STEM EDUCATION NEWSLETTER

Samtse College of Education, 2026

Volume 6

Inside this issue

MESSAGE FROM STEMERC HEAD

Dear Readers,

Welcome to the sixth volume of our STEM Newsletter, brought to you by the STEM Education Research Centre (STEMERC). It is my pleasure to share this latest edition, which highlights the dynamic and ever-evolving landscape of STEM education in Bhutan and beyond.

This volume features a diverse collection of articles, from engaging classroom activities and innovative projects to small-scale research-driven insights on environmental sustainability, health, and digital literacy. Notably, several contributions are by first-year students, who are just in their second semester after joining the college from high school. Their participation reflects remarkable enthusiasm, curiosity, and creativity, demonstrating that even at the very start of their academic journey, students can make meaningful contributions to STEM learning. Each piece showcases the dedication of both students and teacher educators in making STEM education accessible, inspiring, and impactful.

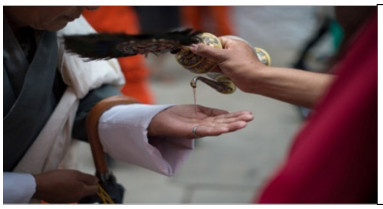
I would like to extend my heartfelt thanks to all the student contributors for their hard work, initiative, and commitment to sharing their learning experiences. I also wish to acknowledge and thank their tutors for guiding, mentoring, and supporting them throughout these projects. Your combined efforts make this newsletter a rich and inspiring collection of STEM learning stories.

At STEMERC, our mission is to empower educators and learners with knowledge, tools, and experiences that foster curiosity, creativity, and critical thinking. Through hands-on projects, collaborative research, and reflective practices, we aim to cultivate a generation equipped to address global challenges, innovate responsibly, and thrive in a rapidly changing world.

I invite you to explore this volume, be inspired by the stories of discovery and dedication, and join us in shaping a future where STEM education not only informs but transforms lives.

For an electronic copy of the newsletter, please visit
http://stem.sce.edu.bt/wp-content/uploads/2026/04/STEM-Education-editing.pdf

Karma Utha (PhD)
Head
STEMERC



DUALITY OF ALCOHOL

Ganga Gurung
Tshering Pelmo
Yeshi Lhaden
Ngawang Choden
Yeshi Tshogay

INTRODUCTION

Alcohol, chemically known as ethanol (C2H5OH) is one of the most widely consumed psychoactive substances. According to the World Health Organisation (WHO), around 2.6 million deaths were attributable to alcohol consumption globally. This accounts for 4.7% of all deaths worldwide. In Bhutan also alcohol has a great impact, leveling from a personal level to the society as a whole. However, alcohol plays some important role in medicinal field as well as the cultural and traditional methods in Bhutan. Alcohol, commonly known as Ara, Bangchang and Singchang are locally made and commonly accessible for cultural uses. Thus, the duality of alcohol can be seen in the Bhutanese society.

WHAT IS ALCOHOL?

Generally, it is a psychoactive substance found in beverages but in chemistry, it is known as Ethanol where a hydroxyl (OH) group is bonded to carbon (C). It is differentiated into of primary alcohol (carbon atom attached to the hydroxyl is bonded to another carbon atom), secondary alcohol (carbon atom attached to the hydroxyl is bonded to two other carbon atoms) and tertiary alcohol (carbon atom attached to the hydroxyl is bonded to three other carbon atoms).

IMPACTS OF ALCOHOL ON BHUTANESE YOUTH

Alcohol being a popular drink among the Bhutanese youths, both school going and college students, it has been affecting the youth physically and mentally. Ethanol causes:

- High impulsivity and risk-taking behaviour: ethanol acts as a depressant on the Central Nervous System, disrupting the neural pathways whereby the person seems to become highly impulsive and bold.
- Impairs judgement and decision making: alcohol affects the glutamate (neurotransmitter responsible for synaptic plasticity and neural communication) and also accelerates the production of dopamine (hormone) causing the consumer to impulsive decision such and drunk-driving and unprotective intercourse.
- Decelerates academic performance: ethanol disrupts the neurochemical pathways for memory and learning and it impairs the hippocampus (chemical synapses for learning).
- Physical impacts: alcohol causes fatigue due to dehydration and electrolyte imbalance.

