspicuous when ionic compounds had monoatomic subscripts ($MgCl_2$, $Al_2(SO_4)_3$) or polyatomic subscripts (KNO_3, K_2SO_4). The Cross-Overrule may be of relevance in such contexts.

Pinarbasi (2007) observed that, when students have posed a question, 'what is salt hydrolysis? 73% of them replied that hydrolysis is the separation of matter into ions by water thus bewildering the concept of hydrolysis for the dissociation process. In the present research, statements given by novice point out that they possessed alternate conceptions. Incorrect responses

may stem from the fact that the pupil may not recognise and consider all the factors holistically due to limited discussion in the chemistry curriculum on various facets of salt hydrolysis. Probably, taking suitable measures like exposing students with multiple and a variety of reactions of salts with water, recalling and reinforcing the concept of acids and bases with a focus on Bronsted – Lowry definition, strengths of acids and bases, quoting a variety of other exemplar reactions leading to the formation of salts, recalling conditions of chemical equilibrium, narrating different types of chemical reactions may help to overcome misconceptions.

In addressing the question regarding the nature of products of hydrolysis (acidic, basic, or neutral), participants opined that products are neutral. The justification was that when an acid interacts with a base, the reaction occurs as stoichiometry, leaving products neutral. This prediction may stem from the fact that in textbooks illustration is done with a strong acid and strong base. As salt hydrolysis appears only as a component of acid-base chemistry, teachers usually take a few examples and a brief discussion. The complexity of the phenomenon is ignored. In addition, laboratory testing of products of hydrolysis is done very rarely. Reasons like non-availability of laboratory, handling a large number of students at a time, cost, time may contribute to shying away of students from the experiments. Microscale technique in finding the response of salt solutions with indicators gave unambiguous results. Students were thrilled to observe that all salts do not undergo hydrolysis, and resulting products need not be neutral. This was evident by a spectrum of colours produced by indicators; these observations were further confirmed by measuring the pH of test solutions using a pH meter.

In the post-laboratory session, the investigator administered an opinion as to find out students' enriched knowledge about salt hydrolysis and microscale technique. Because of background knowledge (provided in Part–I), they were unimpeded about the objectives of the experiment. This created more interest and confidence. Participants expressed that microscale experiments served as an excellent supplement to discussion and effectively unveiled various facets of salt hydrolysis. The microchemistry kit helped them save time, space, chemicals, and being eco-friendly; it also enabled easy disposal of waste.

Above all, group activity was done in the classroom itself; traditional laboratory requirement was not an issue. This new exercise placed them in place of a researcher, offered hands-on experience, and helped conceptualise the theme 'Salt hydrolysis' satisfactorily. The application of the micro-scale technique in performing laboratory experiments successfully is also reported by Kelkar and Dhavale (2001), Kalogirou and Nicas (2010), and Pareek, et al. (2014).

Suggestions

1. In explaining salt hydrolysis, exemplar compounds belonging to a different category of salts can be chosen, and cases of specific salts may be analysed.
2. Students can be encouraged to include relevant chemical formulae while writing the name of salts. This exercise will boost

their confidence in remembering symbols of elements and enable them to express the formula of any given compound.

3. Different salts can be chosen for illustration in teaching acid-base chemistry, especially neutralisation (salt formation) reactions/salt hydrolysis. This can imply that the nature and pH of a salt solution depend on parent acid and parent base.

4. In dealing with salt hydrolysis, different kinds of chemical reactions lead to the formation of salt like precipitation, decomposition may be discussed with relevant examples. This will offer a broad perspective to students; provide scope to explore other possible modes of obtaining salts.

5. Experiments can be an integral part of an investigation dealing with science concepts. This will induct /enhance laboratory skills, offer hands-on– experience, enable me to appreciate chemistry and experimental science.

6. Application of microscale chemistry techniques maximizes opportunities for careful observation and interpretation. In addition, it offers the chance to conduct several trials with less expenditure and limited time.

Conclusion

In sum, the research confirms that the concept of salt hydrolysis is difficult for learners. In the present study, an integrated approach is followed, including discussion and experimental components. Pre–laboratory session could offer a sound theoretical background while the experimental part offered hands-on-experience in understanding' salt hydrolysis', examining the properties of the resulting solution (acidic/basic/neutral), and recording pH values. Students received both sessions well, served complimentary to each other, and gave a detailed insight into the phenomenon. In addition, the use of the constructivist approach enabled us to get a good idea about the theme with illustrative examples and non–examples. Application of microscale chemistry technique was of immense value to learn all crucial steps of learning science concepts. Participants experienced that, indeed, chemistry is an experimental science. They could save time, cost, space in the task despite conducting repeated trials. Even waste disposal was easy. This aspect was evident in the post–laboratory discussion. It is suggested that such integrated efforts can be used effectively in dealing with chemistry concepts.

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Annexure-I

Salt Hydrolysis

The concept of 'Salt' is introduced in secondary school textbooks only within the definition of neutralization. 'Salt ' is treated as a product formed when Bronsted-Lowry acids and Bronsted-Lowry bases react with each other.

Salt is an ionic compound containing positive ions other than H+ and negative ions other than OH-. Most salts dissociate to some degree when placed in water. In many cases, ions from salt react with water molecules to produce hydronium ions (H_3O^+) or hydroxide ions (OH). Any chemical reaction in which water is one of the reactants or interaction between an ion or ions of Salt with water resulting in the formation of a weak acid or a weak base or both (weak acid and weak base) is called hydrolysis.

There are four distinct groups of hydrolytic behaviour of salts. They are:

(a) Salts of strong acids and strong bases

(b) Salts of strong acids and weak bases

(c) Salts of weak acids and strong bases

(d) Salts of weak acids and weak bases

(a) Salts of strong acids and strong bases

Salt of strong acid and the strong base does not undergo hydrolysis. Solution of such Salt is neutral, and pH value will be around seven at 298 K. e.g.,: Na Cl dissociates in water to give an anion Cl^-. H Cl and Cl^- constitute an acid-base conjugate pair:

$HCl + H_2O \longrightarrow H_3O^+ + Cl^-$

conjugate base. Since H Cl is a strong acid, Cl^- is a very weak base and unable to accept a proton (H+) from an acid, particularly water. Hence, Cl- does not hydrolyse. As a result, it cannot generate OH- ions as represented below:

$Cl^- + H_2O \longrightarrow HCl + OH^-$

The pH of the sodium chloride solution remains unaffected.

(b) Salts of strong acids and weak bases

Hydrolysis of Salt of strong acid and a weak base is due to hydrolysis of cation of a weak base. This can be represented as

$BOH \rightleftharpoons B^+ + OH^-$

B+ is the conjugate acid of the weak base, BOH. Therefore, it is a relatively strong acid. It accepts OH^- ion from water (H_2O) and forms unionized BOH and H^+ ions.

$B^+ + H_2O \rightleftharpoons BOH + H^+$

Accumulation of H^+ ions in solution imparts acidic nature.

(c) Salts of weak acids and strong bases

When Salt of a weak acid and strong base ionizes in an aqueous solution to form anion A^-,

$HA \rightleftharpoons H^+ + A^-$

A^- is the conjugate base of weak acid HA and is relatively strong. Thus, A^- accepts H^+ ion from water (H_2O) and undergoes hydrolysis.

$A^- + H_2O \rightleftharpoons HA + OH^-$

The resulting solution is slightly basic due to excess OH^- ions.

(d) Salts of weak acids and weak bases

When Salt of a weak acid and weak base is added to water, both B+ (conjugate acid) and A- (conjugate acid) ions participate in hydrolysis as they are relatively strong, accept H+ and OH- ions, respectively.

$A^- + H_2O \rightleftharpoons HA + OH$-----(i)

$B^+ + H_2O \rightleftharpoons BOH + H^+$----(ii)

Overall, hydrolysis may be represented as

$A^- + B^+ + H_2O \rightleftharpoons BOH + HA$

pH of the resulting solution will depend on the relative extent of anion hydrolysis (i) and cationic hydrolysis (ii). If both ions react to the same extent, $[OH^-] = [H^+]$, solution is neutral. If cation reacts to a greater extent, the solution is slightly acidic. If anion is a little more reactive, the solution will be basic.

COMPUTATIONAL PHYSICS WITH SPREADSHEET – II

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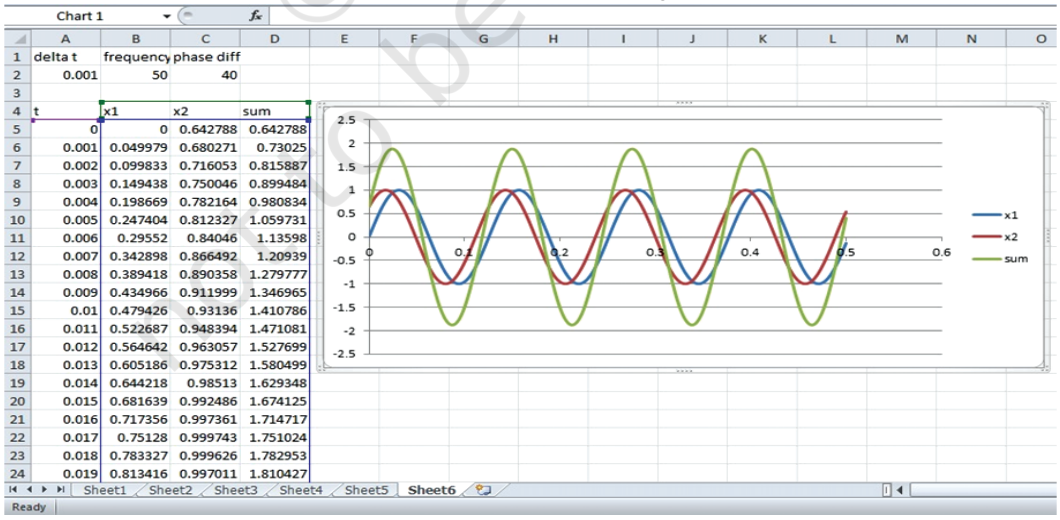
In the first two articles of the series, we have discussed the use of EXCEL as a tool to understand graphs and variations of physical quantities with respect to each other based on equations. In this article, we go one step further to show how to understand phenomena that deal with variation with respect to time and space are understood using EXCEL. When students are taught the superposition of waves, they are merely shown the graphs of how these waves add in space (stationary waves) and in time (beats formation). These graphs are merely abstract representations unless they can draw or are shown how to draw. This calculation becomes very time-consuming unless we can use computers. Now this power is accessible to most students on their mobile, and MS-EXCEL is free for android users. In this article, we show how to study the formation of beats and stationary waves with the help of MS-EXCEL. How to use EXCEL is already discussed in the first article of the series

Keywords: Addition of two waves, Formation of beats, formation of stationary waves

Addition of SHM

When two simple harmonic motions of the same frequencies are added, the total is also a simple harmonic motion with a phase difference equal to the average phase of the two-component waves.

It is instructive to see that by changing the phase difference between the two waves, how the phase difference and the amplitude of the sum change.



t	x1	x2	sum
0	0	0.642788	0.642788
0.001	0.049979	0.680271	0.73025
0.002	0.099833	0.716053	0.815887
0.003	0.149438	0.750046	0.899484
0.004	0.198669	0.782164	0.980834
0.005	0.247404	0.812327	1.059731
0.006	0.29552	0.84046	1.13598
0.007	0.342898	0.866492	1.20939
0.008	0.389418	0.890358	1.279777
0.009	0.434966	0.911999	1.346965
0.01	0.479426	0.93136	1.410786
0.011	0.522687	0.948394	1.471081
0.012	0.564642	0.963057	1.527699
0.013	0.605186	0.975312	1.580499
0.014	0.644218	0.98513	1.629348
0.015	0.681639	0.992486	1.674125
0.016	0.717356	0.997361	1.714717
0.017	0.75128	0.999743	1.751024
0.018	0.783327	0.999626	1.782953
0.019	0.813416	0.997011	1.810427

Fig.1

Formation of Beats

To see the formation of beats, we take two waves as

First Wave: $y_1 = sint$, and Second Wave $y_2 = sin(1.1t)$:

Superposition gives: $y = y_1 + y_2$:

Here we have chosen: $\omega_1 = 1.0$ and $\omega_2 = 1.1$

We generated this data using MS EXCEL. Say first x value (in this case, zero) is in cell C5. Then type '=SIN(t)' and ' =SIN(1.1*t)' in D5 and E6 respectively and enter. Type = D5 + E5' in F5. After the value is generated, please select the box and drag + sign on the lower right corner of the box by bringing the mouse cursor at it and generating data for each value of x. Selecting all four data columns, choosing the appropriate plot generates the wave pattern.

You may modify these waves with different frequencies by changing ω_2 to some other value and seeing its effect.

In all first graphs that depict waves y_1 and y_2. The second graph shows the superposition of the two together.

It can be seen that the amplitude of the superposition varies from maximum to minimum in time

$$\frac{1}{n_1 - n_2} = \frac{2\pi}{w_1 - w_2} = 20\pi = 62.84$$

Table 1

t	y_1 = sin(t)	y_2 = sin(1.1*t)	$y = y_1 + y_2$
0	0	0	0
0.1	0.099833	0.109778	0.209612
0.2	0.198669	0.21823	0.416899
0.3	0.29552	0.324043	0.619563
0.4	0.389418	0.425939	0.815358
0.5	0.479426	0.522687	1.002113
0.6	0.564642	0.613117	1.177759
0.7	0.644218	0.696135	1.340353
0.8	0.717356	0.770739	1.488095
0.9	0.783327	0.836026	1.619353
1	0.841471	0.891207	1.732678
1.1	0.891207	0.935616	1.826823
1.2	0.932039	0.968715	1.900754
1.3	0.963558	0.990105	1.953663
1.4	0.98545	0.999526	1.984976

1.5	0.997495	0.996865	1.99436
1.6	0.999574	0.982154	1.981728
1.7	0.991665	0.955572	1.947236
1.8	0.973848	0.917438	1.891286
1.9	0.9463	0.868215	1.814515
2	0.909297	0.808496	1.717794
98	-0.57338	0.833742	0.26036
98.1	-0.65231	0.889317	0.237007
98.2	-0.72472	0.934143	0.209423
98.3	-0.78989	0.967677	0.177788
98.4	-0.84717	0.989514	0.142348
98.5	-0.89598	0.999389	0.103412
98.6	-0.93584	0.997185	0.061347
98.7	-0.96635	0.982926	0.01658
98.8	-0.9872	0.956787	-0.03041
98.9	-0.99819	0.919081	-0.07911
99	-0.99921	0.870266	-0.12894
99.1	-0.99024	0.810932	-0.17931
99.2	-0.97138	0.741795	-0.22958
99.3	-0.94281	0.663691	-0.27912
99.4	-0.90482	0.577565	-0.32726
99.5	-0.8578	0.484457	-0.37334
99.6	-0.8022	0.385494	-0.4167
99.7	-0.73858	0.28187	-0.45671
99.8	-0.66759	0.17484	-0.49275
99.9	-0.58992	0.065696	-0.52423
100	-0.50637	-0.04424	-0.55061

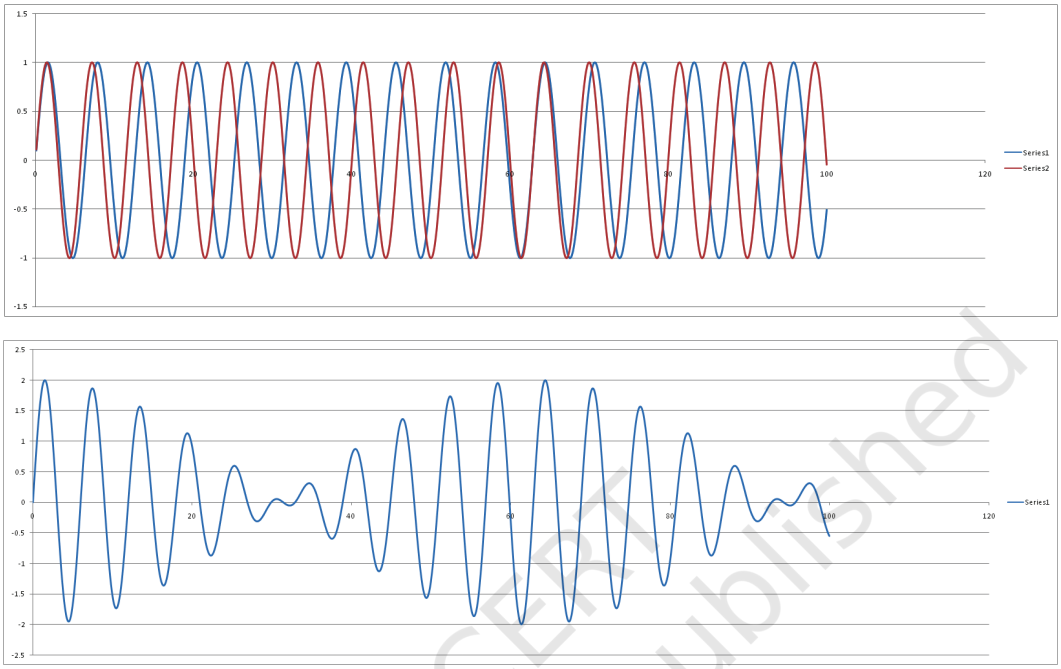


Fig.2

Students may take n_2/n_1 as some number other than 1.1 and see what happens to the beats pattern.