IMPACT ON HEALTH AND SOCIAL LIFE

- Alcohol poisoning: excessive alcohol consumption can lead to unconsciousness, shortness in breathing and even death
- Liver and heart health risk: stages long term damage to vital organs.
- Brain Damage: impairs brain function, memory loss and even dementia
- Risk of addiction: exposure to alcohol can lead to long term dependence and causes AUD (Alcohol Use Disorder) which is a condition where the consumer cannot control the amount of alcohol intake.
- Social impacts: impacts your relationship, public safety and also the society.

MEDICINAL IMPORTANCE

- **Antiseptics –** ethanol and isopropanol used as antiseptics in medical field
- **Disinfectants –** isopropanol is used for disinfecting wounds and sterilizing medical instruments
- **Preservatives –** preservatives for pharmaceutical products
- **Cough syrups –** small amount of ethanol is used in cough syrups
- **Fever reduction (external use) –** sponging to reduce fever or cool the skin.

CULTURAL BENEFITS OF ALCOHOL

- **Dong Chang -** welcome drink to guest gesturing hospitality and respect
- **Joen Chang –** farewell drink to guest gesturing goodwill
- **Chab Doen –** used in offerings and making of detshe
- **SerKeym and Sur –** offered to deities to cure illness
- **Marching –** offered to auspicious guest to clear the obstacles of the day
- **Khap Chang –** offered when roofing the house
- **Festive occasions –** offered during festivals and special occasions.

CONCLUSION

Alcohol a popular among the Bhutanese which serves us both culturally and medicinally has its own benefits and shortcomings. Using it wisely can cure or else it leads to disharmony in the society, mental illness and impacts the physical health as well. Therefore, alcohol consumption should be avoided for a healthy living.

Plastic Waste in Bhutan: A Scientific Approach to a Growing Challenge

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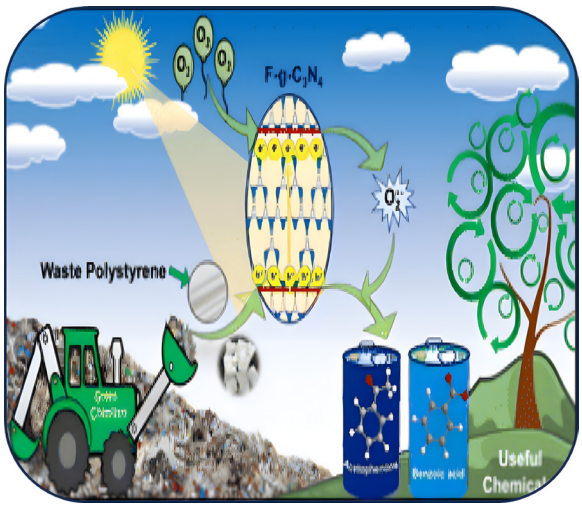
While Bhutan is admired for its environmental values and Gross National Happiness (GNH), plastic pollution is emerging as a significant threat to its ecosystems and communities.

Despite multiple bans and awareness campaigns, improper plastic waste disposal remains a serious issue in both urban and rural areas. This article highlights the current status of plastic waste in Bhutan, the role of chemistry-based solutions, and potential strategies aligned with Bhutan's cultural and environmental priorities.

Common plastics in Bhutan include PET, HDPE, LDPE, PP, and PS, all petroleum-based and chemically resistant. These materials are durable and widely used, but their resistance to degradation poses a long-term environmental hazard. Improper disposal has blocked drainage systems, harmed livestock and aquatic ecosystems, and introduced microplastics into Bhutan's river systems.

STEM-Based Solutions to Plastic Waste

Several promising chemistry-based solutions can help Bhutan manage plastic waste:



- **Photocatalytic Degradation:** Titanium dioxide (TiO_2) activated by UV light can break down PET into smaller molecules.
- **Pyrolysis:** This thermal method converts plastic (LDPE, HDPE, PP) into fuel and gas, which can be used in rural communities.
- **Bioplastics:** Substitutes like PLA and PHA derived from starch or sugarcane naturally decompose and are more sustainable.
- **Enzymatic Degradation:** PETase enzyme from Ideonella sakaiensis breaks PET into its raw components, allowing recycling.