Formation of Stationary Waves

Incident Wave: $y_1 = 2\sin(\omega t+\pi x+0.2)$, Reflected Wave :$y_2 = 2\sin(\omega t-\pi x+0.2=\pi)$ Superposition gives: $y = y_1 + y_2 = 4\sin\pi x \cos(\omega t+0.2)$ Here we have chosen : $\lambda = 2$

We have taken the incident wave like the one travelling in negative x-direction and reflected at x = 0 by a rigid boundary (this brings an additional phase of 180°.

We generated this data using MS EXCEL. Say, first x value (in this case, zero) is in cell E6. Then type '=-2*SIN(3.142/4 - 3.142*E6+0.2)' and ' =2*SIN(3.142/4 + 3.142*E6+0.2)' in F6 and G6, respectively and enter. Type '= F6 + G6' in H6. After the value is generated, please select the box and drag + sign on the lower right corner of the box by bringing the mouse cursor at it and generating data for each value of x and selecting all four data columns, x, y_1 and y_2, and choosing appropriate plot generates the wave pattern. Repeat this at different time instants. In the end, we have a plot of all eight standing waves within one time period, showing what it looks like.

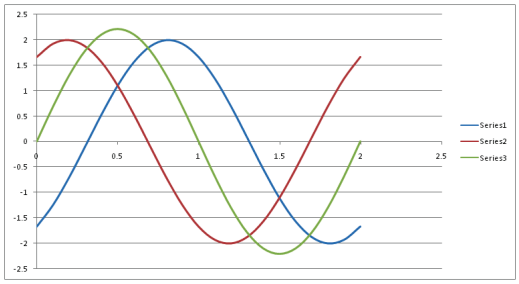
You may modify these waves with different phases by changing 0.2 additional phase to some other value and seeing its effect. You may make this extra phase 0 and see the effect on all the waves. In all first eight graphs that depict waves at a different instant, 1st series is an incident wave, 2nd

series is a reflected wave, and 3rd series is a superposition of the first two. The last graph shows all eight superpositions together. If one takes double or, say, 20 such graphs within one time period, it may generate a loop itself where individual superposed waves may not get noticed.

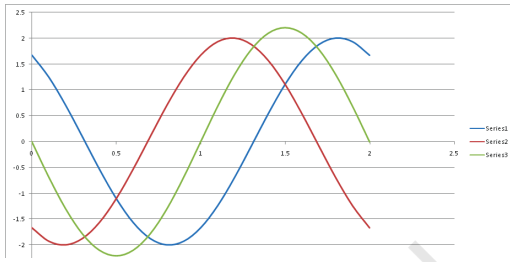
Table. 2

	theta = 0.7855	**at T/8**	**PI=3.142**
x	y^1= 2*sin(theta + PI*x+0.2)	Y^2 = - 2*sin(theta - PI*x+0.2)	$y = y^1+y^2$
0	1.667096836	-1.667096836	0
0.1	1.926955785	-1.24400886	0.682946924
0.2	1.998142361	-0.69911731	1.299025051
0.3	1.873686534	-0.085773685	1.787912849
0.4	1.56577404	0.535968226	2.101742266
0.5	1.104553253	1.105232339	2.209785591
0.6	0.535183288	1.566280783	2.10146407
0.7	-0.086587621	1.873971317	1.787383696
0.8	-0.699880549	1.998177301	1.298296751
0.9	-1.244646673	1.92673746	0.682090787
1	-1.667546771	1.666646623	-0.000900148
1.1	-1.92717379	1.243370842	-0.683802948
1.2	-1.99810709	0.698353954	-1.299753135
1.3	-1.87340144	0.084959734	-1.788441706
1.4	-1.565267038	-0.536753076	-2.102020114
1.5	-1.103873984	-1.105911241	-2.209785225
1.6	-0.53439826	-1.566787265	-2.101185526
1.7	0.087401542	-1.874255789	-1.786854246
1.8	0.700643673	-1.998211909	-1.297568236
1.9	1.245284279	-1.926518816	-0.681234537
2	1.667996431	-1.666196134	0.001800296

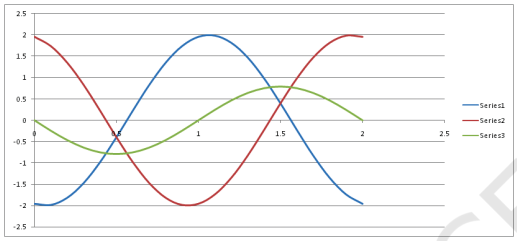
At t = T/8



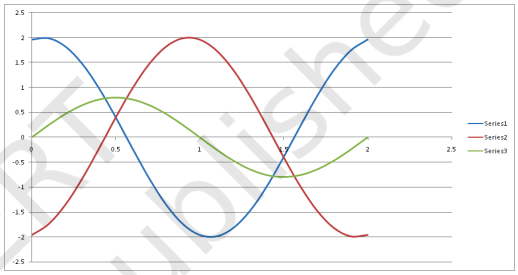
At t = $\frac{5}{8}$ T



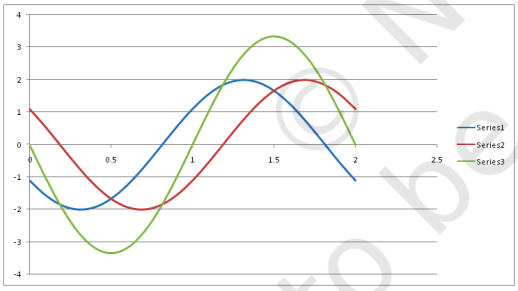
At t = T/4



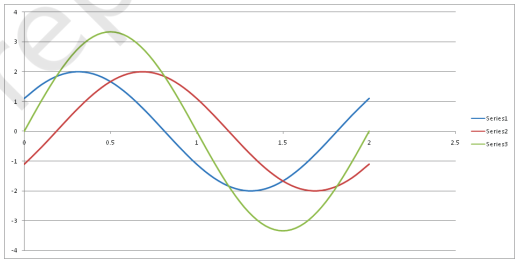
At t = 3T/4



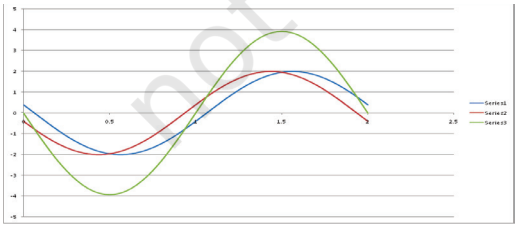
At t = 3T/8



At t = 7T/8



At t = T/2



At t = T

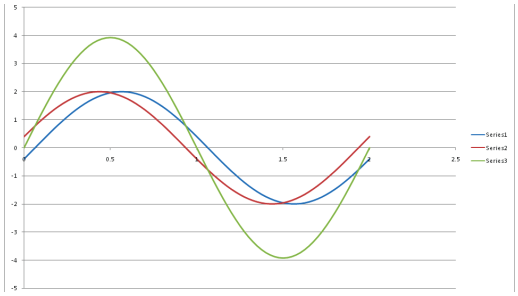


Fig.3

The figure below shows all eight superposed waves simultaneously. If the frequency is more than 10 Hz, we see all superpositions simultaneously, making them appear as loops of lengths λ/2. This is as seen below.

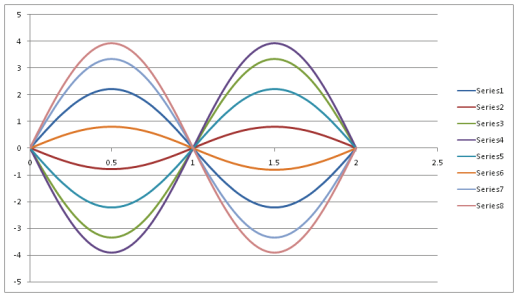


Fig. 4

Students may try taking more than 8 slices of the time period and try to understand the pattern better.

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ANALYSIS OF IN-SERVICE AND PRE-SERVICE TEACHERS' UNDERSTANDING OF SOME CONCEPTS OF BIOTECHNOLOGY IN BIOLOGY CURRICULUM

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The emergence of multidisciplinary approaches has always benefited science with newer discoveries. Biotechnology which has tremendous applications with many possibilities should be introduced to students efficiently for their better vision of the subject. The purpose of this study is to analyse the in-service and pre-service teachers about their awareness regarding the latest additions in the field of biotechnology. In order to assess, a questionnaire was developed and the responses from both categories were thoroughly analysed with descriptive statistics. It was observed that the pre-service teachers have a better understanding of the biotechnological concepts than those in-service teachers. Considering the fact that pre-service teachers are in their studying phase, it is interpreted that this category of teachers is trained with an updated syllabus compared to the other. This might be an addition that helps them to be updated. The in-service teachers having good exposure to the older syllabus lack awareness regarding topics from the latest Biotechnological applications. Poor capacity-building programmes and fewer chances for proper up-gradation are some of the barriers for the teachers who are already in service. The addition of biotechnological concepts in the syllabus and improved capacity-building programmes might help to improve the awareness of the pre-service and in-service teachers, respectively.

Keywords: In-service teachers, Pre-service teachers, Fermentation Technology.

Introduction

Every new concept imbibes into a child with the emergence of new neuron activity patterns (Uddin, et al., 2020). The way of teaching-learning plays an important role in the amount of excitement towards any subject that students possess. The process of science learning inculcates ideas clearly and makes them capable of thinking innovatively. Classical biology is the root of every modern branch emerged in the area of biology to date. The discovery of Gregor Mendel, an Austrian monk, helped biology to attain its importance at par with chemistry and physics. The irreplaceable work of Mendel by discovering the genetic concepts finally helped biologists to find the cause-and-effect relationship along with quantifying observations. Finding new chains of linking biology was a spark between the holistic and reductionist approaches (Kellenberger, E., 2004).

The integration of multidisciplinary and holistic education across science and other subjects ensures unity and collaboration (Schumacher, et al., 2016; Bensaude-vincent., 2016; National Research Council,US 2009). This leads to the emergence of different streams in biology including molecular biology, cell biology, microbiology, biochemistry, bioengineering, biomedical engineering, biomanufacturing, molecular

engineering, bioinformatics, etc. (Sadiku, et al., 2018). Technological mammoth such as bioprocessing, tissue culture plays an inevitable role in the production of secondary metabolites, alcoholic beverages, single-cell protein, and antibiotics, etc. at an industrial scale. Education policy has stated that there are three fundamental elements that affect the educational system; they are teacher, student, and educational environment. Teachers being an important component of the teaching-learning process, their continuous professional development play a crucial role in the improvement of students' academic comprehension and their learning environment as well.

As we discussed the importance of teachers in the educational system, the in-service teachers who had accomplished their education erstwhile, but may not keep themselves abreast with new researches and fast development of biology appear as its applications under biotechnology. Due to the dynamic nature of biology and numerous ongoing research activities, the rapid advancement of the field is huge, but the deprivation of their current knowledge creates a gap in academic comprehension.

On the other hand, pre-service teachers are in their learning phase mastering their skills according to the given curriculum. Pre-service teachers are also responsible for higher secondary teaching often after their completion of postgraduate degree, which might create chaos in their own academic discourse while classroom teaching as a teacher. Moreover, syllabus of pre-service teacher education programme includes these concepts of biotechnology in their biology curriculum at the undergraduate level.

There is a need for continuous improvement in the teacher development programme and professional education which was helpful for an individual to become an effective teacher (Reynard, 1963). Research depicts that several efforts had been made for capacity building of in-service teachers similar to pre-service teachers by using various approaches. This helped the teachers to fill the gap of understanding about the subject in elementary education (Weaver, 1965). Several other studies also concluded that there is a need for improving in-service capacity building programs in the education system (Wynn, et. al., 1961). In 1959 Gerheim and Cory found that teachers were cooperative and they valued the implementation of the in-service capacity building programme conducted for their professional development (Gerheim, 1959 and Cory, 1959). Different workshops, discussions, and conferences were also conducted for the betterment of the programme (Willink, 1959). Studies also indicate that a system-based change in the pre-service teacher education programme will be beneficial for developing a leadership capacity in order to sustain the education system (Ferreira, J.A., et al., 2015).

On the basis of the findings concluded through different studies, there is a need to know about the understanding of in-service and pre-service teachers in the newly introduced area. So, along with traditional biological aspects which serve as the fundamental pillar, the importance of the newly introduced area of biology which has a huge technical possibility should also be conveyed to learners effectively. For this purpose, we have selected areas related to fermentation technology and plant tissue culture for assessment as the major topic

since their applications are highly exploited at the industrial level.

Thus, the present study was carried out keeping in view the following research questions:

1. Do the in-service post graduate teachers understand the concepts of biotechnology in biology curriculum at the senior secondary level?
2. Do the pre-service teachers understand the concepts of biotechnology in their biology curriculum?
3. What are the gaps for need-based capacity building programme for in-service post-graduate teachers in subject biology?
4. What are the recommendations for improving biology curriculum for pre-service teacher education programme?

Objectives

Realising the current needs and facts described previously, further research on biotechnology education is necessary. The major aim of this study is to identify the gaps for curricular inputs and designing the need-based capacity building programmes for the pre-service and in-service teachers, respectively. Effective changes might enhance the vision and aura of teachers and thereby helping in better implementation of the subject in school education.

The study was carried out considering the following specific objectives:

- To assess the in-service post graduate teachers' understanding of new areas of biotechnology in biology curriculum at the senior secondary level
- To assess pre-service teachers' understanding of concepts of biotechnology in their biology curriculum
- To provide suggestions for need-based capacity building programme for in-service post-graduate teachers in biology subject
- To provide recommendations for biology curriculum for preservice teacher education programme

Research Methodology

Theoretical framework

Biotechnology concepts in biology curriculum has a specific standing related to teachers' content knowledge (CK) because of its multidisciplinary and interdisciplinary nature (Bensaude-Vincent, 2016) and applied aspects combined to it provides solution to societal problems (Kleiman, 2009). Learning of biotechnological concepts always built upon the basic biological concepts (Falk, et al., 2008) and develop problem solving competency among learners of biology (Fatmawati, 2016). Moreover, there is more influx of information through various information sources making the biotechnological concepts more familiar (Kirkpatrick, et al., 2002) in which students may have more curiosity in the classroom. Content knowledge is an essential part of teacher's professional knowledge (Rogers, et. al., 2007; Baumert, et al., 2010). There is general unanimity that CK is very much required, however it is not sufficient for efficient teaching-learning process (Rogers, M.P. et. al., 2007).

Researchers all over the world have assessed CK of teachers using various methodologies.

One of the most common methods was attempted to directly measure CK using tests, consisting of right/wrong and/or multiple-choice items (e.g., Jeffrey Hill, et al., 2008). There are researches on the teachers' misconceptions regarding subject content knowledge which have influenced learning outcomes of students (Krauss, et al., 2008).

There is little or no mention of theoretical frameworks in the literature regarding assessing the understanding the concepts of biotechnology in the current curriculum of biology among in-service teachers teaching biology or among pre-service teachers in their biology curriculum. To assess the understanding of newly incorporated biotechnology concepts by in-service teachers teaching biology and pre-service teachers in their biology curriculum require an appropriate measuring technique for accurate data collection and arriving at correct and error free conclusions for meeting out the objectives of the study. Construction of an appropriate instrument for assessing deep-seated understanding of theory as well as the practical part of the concepts is a prerequisite. So that recommendations may be made for designing need-based capacity building programme for in-service teachers. Besides, recommendations may be provided for curriculum improvement in teacher development courses.

Since any instrument for such studies was not reported earlier it is appropriate to develop a tool afresh including items that assess understanding and process skills of the concepts of biotechnology. Thus, a thorough literature survey was carried out and similar studies in other fields were followed to maintain compatibility with other PCK assessment instruments (König, et al., 2011; Rohaan, et al., 2009; Schmelzing, et al., 2013). In the present study we have considered assessment of knowledge component only that included items assessing content, methods and skills in biotechnology.

Tool development

Keeping in view the specific objectives assessment tools included items that can assess the understanding of in-service and pre-service teachers in the following concepts which are a part of the present curriculum of biology:

1. Plant tissue culture technology (PTCT)
2. Fermentation technology (FT)
3. Applications of PTCT and FT

Items of the questionnaire were covered to assess the understanding of theoretical aspects, practical and technological skills and terminology recognition and differences and deep-seated understanding of concepts.

Items were subjected to expert validation and field try-out and finalised.

Research Design

The present study was completed using survey method in which a questionnaire after expert validation and field try-out was administered among in-service and pre-service teachers.

Participants

Two categories of participants were identified as respondents of the questionnaire:

(i) In-service teachers from different school set-ups including Post Graduate Teachers of KVS, NVS, state government school teachers and private school teachers teaching biology

(ii) Pupil teachers of integrated B.Sc. B.Ed. professional development courses. Only biological science students were a part of the study.

Sampling Techniques

Sample of the present study was drawn by using purposive sampling technique. In-service teachers attending capacity building programmes or refresher courses were a part of the study. Some of the in-service teachers from private schools of Ajmer (Rajasthan) were also respondents. Fourth year Pre-service teachers of integrated B.Sc B.Ed course with biological science background were also a part of the sample.

Data Analysis

Analysis of the data was carried out using descriptive analysis by calculating percentage, mean, standard deviation, standard error of mean as well as t-test analysis. We utilised the Origin 2021b programme for this.

Results and discussion

The participants' responses to questionnaire were examined and presented in Table 1. Table 1 reveals that the responses of in-service and pre-service teachers recorded for the items 1 to 25 shows diversity in marking their answers.

Results illustrated in Table 1 reveals that pre-service teachers perform better in terms of pure cell culture and air lift fermenter concepts with respect to the other group. However, the findings from the analysis were unsatisfactory for all respondents. Topics from developmental biology such as differentiation, de-differentiation and determination, as well as more advanced topics such as micropropagation, elicited very few positive responses from the two groups of teachers.

Table: 1 Responses for biotechnological aspects of in-service and pre-service teachers

S. No.	Items included in the questionnaire	In-service teachers Sample Size (74)		Pre-service teachers Sample Size (114)	
		(+ve) Response	(-ve) Response	(+ve) Response	(-ve) Response
1	Recognise aseptic environment in tissue culture	56	18	104	10
2	Recognise technical requirement of aseptic transfer in tissue culture skills	60	14	102	12
3	Understand pure culture of a single organism in culture tube	12	59	19	95
4	Recognise callus	59	15	95	19
5	Aware of the terminology in vitro cultivation	66	8	109	5
6	Aware of the process of differentiation	60	14	80	34
7	Aware of the process of dedifferentiation	37	37	57	57
8	Aware of the process of determination	17	57	43	71
9	Recognise an explant	37	37	58	56

10	Recognise suspension culture	33	41	65	49
11	Understand application of plant tissue culture for haploid plant production	54	20	71	43
12	Recognise "de novo"	35	39	47	66
13	Recognise epicotyl	51	23	80	34
14	Understand the process of hardening	18	56	26	88
15	Understand the process of fermentation	21	53	21	93
16	Differentiate between plant growth regulators and hormones	34	40	33	81
17	Recognise enzymes	25	49	57	57
18	Recognise Hypocotyl	31	43	48	66
19	Understand mode of bioreactor operations and growth cycle of a cell culture	23	51	45	69
20	Understand growth cycle of a culture system	42	32	54	60
21	Understand mode of bioreactor operations and growth cycle of a cell culture	38	36	65	49
22	Recognise genetic or epigenetic variations	40	34	76	38
23	Recognise bioreactor design	9	65	27	87
24	Understand the process of downstream processing	28	46	32	82
25	Understand the parameters of bioreactor operations	40	34	80	34

When compared to other topics, moderate responses were seen while addressing the function of hormones in growth, the method of operation of the fermentation process

items concerning haploid plants, aeration, and agitation in reactors are better, which demonstrates that the teachers have been well exposed to these concepts of

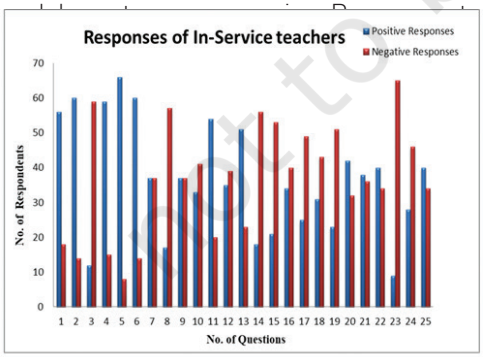

Fig. 1: In-service Teacher's Feedback

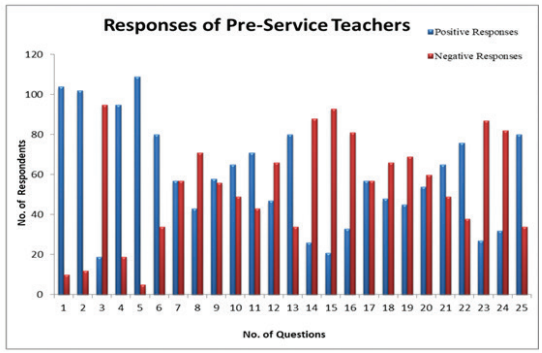

Fig. 2: Pre-service Teacher's Feedback

The least affirmative responses provided by the in-service teachers for assessment items 3, 14 and 23 were related to tissue culture techniques in biotechnology, Similarly, the number of positive responses to item number 9, 12 and 18 was also very less as depicted in Figure 1, which are related to understanding of biological terminology required not only for science communication but also required for other competencies. Also, their response for basic concepts of biology required for understanding the concepts of biotechnology for item 8 and 17 was also consistently less positive.

The lowest number of positive responses were provided for item 3 in the case of teacher trainees, demonstrating a considerable disparity between the two categories of teachers' positive response rates (Table 2).

Table –2 Percentage of Positive Responses of both the Groups

Q.NO.	In-service	Pre-service
1.	75	91
2.	81	89
3.	16	16
4.	79	83
5.	89	95
6.	81	70
7.	50	50
8.	22	37
9.	50	51
10.	44	57
11.	72	62
12.	47	41
13.	68	70
14.	24	22
15.	28	18
16.	45	28
17.	33	50
18.	41	42
19.	31	39
20.	56	47
21.	51	57
22.	54	66
23.	12	23
24.	37	28
25.	54	70

The findings may have significance for understanding that pre-service teachers know the curriculum more effectively than in-service teachers. While both groups provided accurate responses for item number three, in particular, in-service teachers had more affirmative responses than pre-service teachers for items 6, 11, 12, 14, 15, 16, 20, and 24. Although for all other questions pre-service teachers have somewhat more knowledge than in service teachers. The pie chart in Figures 3 (A and B) makes it very evident that pre-service teachers outperform as compared to In-service teachers in terms of favourable replies. Pre-service teachers answered more positive response to the items assessing cutting-edge technologies like plant biotechnology, bioreactors, fermentation technology, cell culture technology, and bioprocess engineering, but in-service teachers responded more to questions about the differentiation process, haploid plants, plant growth regulators, and downstream processing etc. In case de-differentiation, the responses recorded from both the groups were equal, i.e. 50 per cent.

The analysis of the data gathered also have shown that neither category understands how to cultivate a single organism in pure culture. Figure 4 represents the understanding of different biotechnological concepts such as growth and development, culture and regeneration, operational modes, designing of fermenter, bioreactor and downstream processing on the basis of percentage score of positive responses from pre-service and in-service teachers. In-service teachers have better clarity about growth and developments, culture and regeneration, operational modes and designing of reactor, even still, relatively few people responded favourably to

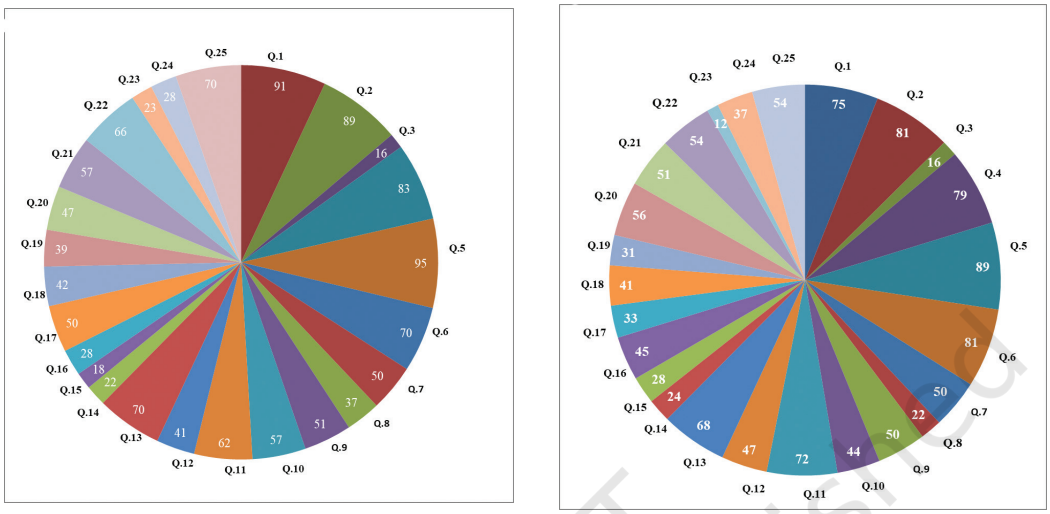

Fig. 3: Percentage of Positive Responses of (A) Pre-Service and (B) In-Service Teachers

inquiries about bioreactors and downstream processing. Thus, topics related to bioreactor and downstream processing with more focus on experimental and the other pedagogical along with assessment inputs should be more emphasized in the curriculum of pre-service teachers. On the other hand, in- service teachers have more understanding about culture and regeneration but least about growth and developments, operational modes, designing of reactor, bioreactor and downstream processing. Thus, these topics should be included while designing of capacity building programme for the in-service teachers which could help them to teach biotechnology efficiently.

It can be concluded from the results discussed above that the pre-service teachers had better understanding about the concepts than those of in-service teachers' group. It can be interpreted that since the pre-service teachers have an updated syllabus in their curriculum and considering the fact that they are still in the studying phase, they might have better access to the information sources that they can keep themselves updated regarding the new developments and researches in the area. In contrast, the in-service teachers have an exposure to an older syllabus which covers limited topics from biotechnology. The lack of chances to upgrade their vision about the newer addition in the field might also be a barrier for the teachers who are already in-service. And, this is the reason they are unable to keep themselves updated to the application-based booming field of biotechnology. They may or may not have access to information retrieval infrastructure where they are affiliated to. Besides, teachers are not in touch with the faculty of different national level institutions working in biological researches. Moreover, teachers working in schools at remote places utilise more time and energy in commuting.

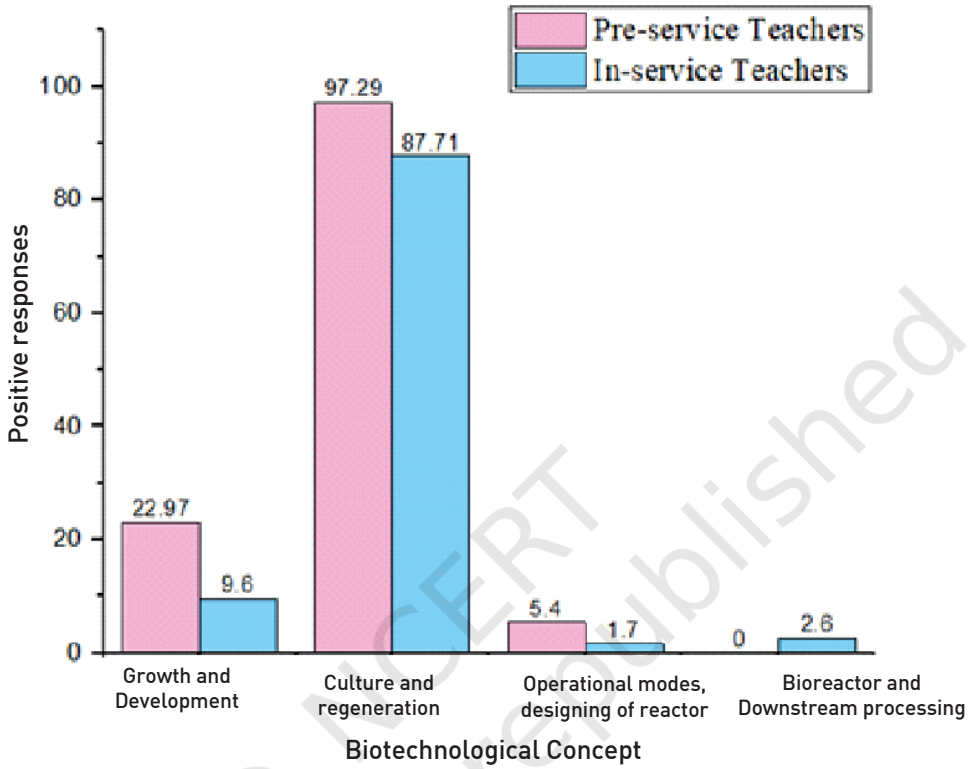

Fig. 4: Positive Responses of Teachers in Biotechnological Concept

Recommendations

In the light of current scenario, it is well understood that biotechnology is an applied evolution and technology integration in biology. Following are the recommendations in context of school education:

1. Advancement in many areas such as cloning, stem cell research, genetic engineering, CRISPR-Cas 9 gene editing tools, phylogenetic research etc; along with plant tissue culture and fermentation technology can be beneficial for both the students who are thinking to pursue their academic career in this area in their tertiary education. And, even if, they are not, it is important that the fundamentals of the same may be a part of biology curriculum in school education so that each and every citizen in India would have minimum literacy for biotechnological concepts because of their biology curriculum in school education.
2. On the basis of the results of the present study, it is recommended that there is a

need to upgrade the syllabus of the pre-service teacher's education programme by introducing recent and advanced biotechnological approaches as content weaved in with pedagogy and assessment to develop required competencies and to achieve learning outcomes.

3. Teachers should be able to focus on student's weaker section by employing different ICT tools like internet, interactive videos, animations, power points, virtual laboratory in teaching of biotechnological concepts, etc.

4. There is a need of hands-on sessions for each topic to improve the ability to perform experiments along with the theoretical clarity among learners.

5. Since concepts of biotechnology are applied aspects of traditional biology, they provide solutions to many contemporary problems. Teachers with enhanced aura with understanding of these biotechnological concepts may take their classroom process in a better shape to enhance students' problem-solving skills by providing hands-on biotechnology activity. Students develop better competencies for critical thinking, problem-solving skills and creativity skills by performing biotechnological experimentations (Pauwels, et al., 2001). Research studies also indicate that an outside hands-on intervention increase students' content knowledge as compared to students receiving biotechnology information in a traditional learning (Bigler and Hanegan, 2011).

6. In case of in-service teachers, there is a need to conduct capacity building programmes frequently which could improve their weaker section along with the introduction into the current advancement in the subject. Through improving the efficiency of both groups of teachers, we can strengthen the fundamentals of students through the existing biotechnological research and it could contribute to the future research directions also.

Future Prospects

The emergence of this study may be beneficial in suggesting an intervention framework for a capacity-building programme for in-service teachers and curricular input for pre-service teachers in the future, so further research in this area is ongoing.

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THE RELATIONSHIP BETWEEN PSYCHOLOGICAL STRESS DUE TO THE SOCIO-ECONOMIC STATUS (PSSES) OF LEARNERS AND THEIR ACHIEVEMENT IN SCIENCE

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The National Curriculum Framework (NCF), formulated by NCERT in 2005, serves as a guideline for syllabi, textbooks, and teaching practices for schools in India. With many years past its implementation, it becomes imperative to ensure its effectiveness, especially at the rural level and identify areas for improvement. A survey was conducted by visiting a rural school in Delhi with students from predominantly weak socio-economic backgrounds. The researcher interacted with learners and gained insight into the school system, teachers, and learning environment.