Local Innovation and Community Action

Bhutan has taken steps to transform plastic waste into usable products:

- The Department of Roads has started using shredded plastic in road construction.
- Clean Bhutan converts PET bottles into polyester wool for bedding and clothing.
- These efforts demonstrate that when STEM meets local innovation, practical solutions arise.

Recommendations for Implementation

- Build small-scale pyrolysis units in Thimphu and Phuentsholing.
- Support startups producing bioplastics from Bhutanese agriculture.
- Introduce plastic chemistry and recycling education in schools.
- Conduct region-specific waste audits to guide policy and practice.
- Enforce stricter plastic bans with biodegradability criteria.

Plastic waste management in Bhutan isn't just about garbage trucks and bins, it's about combining science, policy, education, and community action. Chemistry-based methods like pyrolysis and enzyme degradation offer real hope. With support from government, schools, and civil society, Bhutan can transform plastic waste into opportunity and build a sustainable, zero-waste future.

From Prohibition to Regulation: Tobacco Policy Shift in Bhutan Post-2021

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In 2010, Bhutan made global headlines by becoming the first country to ban the sale of tobacco nationwide. This bold move was rooted in concerns over public health, cultural values, and spiritual well-being. Health concerns mainly drove the decision, as tobacco use is a leading cause of preventable diseases such as cancer, heart disease, and respiratory problems (West, 2017). It also aimed to reduce the national burden of tobacco-related illnesses.

Culturally, tobacco is seen as impure and spiritually harmful, especially in a Buddhist society where its use is discouraged. This decision aligned with Bhutan's development philosophy of Gross National Happiness (GNH), which emphasises citizens' holistic well-being, including physical health, spiritual values, and sustainable living.

However, in a surprising turn of events, Bhutan lifted this ban in July 2021 amid the COVID-19 pandemic. The move was driven by certain limitations, risks, and challenges faced in maintaining the ban. This article reflects on the consequences —both intended and unintended—of reversing the ban, as seen through the public's mixed reactions.

The Policy Shift of 2021

In July 2021, amid the COVID-19 pandemic, Bhutan's Parliament amended the Tobacco Control Act to lift the sales ban and allow licensed outlets to sell tobacco legally (West, 2017).

Three main concerns drove this decision:

The arrival of COVID-19 brought an urgent health crisis to Bhutan. The highly contagious virus spread quickly through human contact, leading to strict border controls and movement restrictions. In this emergency, the tobacco ban posed new risks: cross-border tobacco smuggling became a serious threat, raising the risk of virus transmission.

Furthermore, despite the nationwide ban, tobacco use continued through illegal means. The government realised that eliminating consumption was unrealistic. Legalising sales was viewed as a more effective way to control and monitor tobacco use, rather than letting it grow illegally. The black market also drained the country of potential tax revenue. Therefore, by legalising sales and imposing taxes, the government could generate income for national development and ensure better regulation and safer distribution.

Public Reactions and the Impact of Lifting the Ban

The lifting of Bhutan's tobacco ban in 2021 stirred a range of reactions, illustrating both the practical benefits and deep societal concerns resulting from the policy shift.

Positives Outcomes:

One major benefit highlighted by the public is the end of black-market reliance. Previously, users had to obtain tobacco illegally, often paying high prices for low-quality products. With legalisation, people can now buy regulated tobacco openly and safely. The change also helped address cross-border smuggling, which posed health risks during the pandemic due to virus exposure through illegal trade. Economically, the policy has boosted sales for licensed vendors, who report increased demand and openness among customers. It has also allowed the government to generate tax revenue that was previously lost to the black market.

Ongoing Challenges

Youth exposure and addiction:

The practical benefits are accompanied by a growing number of public concerns. A large portion of the population expressed anxiety over the consequences of making tobacco more accessible due to the fear of long-term addiction. One of the most repeated worries is the increase in tobacco use among youth. Teachers and parents have observed that more students are using tobacco openly, especially in school hostels and public areas.

Health impacts:

These concerns are supported by science. From a chemical standpoint, tobacco smoke contains thousands of compounds, including nicotine, a highly addictive stimulant, and tar, which deposits carcinogenic substances such as benzene and formaldehyde in the lungs. (West, 2017).These substances are known to damage tissues and disrupt cellular processes, increasing the risk of cancer, heart disease, and respiratory illness. Health professionals echoed these concerns, reporting a rise in cases related to respiratory and oral issues. Though they acknowledge that it's still early to assess the full health consequences, they warn that the burden on Bhutan's healthcare system may grow.