One needs to look at science education from a psycho social perspective i.e. factors that intervene in the learning of science. This becomes especially important for the rural students who comprise a major section of school going population. Since these students come from background characteristic of first generation learners, little to no understanding of science education and low nutrition etc. In order to get a first-hand experience of factors affecting the learning process of science directly or indirectly among learners is crucial to ensure its benefits are reaped at grass root level and to find out gaps, if any, for further interventions

This research study investigates the gaps in science learning due to psychological stress in children from weak socio-economic backgrounds and related factors in Indian schools.We found that stress negatively impacts learners' performance in science and an alarmingly high level of learners self-diagnosed with stress and related psychological problems. In addition to this, the relationship of perceived autonomy and self-regulatory behaviour were found to influence science performance positively. It is noteworthy, that in this study we found nutritional habits and family type (joint/nuclear) greatly influence science performance stress levels, perceived autonomy and regulatory behaviours in learners. The paper discusses these factors at the theoretical and policy levels, intending to provide recommendations improve science literacy despite the social background.

Introduction

The idea of getting first-hand experience with curriculum transactions and factors affecting the learning process of science directly or indirectly among learners is crucial after curriculum reformation to ensure its percolation at the grass root level and to find out gaps, if any, for further interventions. After approximately 6-7 years of implementing the new curriculum (NCF, 2005; NCERT, 2006), it is expected to have been fully implemented, with nationwide orientation workshops being conducted for educators and academicians from states/ union territories by NCERT.

The curriculum focuses on a paradigm shift from a teacher-centred to a learner-centric approach to teaching-learning. In this light, the opportunity to visit a rural school in India for three months was utilised. In this endeavour, one of the researchers (Sunita Farkya, Professor DESM, NCERT) visited Sarvodaya Kanya Vidyalaya, a Delhi government rural school in Aaya Nagar, Delhi. The objective of this visit was to interact directly with learners and gain a deep-sighted understanding of the school system, learners, teachers and learning environment. The visit to this rural school was crucial in framing the research framework and developing the

questionnaire/tool to collect feedback about the various interacting factors affecting the teaching-learning process and process of learning science. The school visited has a purely rural background; however, the school is located near a suburban area in Delhi. Most of the children coming to this school belong to a weak socioeconomic family background. The learners hailed from nearby states, including Uttarakhand, Uttar Pradesh, Rajasthan, Haryana, Punjab, Himachal Pradesh, and Madhya Pradesh, thereby bringing in a wide variety of diversity in terms of -cultures, backgrounds and socioeconomic statuses. Both parents are well-versed in agricultural methods and techniques due to their agricultural heartland roots. The parents of learners who have migrated to the city mostly work as labourers on daily wages or plumbers, or carpenters (in the case of fathers), and as domestic help or housewife (in the case of mothers), making the average family income less than INR 20,000.

Socio economic status of the family impacts the well-being of the members in different ways. One important psychological impact is the stress of the members. While parents are anxious in meeting the basic needs and requirements for living the anxiety and stress percolate to other members in the form of frequent arguments, violence, nutritional deficits, malpractices etc., which have a direct bearing on their academic involvement and engagement. Therefore research has understood and acknowledged the impact of social conditions which lead to variations in health and well-being and are also referred to as the social causation perspective.

Apart from the academic reason of curriculum, pedagogy and assessment, science learning is also based on psychosocial aspects like parental orientation, support and motivation. Students coming from lower SES generally miss out on the parental involvement in their formal education. This lack of involvement can be seen in their breakfast habits and nutrition. Only 42.8 per cent of the children ate breakfast regularly which often fails to meet required energy and protein demands(Chitra, et al., 2007). Lack of nutrition compounds the effect of stress and that reflects in their poor academic performance. Further, it is also seen the students coming from lower SES have little to no education support as they are first-generation learners and their parents have no understanding of science and orientation towards it. These factors increase the academic difficulty of students and the academic gap keeps increasing with little to no support from parents either due to their illiteracy or ignorance.

Theoretical Foundation in Literature

When the economic circumstance improves with employment of parents resulting in better family income it shows correlation to decline in behavioural problems amongst children (Costello, et al; 2003) i.e. as the fail stress reduces the children flourish better. Another way family income correlates with children well-being is through the investment that the parent makes in their children. As the family's finances improve the investment of parents in their children by way of education and nutrition also improve (Conger & Conger, 2002, Bradley & Corwyn, 2002; Mayer, 1997). Mistry and her colleagues also showed that the impact of income on child's social and cognitive outcomes through family processes was stronger for poorer families (Mistry, et al; 2004. Further Socio economic status influences parenting behavior and their

educational support for their children which leads to children's better learning habits and therefore positively affect their academic performance.

The children who come to the Indian science classrooms belong to heterogeneous socio-economic-regional and cultural backgrounds. They may or may not continue to pursue science related careers in future still each and every citizen of India needs to be scientifically literate (NCF, 2005). How school science teaching can meet the requirements of all the students? What can one reasonably expect from a student in terms of their understanding of science after learning at upper primary level? These are some of the questions yet to be addressed. The purpose of the research study is to find out the gaps in science learning with respect to psychological stress to children due to socio-economic backgrounds of their families.

Objectives

The objectives of this study were to:

1. assess the level of psychological stress among learnersand its implications on science achievement amongst students of class eight.
2. explore the relationship of Socio-economic status on the stress and achievement in science.

Research Methodology

The Sarvodaya Kanya Vidyalaya, Aaya Nagar, in Delhi purely has a rural background; however, the school is located near a sub-urban area in Delhi. Most of the children coming to this school come from a family background with a labourer father working on daily wages or working as plumber, carpenter or such kind of workers and domestic help or house wife mothers, coming from rural backgrounds from nearby states (Uttarakhand, U.P, Rajasthan, Haryana, Punjab, HP, MP or sometimes from other states) also encompassing a wide variety of cultures, diversity, backgrounds and socioeconomic statuses of learners. Thus both the parents are well versed in agricultural methods and techniques. Most of the learners coming to the school have a poor socioeconomic background.

Research Design: A cross-sectional, questionnaire-based survey was carried out. This survey was based on the Exploratory sequential design by Creswell & Clark (2011).

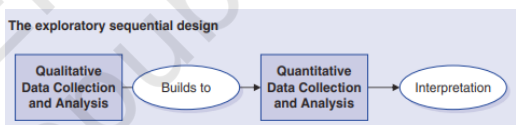

Fig 1: The explanatory sequential design by Creswell & Clark (2011)

Sampling : The sampling technique was purposive. This study was conducted in an 'all girls' government school from a rural region with infused boundaries of urban Delhi. One of the authors carried out this study as part of routine work during the field visit for three months. All the respondents selected for tool administration and data collection were females in the eighth standard and used English as the medium of instruction.

Tools : The students were given seven questionnaires and a science quiz each. They were clearly instructed regarding the procedure to respond, and all of them could answer autonomously without help from peers or teachers. The six questionnaires

were: details of the subject, why I do a thing, stress scale, learning climate questionnaire, and common questionnaire. Each of survey was used as a quantitative and qualitative tool to identify and establish the relationship between psychological stress and socioeconomic status of individual learners and its impact on their achievement in science. A brief description of these tools is given below:

(a) Stress score

The stress scale used for qualitative analysis of stress in the sample population was an adaptation of the Hopkins Symptoms Checklist (HSCL) [Derogatis & Cleary, 1977; Lipman et al., 1979]. It is a Self-Report Symptom Inventory developed for individuals, which gives an understanding of possible psychological symptoms being experienced by the subject under stress. In our study, the stress scale used was a self-rating inventory with a yes or no answer format. The used scale had 30 items drawn from the HSCL measuring 11 reactions to stress. These 11 reactions were reflected in various questions of the study.

The total scores of each item were added to get a final score on stress levels, and the subscale items could be added separately to give sub-scale scores for all the 11 psychological reactions that could further be used for a richer interpretation of the stress of the students.

(b) Perceived autonomy

To assess learners' autonomy in the classroom, the Learning Climate Questionnaire developed by Ryan and Connell (1989) was used. The scale is a measure of autonomy, one of the several variables of Self Determination Theory (SDT). Essentially SDT caters to understanding the quality of social contexts that influence the motivation, performance, and well-being of individuals who operate within them. The climate questionnaire yields a score on a 7-point scale, which shows how the respondents perceive their supervisors/teachers/managers etc., i.e. supportive or non-supportive of autonomy. Higher scores show higher perceived autonomy support. The scores were calculated by averaging the individual item (15 items) scores. However, averaging the item score, item 13 was 'reversed' (i.e. the score of item 13 was subtracted from Item 8 and used). High average scores reflect high-perceived autonomy support.

(c) Self-Regulation

The Academic Self-Regulation Questionnaire (SRQ-A) was used to assess the scale of self-regulation. It is primarily concerned with the reasons as to why students do their school-work. Developed by Ryan and Connell (1989), this scale has four subscales: External Regulation, Introjected Regulation, Identified Regulation, and Integrated Regulation. These behavioural aspects are based on the SDT, and differentiate different types of behavioural regulations in terms of the degree to which they represent autonomous or self-determined (versus controlled) functioning.

The questionnaire had 30 items. The following are the subscales that comprise the questionnaire External Regulation, Introjected Regulation, Identified Regulation and Intrinsic Motivation. Firstly, the subscale scores for each of the four subscales were calculated by averaging the items that make up that subscale. The responses on the 4-point scale were scored as follows Very true is scored

as 4, Sort of true was scored as 3, Not very true was scored as 2, and, Not at all true was scored as 1.

Following this, the Individual subscale score or Relative Autonomy Index (RAI) were calculated and used for analysis. The more controlled the regulatory style represented by a subscale, the larger its negative weight (RAI); and the more autonomous the regulatory style represented by a subscale, the larger its positive weight (RAI). To calculate the RAI, the following formula was used:RAI = (2 x Intrinsic Motivation Score) + (Score on Identified Regulation) – (Score on Introjected Regulation) – (2 x External Regulation Score).

(d) Details of the subject and common questionnaire

These questionnaires were prepared to incorporate questions to understand and analyse the different family backgrounds of learners, family members, the financial status of the family, hobbies they like, career aspirations, routine activities they enjoy like eating, sleeping, and playing etc. Specifically, learners were asked whether they have breakfast before coming to school and the meals they most commonly have for breakfast. Another specific detail was the family type i.e. joint/nuclear, and the number of family members.

(e) Tools for Attainment in Learning of Science (TALS)

A questionnaire that was essentially based on primary and middle school science concepts was developed and validated by experts opinion and field try out. Some questions were multiple choice based, while others were subjective questions. The maximum score that could be obtained was 25.

Statistical analysis: Based on the data collected through the questionnaires, the statistical analysis in this study was performed using R-4.2.2 software. In any statistical study, there can be three variables,namely: -

- Dependent Variable is the variable that is the primary object of research. It is the "effect" that researchers want to study.
- Independent Variable(s) is the variable that causes the phenomenon under study. It is the "cause" that creates the "effect".
- Control Variables are the variables that are not intended to be the primary focus of the "cause" of the "effect", but they also control or influence the "effect".

The objective of this study is to observe the effects of stress, motivation and perceived autonomy among female learners on their learning outcomes in science. Therefore, in this context –

- Dependent Variable: Learning Outcomes, measured by the scores in Science questionnaire.
- Independent Variable: Stress, RAI, and Autonomy Scores
- Control Variables: Breakfast, Family Type

Based on these variables, two types of statistical tests were performed:-

a) Descriptive Statistics

- Histogram and Boxplots depicting the distribution of Independent (Stress, RAI, and Autonomy) and Dependent Variables (Science Quiz Scores)
- Boxplots depicting the distribution of Independent and Dependent Variables

faceting by Control Variables (Breakfast and Family Type)

b) Linear Regression Models

- Model-1: Regression of Score on all Independent and Control Variables (Breakfast, Family Type).
- Model-2: Regression of Score on RAI and Control Variables (Breakfast, Family Type).
- Model-3: Regression of Score on Stress and Control Variables (Breakfast, Family Type).
- Model-4: Regression of Score on Autonomy and Control Variables (Breakfast, Family Type).
- Model-5: Regression of Score on Stress, Breakfast, and accounting for their interaction term.
- Model-6: Regression of Score on Stress, Family Type, and accounting for their interaction term.

RESULTS AND DISCUSSIONS

Stress among learners: The stress of individual learners and the underlying psychological symptoms being experienced due to it were analysed by a stress scale based on the Hopkins Symptoms Checklist (HSCL). The average stress score was 16.8, a distribution of scores as shown in Fig 2.

It was found that a staggering 67.3 per cent were facing despair, while more than 50 per cent could identify themselves facing 10 out of 11 psychological symptoms induced by stress. The psychological symptoms categorised by HSCL and average students (%) facing the symptom and its correlation with their science achievement were analysed as projected in Table A1 (in appendix).

The learners reported a high level of perceived stress. The stress can be an offshoot due to the student's social, emotional, physical, and family problems and may negatively influence their learning ability and academic performance [Shah, M. et al., 2010].

Perceived autonomy among learners: The learning climate questionnaire (LCQ) was used as a scale to measure the perceived autonomy of support by the learners. The scale of score ranges from 1-7, with 7 being the highest perceived autonomy support. The score for more than 30 per cent of students

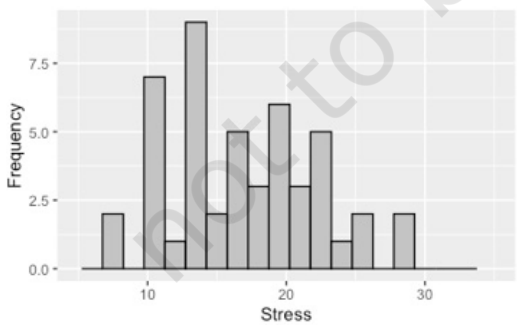

Fig 2: Histogram representation of the range of stress score distribution among learners, 0 being lowest and 30 being maximum.

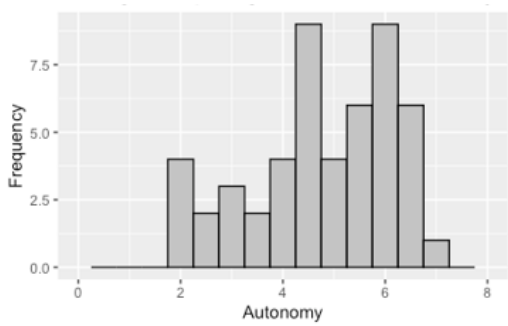

Fig 3: Histogram representation of the range of autonomy score distribution among learners, 0 being lowest and seven being maximum.

lay between 5-6 and nearly 25 per cent of students' scores lay below 4.

Self-Regulation among learners: In order to quantify the perceived autonomy, for determination of intrinsic vs extrinsic motivation among students, Academic Self-Regulation Questionnaire (SRQ) was used. Based on the scores of four subscales, external regulation, introjected regulation, identified regulation and intrinsic motivation, the Regulation autonomy index (RAI) was calculated. As the controlled subscales (external regulation, introjected regulation) are weighed negatively, and autonomous scales (identified regulation: and intrinsic motivation) are weighed positively, a larger negative weight represents a controlled regulatory style. It was found that more than all students had a negative RAI, varying from 0 to -30. More than 50 per cent of students were identified with a highly negative RAI (-15 to -30), indicative of their lack of behavioural freedom and autonomy. It was also noted that 60 per cent of students who had a high-stress score (→15) showed a highly negative RAI score (→-15).

Science score of learners: The students in this study were given a science questionnaire with basic and applicative type of questions related to general science. The answers to which were based on choosing the correct choice among given multiple choices. The average score of class was 14.7 out of 25. The marks distribution of 50 students is as shown in the Fig 5.