Cultural and Spiritual Concerns:

From a spiritual standpoint, religious figures emphasised that tobacco clouds the mind and harms the body, which goes against Buddhist teachings and the core values of Gross National Happiness. A 27-year-old non-smoker also shared, "Lifting the ban felt like reversing years of hard work. Tobacco harms not just the body but the spirit." She also expressed concern about cultural and health impacts, noting that Bhutanese culture emphasises mindfulness and care for the body—principles that tobacco use directly contradicts.

Looking Ahead: A Balanced Approach

While the lifting of the ban solved certain practical problems, it brought new ethical and health problems. Bhutan's government now faces the challenge of balancing regulation with education:

The implementation of public awareness campaigns is essential to promote understanding of the dangers associated with tobacco use, particularly among youth, through targeted initiatives within schools and on social media platforms. Additionally, there is a pressing need for stronger age restrictions; enforcing strict laws to prevent underage access to tobacco products and imposing penalties on vendors who violate these regulations is critical for safeguarding young individuals.

Furthermore, to assess the long-term implications of tobacco use following its legalisation, it is imperative to launch comprehensive health monitoring studies (Namusisi, n.d.). Engaging cultural and community leaders, including those from religious organisations, is also vital in promoting alternative lifestyles that align with the principles of Gross National Happiness (GNH).

Conclusion

while Bhutan's policy shift from prohibition to regulation reflects a complex balancing act between modern challenges and traditional values. Going forward, it is vital to ensure that regulatory convenience does not erode the country's health standards or cultural fabric. With strong public health policies, education, and community engagement, Bhutan can continue to prioritise Gross National Happiness while adapting to the realities of modern life.

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Understanding Non-Communicable Diseases: Diabetes and High Blood Pressure

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Introduction

Chronic illnesses that cannot be passed from one person to another are known as non-communicable diseases (NCDs). In contrast to infectious diseases, they often manifest in silence and are strongly linked to genetics, diet, and lifestyle. Diabetes mellitus and hypertension (high blood pressure) are two of the most prevalent NCDs and are both becoming major health issues in Bhutan and around the world.

The Silent Health Threat: Hypertension

Background in Biology

The force that circulating blood applies to artery walls is known as blood pressure. When this pressure remains abnormally high, it causes hypertension, which, over time, damages blood vessels and forces the heart to work harder.

Chemical Significance

Blood pressure is largely controlled by electrolytes like calcium, potassium, and sodium. For instance, consuming too much sodium causes water retention, which raises blood volume and arterial pressure.

Issues

Dangerous side effects from uncontrolled hypertension include: stroke, which reduces blood flow to the

brain; heart attack, which blocks blood flow to the heart muscle; kidney failure, which occurs from chronic pressure on sensitive kidney vessels; and vision loss, which occurs from damage to the blood vessels in the eyes.

Reasons and Dangers

- Diets heavy in fat and salt;
- Obesity and sedentary lifestyles;
- Heavy drinking and smoking; and
- Stress and a family history of high blood pressure

Treatment and Prevention

Reducing salt intake, exercising frequently, abstaining from alcohol and tobacco, managing stress, and taking prescribed medication when lifestyle modifications are insufficient are all ways to prevent or control hypertension.

According to studies, one of the main causes of premature death globally is high blood pressure. Since symptoms frequently don't show up until serious harm has already been done, many people go undiagnosed.

Diabetes Mellitus: An Increasing Global Issue

Background in Biology:

Diabetes mellitus is a metabolic disease brought on by either the body's inability to use insulin efficiently (Type 2) or insufficient insulin production (Type 1). Without the hormone insulin, which controls blood sugar, glucose accumulates in the blood and can cause major problems.

Causes include a genetic predisposition and an unhealthy diet heavy in fat and sugar.

Signs and symptoms:

Frequent urination and excessive thirst, persistent weakness and exhaustion, blurred vision, and sluggish wound healing are common signs of diabetes.

Treatment and Prevention:

Diabetes can be controlled through a combination of a nutritious diet low in fat and sugar, regular exercise, effective weight management, medication or insulin injections, depending on the severity, and routine blood sugar checks.