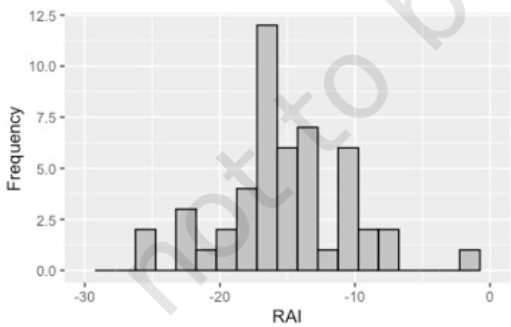

Fig 4: Histogram representation of the range of RAI score distribution among learners, varying from 0 to -30

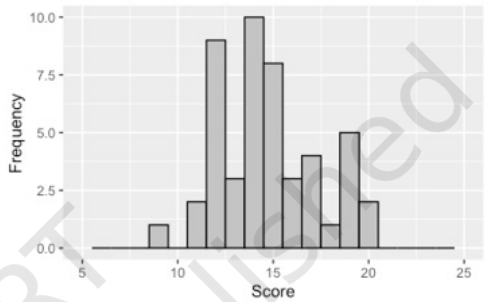

Fig 5: Histogram representation of the range of Science quiz score distribution among learners, varying from 0 to 25

Impact of learners' nutritional habits on their stress, perceived autonomy, self-regulation and science score

The nutritional quantity and quality of learners is an important factors for their physical and mental well-being [Rucklidge, J. et al, 2021]. In a study by Dani and the group, it was found that nutrition also has potent effects on brain function. It was concluded that protein, iron, iodine, and breakfast consumption all impact a child's learning capability and behaviour. The study identified additional, potent roles of micronutrients, such as essential fatty acids, minerals, and vitamins, in preventing learning and behavioural disorders [Dani, J. et al., 2005]. In the survey, we identified whether the learners take breakfast before coming to school or not. We found an interesting trend between the relationship of stress scores and the achievement in science of learners with their breakfast habits. It was found that

learners who regularly had breakfast before school scored higher on the TALS and showed lesser stress levels. While the RAI score was reduced, the perceived autonomy score significantly improved in learners having breakfast. These results are shown in Fig 6 by box plots, where 0= not having breakfast and 1= having breakfast.

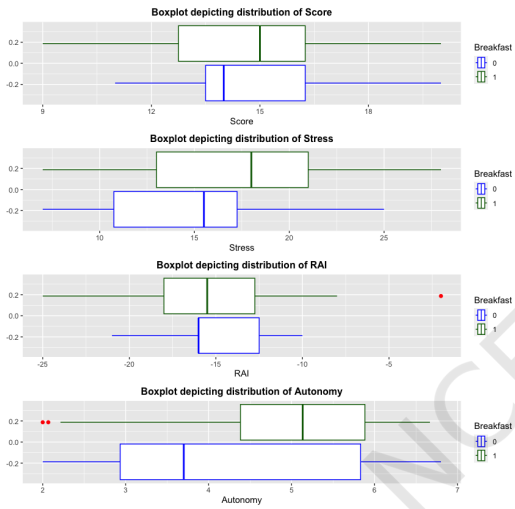

Fig 6: Box plot distribution showing the impact of breakfast on four variables of learners- science score, stress score, RAI, and perceived autonomy.

Impact of learners' family type (joint/ nuclear) in their stress, perceived autonomy, self-regulation and science score

Nowadays, lifestyles are rapidly changing owing to social and cultural changes, rapid urbanisation, and hustle. In such a scenario, the family is an important support system, especially for mental health [Chadda and Deb, 2013]. In our study we found that the 'family type' i.e., joint or nuclear, had a serious correlation with learners' stress. The average stress score for nuclear family learners was higher than that of learners from the joint family system. Similar results were shown in a study by Chadda and Deb, 2013. Additionally, we also found that the science score was improved in students coming from joint family type while the perceived autonomy score was decreased in them. There was no significant change in the RAI based on the family type. These results are shown in Fig7 by box plots, where 0= nuclear family and 1= joint family

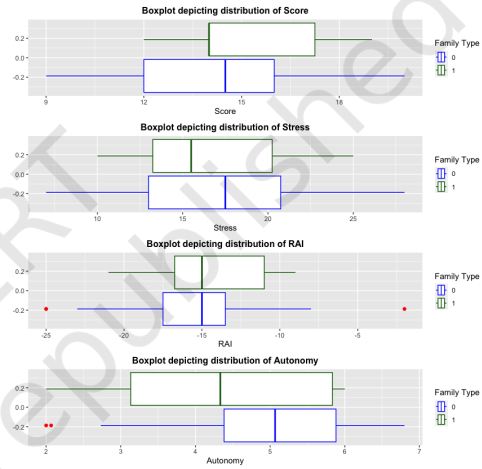

Fig 7: Box plot distribution showing the impact of family type (joint/nuclear) on four variables of learners- science score, stress score, RAI, and perceived autonomy. Note- Family type: 0= nuclear family, 1= joint family

Probable triggers of stress in learners

The learners in our study belonged to economically weak families, a probable stress trigger. The Family Stress Model (FSM) predicts that economic hardship primarily influences the development of children through parents' lives. It is noticed that family economic hardship and pressure are indirectly related to children's adjustment through their influence on parents' behavioural and emotional functioning [Conger and Donnellan, 2007].In

addition to the environment at home, difficult situations in the classroom, such as exams or interpersonal conflicts, can also challenge or exceed the coping strategies or resources available and thus threaten the learner's homeostasis, and inner balance, leading them to feel 'stressed' [Vogel and Lars,2016]. This study found a positive correlation between perceived homework stress and overall stress among learners. While an academic attitude development tool, homework can often be stressful for learners [Katz et al.,2012] if done as a result of extrinsic motivation rather than intrinsic motivation. In this study it was noted that the trend of the perceived autonomy score showed a negative correlation with the stress score. The majority of the students who had higher perceived autonomy scores (between 4-7) had lower stress scores (←15) and vice versa. Additionally, a moderately positive correlation was found between the perceived autonomy score and science achievement. The results are coherent with a Chinese study that suggests that academic stress is a multidimensional construct with four subconstructs: pressures to perform, stress related to teacher expectation, perception of workload and stress related to academic self-perceptions [Zheng et al, 2020].

Impact of stress, perceived autonomy and RAI on Science Learning

In our study, we found that stress and most of its psychological symptoms have a profound negative correlation with learning and achievement in science (as shown in Table 2). It is notable that stress, even in low amounts, can hinder effectively carrying out tasks [Motowidlo SJ et al., 1986] and deeply hampers the cognitive ability to concentrate [Sailer HR et al., 1982]. Additionally, stress has been found to impair memory, diminishing the ability to recall or recognise previously learnt facts and concepts [Schwabe et al., 2010].

The learners in this study belonged to a weaker socioeconomic status [SES]. Many studies have established that SES, inversely related to mental health risks, is a major cause of a lack of self-regulatory behaviour [Blair and Clancy (2010)]. Family stress, relationship with caregivers and financial stress of caregivers has been found to impact the self-regulatory behaviour in learners [Duran et al., 2020]. It was found that learners who perceived higher support from teachers were less stressed and performed better in science. Learners spend a good amount of day in school, and experiences of school can positively or negatively influence their thoughts, mood and perception of self-worth. There is considerable evidence showing that teachers can provide a positive climate in which students can learn to face different challenges and difficulties [Zhang et al. 2021]. Teachers can play a fundamental role in providing autonomy support aimed at satisfying students' need for autonomy by offering students choices, appreciating students' points of view, and encouraging them to develop autonomously [Reeve, 2009]. Teachers can also fulfil students' need for relatedness by developing positive teacher–student relationships by showing affection, dedicating time to students, expressing understanding, and providing support when needed [Stroet et al., 2013]. Thus, both strategies might act as "corrective experiences" that modify students' negative views of themselves or their relationships with others and alleviate students' academic and interpersonal stress [Rhodes et al., 2006]. This study found that 60% of students who had a high-stress score (→15) showed a highly

negative RAI score (→-15), indicative of lack of indicative of their lack of behavioural freedom and autonomy.

Linear Regression Model(s):- Based on the dependent, control and independent variables as mentioned in methods section, six regression models were generated as shown in A2 (mentioned in the appendix). Out of the six generated models, model 1, was found most suitable to our study.

Equation forModel-1:$\widehat{(Score)} = \beta\_0 + \beta\_1 \cdot (Breakfast) + \beta\_2 \cdot (Family\ Type) + \beta\_3 \cdot (Stress) + \beta\_4 \cdot (RAI) + \beta\_5 \cdot (Autonomy)$

From the model it is clear that having breakfast should positively affect children's performance in the Science Quiz ($\beta\_1>0$). The joint family type is also causing a positive increment in the science score ($\beta\_2>0$). As expected, stress bears a negative effect on the performance in the quiz ($\beta\_3<0$). RAI, as a measure of motivation for learning, as expected effects on the performance in the questionnaire positively ($\beta\_4<0$). While the model predicts a negative perceived autonomy enhances the score in science ($\beta\_5<0$).

The model estimations are coherent with the results obtained and arguments provided above. In such a light, this mode can act as a benign beginning to statistical reform of learners' learning achievement.

Recommendations:

Education is a fundamental right that should be accessible to every child, regardless of their socio-economic background. In this regard, it is crucial to address the unique needs and challenges faced by school-going children from socially and economically weaker sections of society. To ensure their holistic development and well-being, various measures can be implemented across different domains. Based on the learnings of this study authors recommend consideration and implementation of the following points for educational institutions and policymakers to create a more inclusive and supportive environment for school-going children from socially and economically weaker sections of society, ultimately enhancing their educational outcomes and overall well-being.

Policy Recommendations:

1. Financial Aid Schemes and Scholarship Programmes: Numerous schemes for the upliftment and empowerment of the girl child have been introduced by the central and state governements that can help girl child financially and with education such as: Beti Bachao Beti Padhao, Sukanya SamriddhiYojna, CBSE Udaan Scheme etc. It is important that educational and public welfare institutes create awareness amongst girls and their guardians from weaker SES about these schemes and help them avail its benefits. Other than existing schemes, educational institutes and states can introduce a range of scholarship programs, including merit-based and need-based scholarships, to incentivize students to pursue higher education and reduce the financial burden on their families.

2. Teacher Training and Sensitisation: Implement specialized capacity building programs to equip educators with strategies for addressing the unique needs of students from low SES backgrounds, including differentiated instruction and classroom management techniques and culturally sensitive and contextual teaching methods. Initiate training and sensitisation of educators to understand initial signs of mental and physical breakdown amongst learners and get them help through counsellors or/and doctors.

3. Nutrition and Health: First and foremost, the mid-day meal program, a significant initiative to promote school attendance, needs to be enhanced. The meals should not only be nutritious but also incorporate traditional and culturally relevant foods to cater to the diverse dietary needs of different regions. Proper nutrition is not only essential for physical health but also plays a critical role in cognitive development. Additionally, it is essential to introduce smaller and more frequent food breaks, especially for pre-primary and primary stage children. This approach ensures that children receive a continuous supply of energy throughout the day, supporting their concentration and overall well-being.

4. Residential hostels: There should be an expansion of residential hostels, specifically for female children coming from low SES groups, to provide safe and conducive learning environments, especially for those who live in remote areas.

5. Academic and Mental health support: Academic support is another critical aspect of ensuring the success of marginalized students. Remedial classes should be made mandatory for students from low socioeconomic status (SES) backgrounds to bridge any educational gaps and reduce the stress associated with academic performance. Moreover, the appointment of counselors or teacher-counselors can provide emotional and academic support to students, helping them overcome stress and anxiety. Mental health initiatives should not be limited to academic stress alone but should encompass the general well-being of students. Such programs can foster resilience and emotional intelligence, essential skills for a child's holistic development. Introduction of traditional practices such as meditation and Yoga can help learners to overcome stress and anxiety.

6. Parent-Teacher Collaboration: Parents are one of the most significant stakeholders of education. Thus, regular parent-teacher meetings and workshops to enhance parents' involvement in their child's education should be facilitated that can provide them with guidance on how to support their child's learning and wellness at home.

Recommendations for Curriculum:

1. Curriculum Framework: The curriculum should be designed to cater to the diverse learning needs of students specifically to the students from SES group.

2. Textbook Development: The implications for textbook development are significant, as textbooks should align with experiential and contextual learning principles.

3. Nutrition Education: Incorporate nutrition education into the curriculum to raise awareness about healthy eating habits and encourage students to make nutritious food choices

4. Meditation and Yoga: These traditional practices have been globally accepted for their benefits in mental and physical well-being. These activities can act as stress buster and help improve cognitive abilities of learners.

Curriculum recommendations:

- The curriculum as suggested by NCF 2005 should be transacted through experiential learning method

Classroom teaching- learning process

- Experiential learning
- Day to day life examples
- Peer learning strategy

- Student councelling and mental health classes.
- Implications for textbooks development
- Teachers' capacity building programme.
- Meditation/ Yoga activities as stress buster

Policy recommendations

- Mid-day-meal timings and quality assurance
- Expansion of facility of residential hostels specifically for female children

Conclusion

The mid-day meal scheme initiated by the government has shown its impact on school attendance, retention and academic performance however it needs to be made more nutritious along with smaller and frequent food breaks to be introduced for pre-primary and primary sections. The schools need to start the practice of two breaks between classes one short break and one long break to ensure that students who do not have breakfast eat something in the initial school hours and then have a longer break where they eat and play so that nutritional and physical food requirements are met to enable them to be better engaged is the academic practices.

Remedial classes that were conceptualised for out of school students under RTI can be extended for students coming from low SES groups. These may be made mandatory as regular assistance in learning would not only reduce the stress of academic performance but also engagement with education.

Mental health initiatives at the state and central government levels can be brought in for general well-being so that the students can develop holistically. Many schools have Counsellor/ teacher counsellor to facilities students in overcoming academic and social stress. These counsellors are also trained in career counselling which would additional go a long way in motivating students for science education by orienting them to various possibilities other than engineering and doctors. This information when shared with parents can also help in bringing about a positive shift in their perception of education specifically science. Administrators and teachers too during parental interaction in SMC's or PTM sensitise and orient parents to the needs of nutrition and breakfast for students. Also efforts are being made by free ration to below poverty line families to ensure their children get proper nutrition to grow well and better engage in education. Further positive parental involvement in child's education through sensitization and orientation programs can also be planned. These however should be more intense at primary levels which is the foundational period and also one where the larger orientation to education therefore impacting dropout.

Limitations- study not statistically significant, but shows worthwhile trends. These may be built with a national level/ larger population (number of subjects to be found from census data) study. Further, government initiatives like the Navodaya Vidlyalaya Samiti(NVS) schools which are residential and cater to lower SES group may be studied to see how nutrition and meals along with 24X7 teacher supervision impacts academic performance and well-being of students. If the study finds impactful effect of residential schools similar schools may be planned by state governments for greater benefit to the children coming from challenged SES.

Conflict of Interest Statement: The authors declare that the research in conducting research there was no commercial or financial relationships.

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APPENDIX

Table 1: Brief overview of items/questions in the survey representing the 11 reactions of stress study among learners.

Reaction number	Reaction type	Questions of the survey reflecting the reaction
1	Despair	6, 8, 29
2	Interpersonal reaction	5, 8, 15, 18
3	Somatisation	4, 9, 16, 20, 30
4	Mental weakness	2, 11, 21, 24
5	Anxiety	1, 14, 25, 26
6	Lack of energy	7, 10, 12
7	Depression	13
8	Throat problem	23, 27
9	Apprehension	17
10	Dizziness	3, 19
11	Muscular problem	22

Table A1: Psychological symptoms as categorised by HSCL, average students (%) facing the symptom, and correlation with science questionnaire score.

Psychological Symptom	Students (%) facing the psychological symptom	Relation with science score
Despair	On a scale of 0-3, 0 representing no despair and 3 representing the highest value, 6% of students felt no despair, 16% scored 1, 48% scored 2, and the rest 30% scored 3	Negative correlation
Interpersonal reaction	On a scale of 0-4, 0 being lowest and 4 being highest interpersonal reaction, 22% scored 1, 38% scored 2, 30% scored 3 and rest 10% scored 4.	Negative correlation

Somatization	On a scale of 0-4, 0 being lowest and 4 being highest somatization score, 18% scored 1, 30% scored 2, 30% scored 3 and rest 12% scored 4.	Negative correlation
Mental Weakness	On a scale of 0-4, 0 being lowest and 4 being highest mental weakness, 2% scored 0,8% scored 1 36% scored 2, 42% scored 3 and 12% scored 4.	Negative correlation
Anxiety	On a scale of 0-4, 0 being lowest and 4 being highest anxiety, 12% scored 0, 32% scored 1, 22% scored 2, 26% scored 3 and the rest 8% scored 4.	Negative correlation
Lack of energy	On a scale of 0-3, 0 being lowest and 3 being maximum lack of energy, 20% scored 0, 24% scored 1, 28% scored 2, and the rest 28% scored 3.	Positive correlation
Depression	62% of students felt depressed.	Negative correlation
Throat problem	On a scale of 0-2, 0 being the lowest and 2 being the highest throat problem, 10% scored 0, 52% scored one and rest, 38% scored 2.	No correlation
Apprehension	66% faced apprehension	Positive correlation
Dizziness	On a scale of 0-2, 0 being the lowest and 2 being the highest dizziness score,16% scored 0, 66% scored one and rest, 18% scored 2.	Negative correlation
Muscular problem	28% faced muscular problems	Negative correlation

A 2.1. Linear Regression models

Model-1: Regression of Score on all Independent and Control Variables (Breakfast, Family Type).