The Significance of these Infirmities

Since they may not exhibit symptoms until complications develop, diabetes and hypertension are frequently referred to as "silent diseases." The fact that they are now affecting young people as well as older adults because of fast changes in lifestyle, poor eating habits, and inactivity makes them especially worrisome.

As students, we think that prevention begins with education and awareness. The risk of these illnesses can be significantly reduced by maintaining an active lifestyle, following a balanced diet, and undergoing routine checkups.

Conclusion

For the current generation, non-communicable diseases like diabetes and hypertension pose a major health threat. Although they are mostly preventable, modern lifestyles are making them more and more of an impact. By making informed choices and spreading awareness, we can protect not only ourselves but also contribute to building a healthier society.

Chemistry is Magic: Turning Curiosity into Discovery

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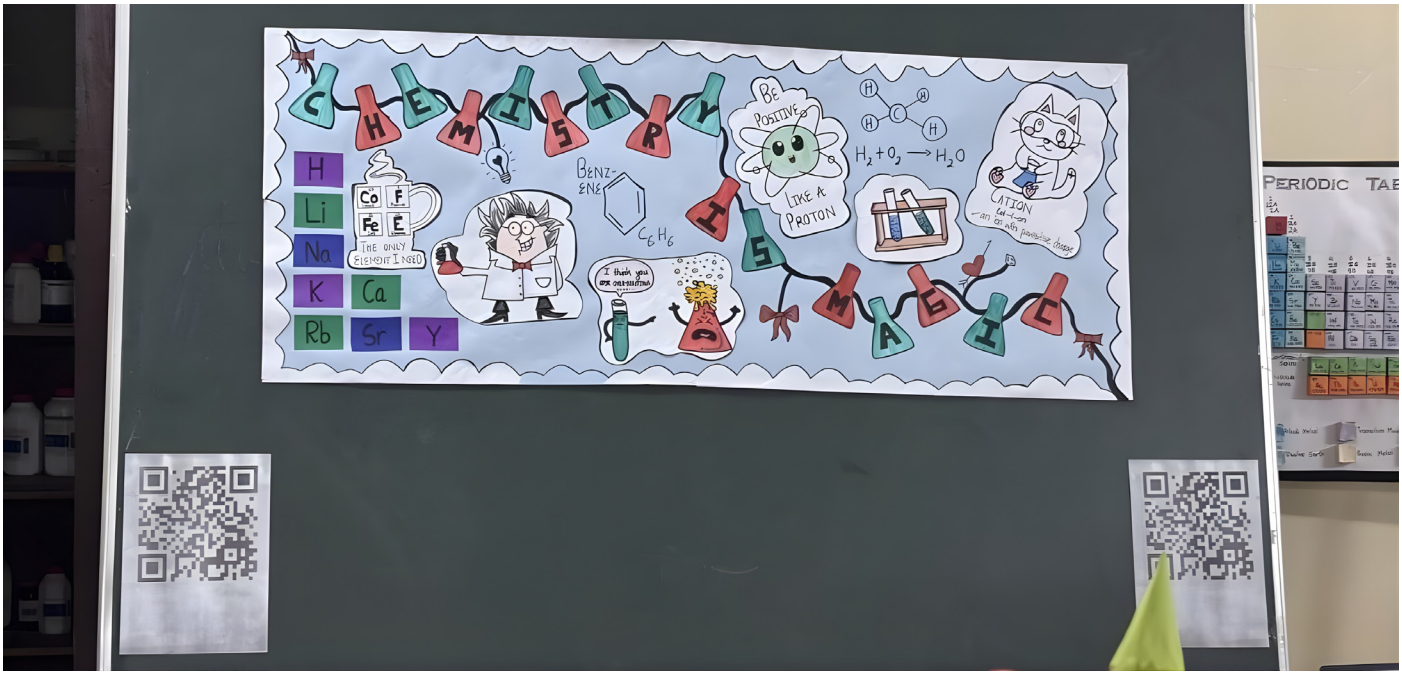


Our exhibition, titled Chemistry is Magic aimed to show that chemistry is much more than equations and lab reports. It is a doorway to curiosity, creativity, and discovery. As future educators, we wanted to present fun and engaging experiments that can easily be performed in classrooms or even at home using simple materials. We selected a series of experiments based on their visual appeal, simplicity, and educational value.

Iodine Clock Reaction

A dramatic color change revealing the hidden timing of reactions.
The iodine clock reaction is a classic experiment known for its sudden and striking color change. For our demonstration, we used Lugol's iodine solution, vitamin C (ascorbic acid), cornstarch, and hydrogen peroxide.

First, vitamin C was mixed with iodine, turning the solution colorless as iodine was reduced to iodide ions. In a separate mixture, hydrogen peroxide, starch, and water were prepared. When both solutions were combined, hydrogen peroxide slowly converted iodide back into iodine. Once the vitamin C was fully used up, the iodine reacted with starch and the solution instantly turned deep blue-black.

This experiment clearly demonstrates redox reactions and reaction rates. By adjusting concentrations, the timing of the color change can be controlled. The delay followed by a sudden transformation perfectly reflects our theme, what seems ordinary at first suddenly becomes magical.

Volcano in a Jar

A colorful acid-base reaction.

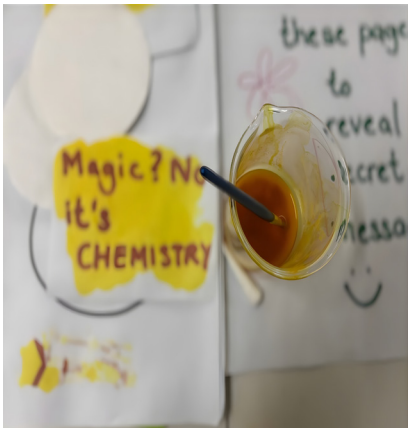
This experiment uses baking soda, vinegar, oil, and food coloring in a transparent jar. Baking soda is added first, followed by oil. Vinegar mixed with food coloring is then poured into the jar.

When vinegar (an acid) reacts with baking soda (a base), carbon dioxide gas is produced. The gas forms colorful bubbles that rise and fall through the oil, creating a “lava” effect.

The experiment demonstrates acid-base reactions in a fun and visually engaging way. Using everyday materials makes science feel accessible and encourages curiosity beyond textbooks.

Invisible Ink with Turmeric

A hidden message revealed through chemistry.



In this activity, a message was written using a baking soda solution and allowed to dry. When turmeric solution was applied, the hidden message appeared.

Turmeric acts as a natural pH indicator. It remains yellow in acidic or neutral conditions but turns reddish-brown in the presence of a base. Since baking soda is basic, the writing changes color and becomes visible. This simple demonstration introduces students to acid-base indicators while creating a magical effect that sparks excitement and interest.

Mini Rocket Launch

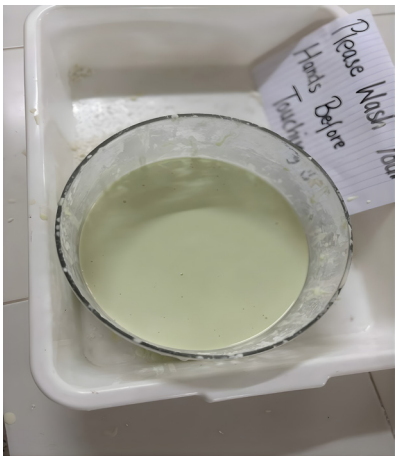
Gas expansion and Newton’s third law in action.

The mini rocket experiment combines chemistry and physics. Vinegar was poured into a small plastic bottle, and baking soda wrapped in tissue was prepared separately. Once dropped into the bottle and sealed with a cork, the reaction produced carbon dioxide gas.

As pressure built up inside the bottle, the cork was forced out and the bottle launched upward. This illustrates Newton’s third law: for every action, there is an equal and opposite reaction. The escaping gas pushes downward while the bottle moves upward.

Beyond being exciting to watch, this experiment shows how chemical energy can be converted into kinetic energy. For safety, it must be conducted outdoors with proper distance maintained.

Oobleck: A Non-Newtonian Fluid
A substance that behaves like both solid and liquid.



Oobleck, made from cornstarch and water (2:1 ratio), demonstrates unusual properties of matter. When handled gently, it flows like a liquid. However, when pressure is applied, it behaves like a solid.

This happens because the cornstarch particles suspend in water. Under force, the particles lock together temporarily, resisting movement. Once pressure is removed, it flows again. Oobleck introduces students to non-Newtonian fluids, viscosity, and states of matter. It shows how simple household ingredients can reveal fascinating scientific concepts.