Model-2: Regression of Score on RAI and Control Variables (Breakfast, Family Type).

Model-3: Regression of Score on Stress and Control Variables (Breakfast, Family Type).

Model-4: Regression of Score on Autonomy and Control Variables (Breakfast, Family Type).

Model-5: Regression of Score on Stress, Breakfast, and accounting for their interaction term.

Model-6: Regression of Score on Stress, Family Type, and accounting for their interaction term.

In all the models, the equations for estimating science score as a function of other variables are as follows -

Model-1: $(\widehat{\text{Score}}) = \beta\_0 + \beta\_1 \cdot (\text{Breakfast}) + \beta\_2 \cdot (\text{Family Type}) + \beta\_3 \cdot (\text{Stress}) + \beta\_4 \cdot (\text{RAI}) + \beta\_5 \cdot (\text{Autonomy})$

Model-2: $(\widehat{\text{Score}}) = \beta\_0 + \beta\_1 \cdot (\text{Breakfast}) + \beta\_2 \cdot (\text{Family Type}) + \beta\_4 \cdot (\text{RAI})$

Model-3: $(\widehat{\text{Score}}) = \beta\_0 + \beta\_1 \cdot (\text{Breakfast}) + \beta\_2 \cdot (\text{Family Type}) + \beta\_3 \cdot (\text{Stress})$

Model-4: $(\widehat{\text{Score}}) = \beta\_0 + \beta\_1 \cdot (\text{Breakfast}) + \beta\_2 \cdot (\text{Family Type}) + \beta\_5 \cdot (\text{Autonomy})$

Model-5: $(\widehat{\text{Score}}) = \beta\_0 + \beta\_2 \cdot (\text{Family Type}) + \beta\_3 \cdot (\text{Stress}) + \beta\_6 \cdot (\text{Family Type} \times \text{Stress})$

Model-6: $(\widehat{\text{Score}}) = \beta\_0 + \beta\_1 \cdot (\text{Breakfast}) + \beta\_3 \cdot (\text{Stress}) + \beta\_6 \cdot (\text{Breakfast} \times \text{Stress})$

The variable estimates were coded as shown in table 3.

Table A2.2: Regression models (1-6) showing the equation for science wrt other variables, with coded values of the variable.

	Science Score Model – M1	**Science Score Model – M2**	**Science Score Model – M3**	**Science Score Model – M4**	**Science Score Model – M5**	**Science Score Model – M6**
Predictors	Estimates	Estimates	Estimates	Estimates	Estimates	Estimates
(Intercept) β_0	17.64 *** (2.97)	15.87 *** (1.55)	15.72 *** (1.42)	14.68 *** (1.50)	16.06 *** (1.54)	18.90 *** (2.47)
Breakfast β_1 (0= no, 1=yes)	0.59 (1.06)	0.36 (1.00)	0.32 (0.96)	0.16 (0.98)		-4.19 (2.94)
Family Type [linear] β_2 (0=nuclear, 1=joint)	0.36 (0.68)	0.41 (0.66)	0.42 (0.64)	0.42 (0.65)	0.90 (2.17)	

Stress β_3	-0.07 (0.08)		-0.06 (0.08)		-0.07 (0.09)	-0.27 (0.15)
RAI β_4	0.09 (0.09)	0.09 (0.09)				
Autonomy β_5	-0.14 (0.34)			0.02 (0.30)		
Family Type [linear] × Stress					-0.03 (0.13)	
Breakfast × Stress						0.28 (0.18)
Observations	47	47	48	48	48	48
R2 / R2 adjusted	0.050 / -0.065	0.033 / -0.034	0.024 / -0.042	0.009 / -0.058	0.023 / -0.043	0.066 / 0.003
* p<0.05 ** p<0.01 *** p<0.001						

SCIENCE NEWS

Picture This: Camera with No Lens

Engineers develop computerised camera without optics that instead uses an ordinary window as the lens

University of Utah electrical and computer engineers have discovered a way to create an optics-less camera in which a regular pane of glass or any see-through window can become the lens.

Their innovation was detailed in a research paper, "Computational Imaging Enables a 'See-Through' Lensless Camera," published in the newest issue of *Optics Express*. A copy of the paper, which was co-authored by University of Utah electrical and computer engineering graduate Ganghun Kim, is downloaded here.

University of Utah electrical and computer engineering associate professor Rajesh Menon argues that all cameras were developed with the idea that humans look at and decipher the pictures. But what if, he asked, you could develop a camera that can be interpreted by a computer running an algorithm?

"Why don't we think from the ground up to design cameras that are optimized for machines and not humans. That's my philosophical point," he says.

If a normal digital camera sensor such as one for a mobile phone or an SLR camera is pointed at an object without a lens, it results in an image that looks like a pixelated blob. But within that blob is still enough digital information to detect the object if a computer program is properly trained to identify it. You simply create an algorithm to decode the image.

Through a series of experiments, Menon and his team of researchers took a picture of the University of Utah's "U" logo as well as video of an animated stick figure, both displayed on an LED light board. An inexpensive, off-the-shelf camera sensor was connected to the side of a plexiglass window, but pointed into the window while the light board was positioned in front of the pane at a 90-degree angle from the front of the sensor. The resulting image from the camera sensor, with help from a computer processor running

the algorithm, is a low-resolution picture but definitely recognizable. The method also can produce full-motion video as well as color images, Menon says.

The process involves wrapping reflective tape around the edge of the window. Most of the light coming from the object in the picture passes through the glass, but just enough — about 1 percent — scatters through the window and into the camera sensor for the computer algorithm to decode the image.

While the resulting photo is not enough to win a Pulitzer Prize, it would be good enough for applications such as obstacle-avoidance sensors for autonomous cars. But Menon says more powerful camera sensors can produce higher-resolution images.

Applications for a lensless camera can be almost unlimited. Security cameras could be built into a home during construction by using the windows as lenses. It could be used in augmented-reality goggles to reduce their bulk. With current AR glasses, cameras have to be pointed at the user's eyes in order to track their positions, but with this technology they could be positioned on the sides of the lens to reduce size. A car windshield could have multiple cameras along the edges to capture more information. And the technology also could be used in retina or other biometric scanners, which typically have cameras pointed at the eye.

"It's not a one-size-fits-all solution, but it opens up an interesting way to think about imaging systems," Menon says.

From here, Menon and his team will further develop the system, including 3-D images, higher color resolution and photographing objects in regular household light. His current experiments involved taking pictures of self-illuminated images from the light board.

Longer Hours on Social Media May Increase Teens' Risk of Cyberbullying

Summary: Cyberbullying may be linked to higher use of social network sites by school children aged 14-17 years, rather than to simply having a social network profile, according to a new study that examined data from several European countries.

Researchers at the National and Kapodistrian University of Athens, Greece found that school children in Romania, Germany and Poland were more likely to experience cyberbullying, such as aggressive and threatening messages, social exclusion, spreading rumors and sharing private, inappropriate or humiliating information, if they used social network sites for more than two hours a week day.

Co-author Professor Artemis Tsitsika said: "This is an important finding which challenges past research suggesting that simply having, rather than excessive use of, a social network site profile increases the risk of becoming a victim of cyberbullying."

The researchers found that a relatively high proportion of school children in Romania (37.3%), Greece (26.8%), Germany (24.3%) and Poland (21.5%) have been bullied online whereas a fewer proportion experience cyberbullying in the Netherlands (15.5%), Iceland (13.5%) and Spain (13.3%).

Professor Artemis Tsitsika added: "We found multiple factors, in addition to the time

spent on social media, which may impact cyberbullying frequency and explain the differences between countries. In Greece and Romania higher cyberbullying may be due to a lack of digital literacy and relevant legislation, as well as sudden rise of social media use and a large technological gap between parents and the younger generation. Promotion of internet safety strategies and teaching digital skills in education may contribute to lower rates of cyberbullying in the Netherlands. In all cases higher daily use with no monitoring and digital literacy background may lead to teenagers posting private information and meeting strangers online."

The researchers call for educational settings to integrate ICT education into their curricula, especially in countries where use of the Internet has risen abruptly.

The authors undertook a school-based study across Germany, Greece, Iceland, the Netherlands, Poland, Romania and Spain. Anonymous questionnaires about internet use, social factors and cyberbullying were completed by 12,372 students aged 14 -17 across the seven countries.

They caution that the observational nature of the study limits conclusions about the direct causes of cyberbullying. As five years have passed since the data used in the study was collected, its ability to represent the current picture of cyberbullying may be limited.

Computing Power Used to Track the Spread of Cancer

Summary: Researchers have developed a new computational method that increases the ability to track the spread of cancer cells from one part of the body to another. This

migration of cells can lead to metastatic disease, which causes about 90 percent of cancer deaths from solid tumors — masses of cells that grow in organs such as the breast, prostate or colon. Understanding the drivers of metastasis could lead to new treatments aimed at blocking the process of cancer spreading through the body.

"Are there specific changes, or mutations, within these cells that allow them to migrate?" asked Ben Raphael, a professor of computer science at Princeton and the senior author of the new research. "This has been one of the big mysteries."

In a study published in the May issue of *Nature Genetics*, Raphael and his colleagues presented an algorithm that can track cancer metastasis by integrating DNA sequence data with information on where cells are located in the body. They call it MACHINA, which stands for "metastatic and clonal history integrative analysis."

"Our algorithm enables researchers to infer the past process of metastasis from DNA sequence data obtained at the present time," said Raphael.

The technique yields a clearer picture of cancer migration histories than previous studies that relied on methods based on DNA sequences alone. Some of these studies inferred complex migration patterns that didn't reflect current knowledge of cancer biology.

"The data sets we get these days are very complex, but complex data sets don't always require complex explanations," said Raphael.

By simultaneously tracing cells' mutations and movements, MACHINA found that

metastatic disease in some patients could result from fewer cellular migrations than previously thought. For example, in one breast cancer patient, a previously published analysis proposed that metastatic disease resulted from 14 separate migration events, while MACHINA suggested that a single secondary tumor in the lung seeded the remaining metastases through just five cell migrations. In addition to a breast cancer data set, Raphael and his team applied their algorithm to analyze metastasis patterns from patients with melanoma, ovarian and prostate cancers.

Several additional features helped improve MACHINA's accuracy. The algorithm includes a model for the comigration of genetically different cells, based on experimental evidence that tumor cells can travel in clusters to new sites in the body. It also accounts for the uncertainty in DNA data that comes from sequencing mixtures of genetically distinct tumor cells and healthy cells.

This approach overcomes a number of challenges to draw meaningful conclusions from the "difficult to analyze, noisy" data that result from tumor DNA sequencing, said Andrea Sottoriva, the Chris Rokos Fellow in Evolution and Cancer at the Institute of Cancer Research, London. "I predict this new method will be of widespread use to the genomic community and will shed new light on the most deadly phase of cancer evolution," he said.

MACHINA's development paves the way for a broader examination of metastasis patterns in large cohorts of cancer patients, which could reveal key mutations that cause different types of cancer to spread.

Raphael also plans to make the method more powerful by incorporating data from tumor DNA and tumor cells that circulate in the bloodstream, as well as epigenetic changes — reversible chemical modifications of DNA.

"A better algorithm is like a better microscope," said Raphael. "When you look at nature with a magnifying glass, you may miss important details. If you look with a microscope you can see much more."

Gum Disease May Be a Key Initiator of Rheumatoid Arthritis Related Autoimmunity

Significantly higher prevalence of gum disease found in individuals at risk of rheumatoid arthritis compared to healthy controls

Summary: The results of the study demonstrate increased levels of gum disease, and disease-causing bacteria, in individuals at risk of rheumatoid arthritis (RA).

"It has been shown that RA-associated antibodies, such as anti-citrullinated protein antibodies, are present well before any evidence of joint disease. This suggests they originate from a site outside of the joints," said Dr Kulveer Mankia of Leeds Institute of Rheumatic and Muscoskeletal Medicine and the Leeds Biomedical Research Centre (study author). "Our study is the first to describe clinical periodontal disease and the relative abundance of periodontal bacteria in these at-risk individuals. Our results support the hypothesis that local inflammation at mucosal surfaces, such as the gums in this case, may provide the primary trigger for the systemic autoimmunity seen in RA."

Rheumatoid arthritis is a chronic inflammatory disease that affects a person's joints, causing pain and disability. It can also affect internal organs. Rheumatoid arthritis is more common in older people, but there is also a high prevalence in young adults, adolescents and even children, and it affects women more frequently than men.

The prevalence of gum disease is increased in patients with RA and could be a key initiator of RA-related autoimmunity. This is because autoimmunity in RA is characterised by an antibody response to citrullinated proteins and the oral bacterium Porphyromonas gingivalis (Pg) is the only human pathogen known to express an enzyme that can generate citrullinated proteins.

"We welcome these data in presenting concepts that may enhance clinical understanding of the key initiators of rheumatoid arthritis," said Professor Robert Landewé, Chairperson of the Scientific Programme Committee, EULAR. "This is an essential step towards the ultimate goal of disease prevention."

In results from the study, dentists diagnosed clinical gum disease in significantly more at-risk individuals than in healthy controls (73% vs. 38%, p=0.02). In addition, the percentage of sites with clinical attachment level (CAL), 2mm, pocket depth (PD), 4mm, bleeding on probing (BOP), periodontal disease (PDD), and active periodontal disease (PDD+BOP), were all significantly greater in the at-risk individuals compared to controls (p<0.05). In non-smokers, PDD and active PDD were more prevalent in at-risk individuals compared to controls.

DNA was isolated from the subgingival plaque, next to the gums, of each participant and used to measure the levels of three types of bacteria, Pg, Aggregatibacter actinomycetemcomitans (Aa) and Filifactor Alocis. Results showed that there was increased abundance of both Pg and Aa in at-risk individuals. However, in at-risk individuals, only Pg was significantly increased at healthy dental sites and was associated with the overall extent of gum disease (p<0.001).

The study included 48 at-risk individuals (positive test for anti-citrullinated protein antibodies, musculoskeletal symptoms but no clinical synovitis), 26 patients with RA and 32 healthy controls. The three groups were balanced for age, gender and smoking. At-risk individuals underwent ultrasound assessment to assess for subclinical synovitis; only two (4%) were found to have ultrasound synovitis. Dentists examined six sites per tooth in each participant and a clinical consensus was agreed in each by three dentists.

Study Finds Less Corruption in Countries Where More Women are in Government

Summary: The new research is the most comprehensive study on this topic and looks at the implications of the presence of women in other occupations as including the shares of women in the labor force, clerical positions, and decision making positions such as the CEOs and other managerial positions.

In a cross-country analysis of over 125 countries, this study finds that corruption is lower in countries where a greater share of parliamentarians are women. The study further finds that women's representation in local politics is important too — the likelihood

of having to bribe is lower in regions with a greater representation of women in local-level politics in Europe.

"This research underscores the importance of women empowerment, their presence in leadership roles and their representation in government, said Sarangi, an economics professor and department head at Virginia Tech. "This is especially important in light of the fact that women remain under represented in politics in most countries including the United States."

Less than a quarter of the members of the U.S. Senate are women and only 19 per cent of the women in the U.S. House of Representatives are women. It is also noteworthy that the United Stated never had a women head or president.

The authors speculate that women policymakers are able to have an impact on corruption because they choose different policies from men. An extensive body of prior research shows that women politicians choose policies that are more closely related to the welfare of women, children, and family.

The relationship is robust to the inclusion of a number of other control variables including economic, cultural, and institutional factors. The study also uses a statistical technique, known as the Instrumental Variable analysis, to account for the confounding factors and to establish causality in the relationship. After all it is possible that it is corruption that drives women's participation in politics and not the other way around!

The authors maintain that while the gender-corruption relationship has been studied before, the previous studies suffered from the critique that the relationship between women's representation in government and corruption was not shown to be causal.

Jha and Sarangi's research is the most comprehensive study on this topic and looks at the implications of the presence of women in other occupations as including the shares of women in the labor force, clerical positions, and decision making positions such as the CEOs and other managerial positions. The study finds that women's presence in these occupations is not significantly associated with corruption, suggesting that it is the policy making role through which women are able to have an impact on corruption.

Sometimes it is believed that the relationship between gender and corruption may disappear as women gain similarity in social status. This is presumably because as the status of women improves, they get access to the networks of corruption and at the same time learn the know-how of engaging in corrupt activities. The results of this study, however, indicate otherwise: the relationship between women's representation in parliament and corruption is stronger for countries where women enjoy a greater equality of status. Once again, this finding further suggests that it's policy making through which women are able to impact corruption.

Jha and Sarangi's study warns that these results do not necessarily mean that women are inherently less corrupt. In fact, their findings suggest otherwise. If women are indeed less corrupt, then there should be a significant negative correlation between all these measures of female participation and corruption.

The policy implications of the study point towards the need for promoting gender

equality in general and promoting the presence of women in politics in particular. Previous research has established that a greater presence of women in government is associated with better education and health outcomes.

Fair Classroom Practices Disarm threat of Evaluation Retaliation

Summary: While tuition inflation presents a challenge for many college-bound students, an area of growing concern for many universities is 'grade inflation' — in part caused when instructors grade more leniently to discourage students from retaliating by giving low teaching evaluations.

Washington State University researchers say instructors can stop worrying about evaluation revenge as long as they use practices in the classroom that students perceive as fair.

"We've long known there's an association between expected students' course grades and how they evaluate teachers. However, our study is the first to show that grades influence evaluations much less, if at all, when students can see what fair processes instructors use to assign grades," said lead author Thomas Tripp, Carson College of Business associate dean, WSU Vancouver.

Tripp conducted this study with former WSU doctoral students, Lixin Jiang, University of Auckland; Kristine Olson, Dixie State University; and Maja Graso, University of Otago.

"Faculty may not feel a need to award artificially high grades if they knew how students' perceptions of justice might influence this relationship," Tripp said.

Fairness is more than grades

The researchers found students' perception of fair classroom processes revolves around four essential teaching practices: (1) following the course rules by using grading rubrics that match stated criteria, and by aligning their course presentation and expectations to the syllabus; (2) obtaining student feedback and incorporating their interests and voice; (3) being aware of bias and grading blindly; and, (4) correcting grades by providing policies for make-up work and absences.

But students' concept of fairness extends beyond just grades, the researchers found.

"We were a bit surprised to learn of other criteria that students defined as 'fair,' including how well the class is run and how much the professor goes out of the way to help students," said Tripp. "We can see how these are important to students, but they don't fit any definition of 'fair' that we know of."

"The most interesting thing we found in our study is that perception of fair process completely eliminated the threat of student retaliation via low teaching evaluations," Tripp said.

Recommendations for instructors

Based on the findings, the researchers recommend instructors follow specific procedures to ensure a fair classroom.

For instance:

Use grading rubrics consistently and share them with students. Course policies, such as late assignment submissions, should be in writing and included in the syllabus. Instructors should include grade-appeal procedures in their course policies, and if possible, have their students submit their

appeals by their student ID numbers rather than by their names. Should a grade appeal move up to a panel, the panel could include students to increase representativeness.

Fair processes worth the effort

"While adding such processes may seem like a lot of work, we believe instituting fair processes is the superior option for several reasons," said Tripp. "Rampant use of grading leniency may contribute to grade inflation, which is advancing each decade and diminishing the power of grades to motivate students to work harder."

Tripp said by ignoring fair classroom processes and by grading leniently, instructors risk creating perceptions of both unfair outcomes and unfair process, a deadly combination that is associated with lower student evaluations of teachers.

Climate Change Accelerating Rise in Sea Levels

Summary: A new study from the University of Waterloo has discovered that rising sea levels could be accelerated by vulnerable ice shelves in the Antarctic.

The study, by an international team of polar scientists led by Canada Research Chair Christine Dow of Waterloo's Faculty of Environment, discovered that the process of warmer ocean water destabilizing ice shelves from below, is also cracking them apart from above, increasing the chance they'll break off.

"We are learning that ice shelves are more vulnerable to rising ocean and air temperatures than we thought," said Dow. "There are dual processes going on here. One that is destabilizing from below, and another from above. This information could have an impact on our projected timelines for ice shelf collapse and resulting sea level rise due to climate change."

The study, which was conducted over two years, applied methods similar to forensic science on ice shelves which had already calved. Using radar surveys and Landsat imagery, Dow reports direct evidence that a major 2016 calving event at Nansen Ice Shelf in the Ross Sea was the result of fracture driven by channels melted into the bottom of the ice shelf. The surveys also demonstrated that similar basal channel-driven transverse fractures occur elsewhere in Greenland and Antarctica.

As warmer salt water erodes channels into the ice that attaches glaciers to stable land, it also generates massive vertical fractures splitting glaciers from above and below. Surface water melting on top of the ice shelves then pours into these cracks, accelerating the problem further.

"This study is more evidence that the warming effects of climate change are impacting our planet in ways that are often more dangerous than we perhaps had thought," said Dow. "There are many more vulnerable ice shelves in the Antarctic that, if they break up, will accelerate the processes of sea level rise."

Negative vs. Positive Social Media Experiences and Depressive Symptoms

Summary: Negative experiences on social media carry more weight than positive interactions when it comes to the likelihood of young adults reporting depressive symptoms, according to a new analysis. The finding may

be useful for designing interventions and clinical recommendations to reduce the risk of depression.

The finding, reported in the journal *Depression and Anxiety*, may be useful for designing interventions and clinical recommendations to reduce the risk of depression.

"We found that positive experiences on social media were not related or only very slightly linked to lower depressive symptoms. However, negative experiences were strongly and consistently associated with higher depressive symptoms," said lead author Brian Primack, M.D., Ph.D., dean of the Honors College and director of the Center for Research on Media, Technology and Health at Pitt. "Our findings may encourage people to pay closer attention to their online exchanges. Moving forward, these results could assist scientists in developing ways to intervene and counter the negative effects while strengthening the positive ones."

In August 2016, Primack and his team surveyed 1,179 full-time students aged 18 to 30 at the University of West Virginia about their social media use and experiences. The participants also completed a questionnaire to assess their depressive symptoms.

Each 10 per cent increase in positive experiences on social media was associated with a 4 per cent decrease in odds of depressive symptoms, but those results were not statistically significant, meaning that the finding could be due to random chance. However, each 10 per cent increase in negative experiences was associated with a 20 per cent increase in the odds of depressive symptoms, a statistically significant finding.

"It is valuable to know that positive and negative experiences are very differently related to depression," said Primack. "But we don't know from our study whether the negative social media interactions actually caused the depressive symptoms or whether depressed individuals are more likely to seek out negative online interactions. As with many things in social science, the answer is probably some combination of the two, but more research will be needed to disentangle cause and effect."

Other characteristics also were linked to the participants having depressive symptoms. For example, compared with men, women had 50 percent higher odds of having depressive symptoms. Identifying as non-white and having only completed "some college," rather than completing a degree, also were associated with higher odds of depressive symptoms. All of these characteristics have previously been shown to increase a person's likelihood of depression.

While the findings still need to be replicated, Primack said public health practitioners could start using them to educate the public of the risks of negative social media interactions. He also points out that cyberbullying occurs not only among adolescents, but also among adults. Universities, workplaces and community spaces could use the findings to increase awareness around positive and negative social media experiences.

Primack noted that health care professionals working with depressed patients could suggest strategies to improve the quality of online experiences, such as restricting time spent on social media to reduce the number of negative interactions and "unfriending" people or groups that tend to enable negative experiences.

Although the finding was not statistically significant, Primack said that increasing the opportunities for positive experiences on social media is still likely to be worthwhile.

"In other studies, engaging in certain forms of social media use has been shown to enhance communication and social connection," he said. "Certainly, there are many situations in which connecting with others in this way might actually lower depressive symptoms. That just wasn't the primary finding in this particular study."

One in Every Five Deaths in Young Adults is Opioid-related in the United States

Proportion of deaths that are opioid-related has increased by nearly 300 per cent in 15 years

One out of every five deaths among young adults in the United States is related to opioids, suggests a study led by researchers in Canada.

The study, published in *JAMA Network Open* and led by St. Michael's Hospital in Toronto, Ontario, found that the percentage of deaths attributable to opioids in the U.S. increased by 292 per cent from 2001 to 2016, with one in every 65 deaths related to opioid use by 2016. This number varied by age group and sex. Men represented nearly 70 per cent of all opioid deaths by 2016, and the highest burden was among young adults aged 24 to 35 years. This study expands on research in Canadian populations.

"Despite the amount of attention that has been placed on this public health issue, we are increasingly seeing the devastating impact that early loss of life from opioids is having across the United States," said Dr. Tara Gomes, a scientist in the Li Ka Shing Knowledge Institute of St. Michael's. "In the absence of a multidisciplinary approach to this issue that combines access to treatment, harm reduction and education, this crisis will impact the US for generations."

Researchers reviewed all deaths in the US between 2001 and 2016 using the Centers for Disease Control and Prevention (CDC) WONDER Multiple Cause of Death Online Database. This record captures mortality and population estimates across the US by age and sex. The most dramatic increase in illicit and prescribed opioid-related deaths was seen in those aged 24 to 35. By 2016, 20 per cent of all deaths in this age group were related to opioid use — up from only 4 per cent in 2001.

Dr. Gomes, who is also a scientist at the Institute for Clinical Evaluative Sciences in Ontario, and her team found that a total of 1,681,359 years of life were lost prematurely to opioid-related causes in 2016, which exceeds the years of life lost each year from hypertension, HIV/AIDS and pneumonia in the US

"These numbers show us the dramatic impact of opioid-related harms across all demographics in the U.S.," Dr. Gomes said. "We know this is not an isolated public health issue — it is one that spans across North America."

This study was funded by the Canadian Institutes of Health Research and supported by the Institute for Clinical Evaluative Sciences.

An Artificial Nerve System Gives Prosthetic Devices and Robots a Sense of Touch

Summary: Researchers have developed an artificial nervous system that could give prosthetic limbs or robots reflexes and the ability to sense touch.

Stanford and Seoul National University researchers have developed an artificial sensory nerve system that can activate the twitch reflex in a cockroach and identify letters in the Braille alphabet.

The work, reported in *Science*, is a step toward creating artificial skin for prosthetic limbs, to restore sensation to amputees and, perhaps, one day give robots some type of reflex capability.

"We take skin for granted but it's a complex sensing, signaling and decision-making system," said Zhenan Bao, a professor of chemical engineering and one of the senior authors. "This artificial sensory nerve system is a step toward making skin-like sensory neural networks for all sorts of applications."

Building blocks

This milestone is part of Bao's quest to mimic how skin can stretch, repair itself and, most remarkably, act like a smart sensory network that knows not only how to transmit pleasant sensations to the brain, but also when to order the muscles to react reflexively to make prompt decisions.

The new *Science* paper describes how the researchers constructed an artificial sensory nerve circuit that could be embedded in a future skin-like covering for neuro-prosthetic devices and soft robotics. This rudimentary artificial nerve circuit integrates three previously described components.

The first is a touch sensor that can detect even minuscule forces. This sensor sends signals through the second component — a flexible electronic neuron. The touch sensor and electronic neuron are improved versions of inventions previously reported by the Bao lab.

Sensory signals from these components stimulate the third component, an artificial synaptic transistor modeled after human synapses. The synaptic transistor is the brainchild of Tae-Woo Lee of Seoul National University, who spent his sabbatical year in Bao's Stanford lab to initiate the collaborative work.

"Biological synapses can relay signals, and also store information to make simple decisions," said Lee, who was a second senior author on the paper. "The synaptic transistor performs these functions in the artificial nerve circuit."

Lee used a knee reflex as an example of how more-advanced artificial nerve circuits might one day be part of an artificial skin that would give prosthetic devices or robots both senses and reflexes.

In humans, when a sudden tap causes the knee muscles to stretch, certain sensors in those muscles send an impulse through a neuron. The neuron in turn sends a series of signals to the relevant synapses. The synaptic network recognizes the pattern of the sudden stretch and emits two signals simultaneously, one causing the knee muscles to contract reflexively and a second, less urgent signal to register the sensation in the brain.

Making it work

The new work has a long way to go before it reaches that level of complexity. But in the *Science* paper, the group describes how the electronic neuron delivered signals to the synaptic transistor, which was engineered in such a way that it learned to recognize and react to sensory inputs based on the intensity and frequency of low-power signals, just like a biological synapse.

The group members tested the ability of the system to both generate reflexes and sense touch.

In one test they hooked up their artificial nerve to a cockroach leg and applied tiny increments of pressure to their touch sensor. The electronic neuron converted the sensor signal into digital signals and relayed them through the synaptic transistor, causing the leg to twitch more or less vigorously as the pressure on the touch sensor increased or decreased.

They also showed that the artificial nerve could detect various touch sensations. In one experiment the artificial nerve was able to differentiate Braille letters. In another, they rolled a cylinder over the sensor in different directions and accurately detected the direction of the motion.

Bao's graduate students Yeongin Kim and Alex Chortos, plus Wentao Xu, a researcher from Lee's own lab, were also central to integrating the components into the functional artificial sensory nervous system.

The researchers say artificial nerve technology remains in its infancy. For instance, creating artificial skin coverings for prosthetic devices will require new devices to detect heat and other sensations, the ability to embed them into flexible circuits and then a way to interface all of this to the brain.

The group also hopes to create low-power, artificial sensor nets to cover robots, the idea being to make them more agile by providing some of the same feedback that humans derive from their skin.

Photosynthesis Involves a Protein 'Piston'

International research collaboration characterizes a protein complex vital in photosynthesis

Summary: The photo system I (PSI)-ferrodoxin (Fd) complex is important in electron transfer during photosynthesis, through which plants convert sunlight, carbon dioxide, and water into complex chemicals and oxygen. Scientists have recently crystallized the PSI-Fd complex for the first time. They found that the PSI-Fd complex contained Fd with weak and strong binding states and that Fd binding caused the PSI subunits to reorganize into a structure that facilitated rapid electron transfer.

Plants convert water and carbon dioxide into sugars and oxygen by photosynthesis. Photosynthesis is thus integral to life as we know it and has been investigated extensively by researchers around the globe.

However, photosynthesis is a complex microscopic process and some of its aspects are still not well understood. For example, Photosystem I (PSI) is a complicated protein system involved in photosynthesis. PSI reversibly forms complexes with ferredoxin (Fd) that mediate transfer of electrons derived from water. The PSI-Fd complex has not been fully characterized and the atomic-

level interactions between PSI and Fd in the complex remain unclear despite their importance as links in the photosynthetic chain. This is because it is difficult to analyze the weak interactions in such an intricate protein system, which is partly caused by the weak binding interactions in the complex making it challenging to crystallize.

An Osaka University-led international collaboration recently made a breakthrough in knowledge of the PSI-Fd complex by collecting X-ray structural data for this complex isolated from a type of hot spring cyanobacteria. Genji Kurisu and collaborators grew bacteria, purified the PSI-Fd complex, and then grew crystals of the complex. X-ray data for the crystals were subsequently collected and resolved. The X-ray data for the complex provided some interesting information; in particular, that not all PSI-Fd interactions were the same. The results were reported in *Nature Plants*.

"We found that the crystal structure of the PSI-Fd complex contained two PSI trimers and six bound Fds in each crystallographic asymmetric unit," Kurisu says. "The Fds were non-equivalent because they were located at different distances from PSI; that is, Fd had strong and weak binding states in the PSI-Fd complex."

The group's findings were corroborated by the results of further characterization of the PSI-Fd complex by spectroscopic and chromatographic measurements, which also indicated that Fd had two different binding states in the complex. By considering all their experimental findings, the researchers developed a mechanism to explain the formation of two Fd binding states in the PSI-Fd complex.

"We propose that the binding of Fd to PSI lowers the symmetry of the three-dimensional structure of PSI," an associate professor, Hideaki Tanaka, in the team explains. "This induces a piston-like motion of one of the subunits of PSI to provide a complex that displays rapid electron transfer through PSI from the donor (Cyt c6) to the acceptor (Fd)."

The piston-like motion of the PSI subunit is thought to possibly act as a molecular signal across the cell membrane to stimulate rapid electron transfer.

The team's findings may provide clues to allow optimization of artificial photosynthesis to obtain complex chemicals from carbon dioxide, water, and light.

Robot Teaches Itself How to Dress People

Instead of vision, machine relies on force as it pulls a gown onto human arms

Summary: A robot is successfully sliding hospital gowns on people's arms. The machine doesn't use its eyes as it pulls the cloth. Instead, it relies on the forces it feels as it guides the garment onto a person's hand, around the elbow and onto the shoulder.

More than 1 million Americans require daily physical assistance to get dressed because of injury, disease and advanced age. Robots could potentially help, but cloth and the human body are complex.

To help address this need, a robot at the Georgia Institute of Technology is successfully sliding hospital gowns on people's arms. The machine doesn't use its eyes as it pulls the

cloth. Instead, it relies on the forces it feels as it guides the garment onto a person's hand, around the elbow and onto the shoulder.

The machine, a PR2, taught itself in one day, by analyzing nearly 11,000 simulated examples of a robot putting a gown onto a human arm. Some of those attempts were flawless. Others were spectacular failures -- the simulated robot applied dangerous forces to the arm when the cloth would catch on the person's hand or elbow.

From these examples, the PR2's neural network learned to estimate the forces applied to the human. In a sense, the simulations allowed the robot to learn what it feels like to be the human receiving assistance.

"People learn new skills using trial and error. We gave the PR2 the same opportunity," said Zackory Erickson, the lead Georgia Tech Ph.D. student on the research team. "Doing thousands of trials on a human would have been dangerous, let alone impossibly tedious. But in just one day, using simulations, the robot learned what a person may physically feel while getting dressed."

The robot also learned to predict the consequences of moving the gown in different ways. Some motions made the gown taut, pulling hard against the person's body. Other movements slid the gown smoothly along the person's arm. The robot uses these predictions to select motions that comfortably dress the arm.

After success in simulation, the PR2 attempted to dress people. Participants sat in front of the robot and watched as it held a gown and slid it onto their arms. Rather than vision, the robot used its sense of touch to perform the task based on what it learned about forces during the simulations.

"The key is that the robot is always thinking ahead," said Charlie Kemp, an associate professor in the Wallace H. Coulter Department of Biomedical Engineering at Georgia Tech and Emory University and the lead faculty member. "It asks itself, 'if I pull the gown this way, will it cause more or less force on the person's arm? What would happen if I go that way instead?'"

The researchers varied the robot's timing and allowed it to think as much as a fifth of a second into the future while strategizing about its next move. Less than that caused the robot to fail more often.

"The more robots can understand about us, the more they'll be able to help us," Kemp said. "By predicting the physical implications of their actions, robots can provide assistance that is safer, more comfortable and more effective."

The robot is currently putting the gown on one arm. The entire process takes about 10 seconds. The team says fully dressing a person is something that is many steps away from this work.

Oral Antibiotics May Raise Risk of Kidney Stones

Summary: Pediatric researchers have found that children and adults treated with some oral antibiotics have a significantly higher risk of developing kidney stones. This is the first time that these medicines have been linked to this condition. The strongest risks appeared at younger ages and among patients most recently exposed to antibiotics.

"The overall prevalence of kidney stones has risen by 70 percent over the past 30 years, with particularly sharp increases among adolescents and young women," said study leader Gregory E. Tasian, MD, MSCE, a pediatric urologist at Children's Hospital of Philadelphia (CHOP). Tasian noted that kidney stones were previously rare in children.

Study co-author Michelle Denburg, MD, MSCE, a pediatric nephrologist at CHOP, added, "The reasons for the increase are unknown, but our findings suggest that oral antibiotics play a role, especially given that children are prescribed antibiotics at higher rates than adults."

Tasian, Denburg and colleagues published their study today in the *Journal of the American Society of Nephrology.*

The study team drew on electronic health records from the United Kingdom, covering 13 million adults and children seen by general practitioners in the Health Improvement Network between 1994 and 2015. The team analyzed prior antibiotic exposure for nearly 26,000 patients with kidney stones, compared to nearly 260,000 control subjects.

They found that five classes of oral antibiotics were associated with a diagnosis of kidney stone disease. The five classes were oral sulfas, cephalosporins, fluoroquinolones, nitrofurantoin, and broad-spectrum penicillins. After adjustments for age, sex, race, urinary tract infection, other medications and other medical conditions, patients who received sulfa drugs were more than twice as likely as those not exposed to antibiotics to have kidney stones; for broad-spectrum penicillins, the increased risk was 27 per cent higher.

The strongest risks for kidney stones were in children and adolescents. The risk of kidney stones decreased over time but remained elevated several years after antibiotic use.

Scientists already knew that antibiotics alter the composition of the human microbiome — the community of microorganisms in the body. Disruptions in the intestinal and urinary microbiome have been linked to the occurrence of kidney stones, but no previous studies revealed an association between antibiotic usage and stones.

Tasian pointed out that other researchers have found that roughly 30 pe rcent of antibiotics prescribed in office visits are inappropriate, and children receive more antibiotics than any other age group, so the new findings reinforce the need for clinicians to be careful in prescribing correct antibiotics. He added, "Our findings suggest that antibiotic prescription practices represent a modifiable risk factor — a change in prescribing patterns might decrease the current epidemic of kidney stones in children."

One co-author of the current paper, Jeffrey Gerber, MD, PhD, is an infectious diseases specialist at CHOP who leads programs in antibiotic stewardship — an approach that guides healthcare providers in prescribing the most appropriate antibiotic for each patient's specific infection, with the aims of improving individual outcomes and reducing the overall risk of antibiotic resistance.

Tasian and colleagues are continuing to investigate the microbiomes of children and adolescents with kidney stones in a single-center study at CHOP. Their goal is to expand this research into broader, population-based studies to better understand how variations

in microbiome composition may influence the development of kidney stones.

Stone Age Hepatitis B Virus Decoded

Study recovers oldest viral genomes, and shows the hepatitis B virus has been circulating in Europe for at least 7,000 years

Summary: Scientists have successfully reconstructed genomes from Stone Age and Medieval European strains of the hepatitis B virus. This unprecedented recovery of ancient virus DNA indicates that hepatitis B was circulating in Europe at least 7,000 years ago. An international team of scientists led by researchers at the Max Planck Institute for the Science of Human History and the University of Kiel has successfully reconstructed genomes from Stone Age and Medieval European strains of the hepatitis B virus. While the ancient virus is similar to its modern counterparts, the strains represent a distinct lineage that has likely gone extinct and is most closely related to chimpanzee and gorilla viruses.

The hepatitis B virus (HBV) is one of the most widespread human pathogens known today, affecting over 250 million people worldwide. However, its origin and evolutionary history remain unclear. Studying the evolution and history of the virus has to date been especially difficult, because until now viral DNA had not been successfully recovered from prehistoric samples. In the present study, which has been accepted for publication in the journal *eLife* and is due to be published on May 10, 2018, an international team of researchers led by the Max Planck Institute for the Science of Human History and the Institute of Clinical Molecular Biology at Kiel University, not only recovered ancient viral DNA from skeletons but also reconstructed the genomes of three strains of HBV.

The ancient history of hepatitis B

For this study, the researchers analyzed samples from the teeth of 53 skeletons excavated from Neolithic and medieval sites in Germany. The remains dated from around 5000 BC to 1200 AD. The researchers screened all samples for viral pathogens and detected ancient HBV in three of the individuals. Full HBV genomes were recovered from these samples, two of which were from the Neolithic period, dating to about 7000 and 5000 years ago, and one from the medieval period. The Neolithic genomes represent the by far oldest virus genomes reconstructed to date.

Interestingly, the ancient virus genomes appear to represent distinct lineages that have no close relatives today and possibly went extinct. The two Neolithic genomes, although recovered from individuals that lived 2000 years apart, were relatively similar to each other in comparison with modern strains, and were in fact more closely related to modern strains of HBV found in Chimpanzees and Gorillas. In contrast, the medieval HBV genome is more similar to modern strains, but still represents a separate lineage. This is the case even when it is compared to two previously published HBV genomes recovered from mummies dating to the 16th century. The HBV strains found in these mummies are closely related to modern strains, suggesting a surprising lack of change in the virus over the last 500 years. These findings point to a complicated history for the virus, which may have involved multiple cross-species transmission events.

Long and complicated evolution of one of today's most common viruses

"Taken together, our results demonstrate that HBV already existed in Europeans 7000 years ago and that its genomic structure closely resembled that of modern hepatitis B viruses, despite the differences observed," explains first author Ben Krause-Kyora, of the Max Planck Institute for the Science of Human History and Kiel University. "More ancient precursors, intermediates and modern strains of both human and non-human primate HBV strains need to be sequenced to disentangle the complex evolution of this virus," he adds.

New tool for studying the evolution of blood-borne viruses

Johannes Krause, senior author and director of the Department of Archaeogenetics at the Max Planck Institute for the Science of Human History, emphasizes the most important implication of the study. "Our results reveal the great potential of ancient DNA from human skeletons to allow us to study the evolution of blood-borne viruses. Previously, there was doubt as to whether we would ever be able to study these diseases directly in the past," he explains. "We now have a powerful tool to explore the deep evolutionary history of viral diseases."

Artificial Intelligence Helps Predict Likelihood of Life on Other Worlds

Developments in artificial intelligence may help us to predict the probability of life on other planets, according to new work by a team based at Plymouth University. The study uses artificial neural networks (ANNs) to classify planets into five types, estimating a probability of life in each case, which could be used in future interstellar exploration missions. The work is presented at the European Week of Astronomy and Space Science (EWASS) in Liverpool on 4 April by Mr Christopher Bishop.

Artificial neural networks are systems that attempt to replicate the way the human brain learns. They are one of the main tools used in machine learning, and are particularly good at identifying patterns that are too complex for a biological brain to process.

The team, based at the Centre for Robotics and Neural Systems at Plymouth University, has trained their network to classify planets into five different types, based on whether they are most like the present-day Earth, the early Earth, Mars, Venus or Saturn's moon Titan. All five of these objects are rocky bodies known to have atmospheres, and are among the most potentially habitable objects in our Solar System.

Mr Bishop comments, "We're currently interested in these ANNs for prioritising exploration for a hypothetical, intelligent, interstellar spacecraft scanning an exoplanet system at range."

He adds, "We're also looking at the use of large area, deployable, planar Fresnel antennas to get data back to Earth from an interstellar probe at large distances. This would be needed if the technology is used in robotic spacecraft in the future."

Atmospheric observations — known as spectra — of the five Solar System bodies are presented as inputs to the network, which is then asked to classify them in terms of the planetary type. As life is currently known only

to exist on Earth, the classification uses a 'probability of life' metric which is based on the relatively well-understood atmospheric and orbital properties of the five target types.

Bishop has trained the network with over a hundred different spectral profiles, each with several hundred parameters that contribute to habitability. So far, the network performs well when presented with a test spectral profile that it hasn't seen before.

"Given the results so far, this method may prove to be extremely useful for categorising different types of exoplanets using results from ground-based and near Earth observatories," says Dr Angelo Cangelosi, the supervisor of the project.

The technique may also be ideally suited to selecting targets for future observations, given the increase in spectral detail expected from upcoming space missions such ESA's Ariel Space Mission and NASA's James Webb Space Telescope.

Degrading Plastics Revealed as Source of Greenhouse Gases

Summary: Researchers have found that several greenhouse gases are emitted as common plastics degrade in the environment. Their study reports the unexpected discovery of the universal production of greenhouse gases methane and ethylene by the most common plastics when exposed to sunlight. Researchers from the University of Hawai'i at Minoa School of Ocean and Earth Science and Technology (SOEST) discovered that several greenhouse gases are emitted as common plastics degrade in the environment.

Mass production of plastics started nearly 70 years ago and the production rate is expected to double over the next two decades. While serving many applications because of their durability, stability and low cost, plastics have deleterious effects on the environment. Plastic is known to release a variety of chemicals during degradation, which has a negative impact on organisms and ecosystems.

The study, published today in *PLOS ONE*, reports the unexpected discovery of the universal production of greenhouse gases methane and ethylene by the most common plastics when exposed to sunlight. The science team tested polycarbonate, acrylic, polypropylene, polyethylene terephthalate, polystyrene, high-density polyethylene and low-density polyethylene (LDPE) — materials used to make food storage, textiles, construction materials, and various plastic goods. Polyethylene, used in shopping bags, is the most produced and discarded synthetic polymer globally and was found to be the most prolific emitter of both gases.

Additionally, the team found that the emission rate of the gases from virgin pellets of LDPE increased during a 212-day experiment and that LDPE debris found in the ocean also emitted greenhouse gases when exposed to sunlight. Once initiated by solar radiation, the emission of these gases continued in the dark.

"We attribute the increased emission of greenhouse gases with time from the virgin pellets to photo-degradation of the plastic, as well as the formation of a surface layer marked with fractures, micro-cracks and pits," said lead author Sarah-Jeanne Royer, a post-doctoral scholar in the Center for Microbial Oceanography: Research and Education (C-MORE) at the time of this

investigation. "With time, these defects increase the surface area available for further photo-chemical degradation and therefore contribute to an acceleration of the rate of gas production."

It is also known that smaller particles, termed 'microplastics,' are eventually produced in the environment and may further accelerate gas production.

"Plastic represents a source of climate-relevant trace gases that is expected to increase as more plastic is produced and accumulated in the environment," said David Karl, senior author on the study and SOEST professor with C-MORE. "This source is not yet budgeted for when assessing global methane and ethylene cycles, and may be significant."

Greenhouse gases directly influence climate change — affecting sea level, global temperatures, ecosystem health on land and in the ocean, and storms, which increase flooding, drought, and erosion.

"Considering the amounts of plastic washing ashore on our coastlines and the amount of plastic exposed to ambient conditions, our finding provides further evidence that we need to stop plastic production at the source, especially single use plastic," said Royer.

Now, Royer is working to develop estimates of the amount of plastic exposed to the environment in oceanic and terrestrial regions, globally, in order to constrain the overall greenhouse gas emissions from plastics.

Source: Science Daily online

WEB WATCH

In this Section, we present websites and a brief introduction about them. Inclusion of a site does not imply that *School Science* endorses the content of the site. Sites have been suggested on the basis of their possible utility to school systems.

- https://www.meritnation.com/

  This website is an online education platform that provides live classes, study materials and animated videos for school students.

- https://geology.com/

  This website is dedicated to Climate Change Articles, Information, News, and Facts is very dense with useful links and articles on climate change, specific to parts of the country and world. The site looks at sea levels, population shifts, volcanoes, Antarctic carbon flow, and much, much more.

- http://www.3ammagazine.com/3am/

  This website 3:AM publishes everything from original flash fiction to criticism, and might be the best place on the net to read about modernist and postmodernist literature in the same place.

- https://www.howstuffworks.com/

  This is an awesome site that explains how everything works. There is a massive section that covers all you need to know about science including life science, innovation, engineering and nature. There is also a great section with a complete scientific dictionary.

- https://www.smithsonianmag.com/

  This website resource covers human behaviour, space, the cosmos, how humans developed, science and the mind and body.

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To Our Contributors

School Science is a peer-reviewed journal published quarterly by the National Council of Educational Research and Training, New Delhi. It aims to bringing within easy reach of teachers and students the recent developments in the areas of science, mathematics, and environment and their teaching, and serves as a useful forum for the exchange of readers' views and experiences in science, mathematics, and environmental education.

Articles suitable to the objectives mentioned above are invited for publication. The initial submission of articles sent for publication should not exceed (excluding references)—6000 words for research papers; 4000 words for analytical, interpretive and persuasive essays and theoretical papers; 1000 words for short popular articles. Photographs included in the article should be of high resolution. The publisher will not take any responsibility or liability for copyright infringement. The contributors, therefore, should provide copyright permission, wherever applicable and submit the same along with the article.

Manuscripts with illustrations, charts, graphs, photographs, etc., along with legends, should be submitted in editable Word 2007 or higher version (normal, plain font, 10-point Times New Roman, Single Line spacing); headings not more than three levels; abbreviations defined at first mention and used consistently thereafter; footnotes wherever relevant. The soft copy of the same should be emailed addressed to the Executive Editor, School Science, Department of Education in Science and Mathematics, NCERT, Sri Aurobindo Marg, New Delhi- 110016 at school.science@yahoo.com

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प्राथमिक शिक्षक (त्रैमासिक) (Prathmik Shikshak) A Quarterly Journal in Hindi for Primary Teachers	₹65.00	260.00
फिरकी बच्चों की (अर्द्ध वार्षिक) (Firkee Bachchon Ki) Half-yearly	₹35.00	70.00

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