All of these experiments use safe, easily available materials, making them suitable for classrooms and home learning. They encourage hands-on engagement and help students disconnect from screens while actively exploring science.

We were honored to present our exhibition in the presence of the Vice Chancellor and Pro Vice Chancellor. Seeing their interest and engagement reassured us that we had successfully communicated the wonder and excitement of chemistry.

To extend our project, we created a simple website using Wix. Although we had no prior experience in web design, we developed a platform containing experiment instructions, explanations, and demonstration videos. While still a work in progress, it reflects our effort to make chemistry more accessible and engaging. The website link: https://sonam18lhaki.wixsite.com/science-kids-4 Admittedly, there are many well-established and comprehensive websites out there that offer detailed science experiments, often with better design and resources. However, our goal wasn't to compete with those. We built this website because, not only does it represent our exhibition, but the process of building the website was a valuable learning opportunity.

As future teachers, developing digital skills can enhance classroom teaching, improve communication with parents, and support interactive learning methods.

In a world full of distractions, we believe science still has the power to inspire. Sometimes, all it takes is a sudden color change, a burst of fizz, or a strange squishy substance to remind us that chemistry truly is magic.

Hologram

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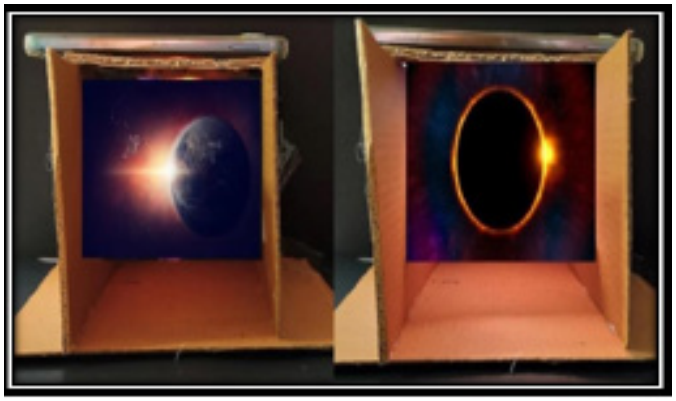
Introduction

The word hologram originated from a combination of two Greek words: “holos,” which means “whole,” and “gramma,” which means “message,” which come together to produce a complete message or a whole picture (Haleem et al.,2022, p.1).

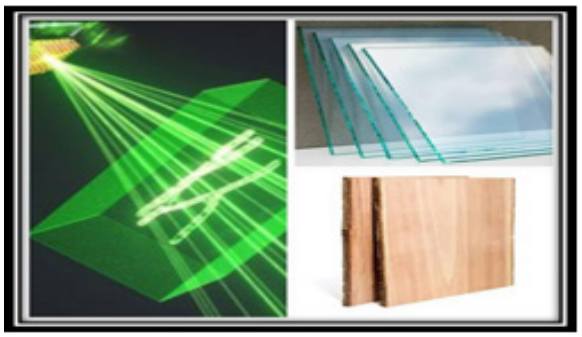
Hologram is a Three-dimensional image created by using the principles of light interference and diffraction. They are recorded on higher solution holographic film by using a panoramic camera and a laser as light source, and exist in the form of interference fringes. And if the same kind of laser is irradiated, two stereo images will appear on the front and back of the holographic film.

Unlike a regular three-dimensional image, a hologram provides a remarkable experience to the observer, making the object appear visually real and present. This is because holograms can bring about parallax; the existence of parallax can enable the observer to observe the image of different images by moving in different directions. (Liu et al., 2021, p.1).



Project description

The objective of this project is to demonstrate the working of a holographic display using simple, accessible materials such as plank wood, glass, and a mobile device. The model aims to create a three-dimensional hologram-like effect, where images or videos appear suspended in mid-air, giving the illusion of a 3D object. This model provides a basic, affordable approach to understanding holographic technology while integrating elements of design and innovation.



Working Principle

The working principle behind this simple hologram setup relies on the concept of light reflection and image manipulation to create the illusion of a 3D floating object. It uses the mobile phone's screen to display a video, which is reflected off angled glass or transparent sheets to create the holographic effect.

Following are the steps of how a hologram works:

- A mobile phone screen is used to display the video or images that will be projected as a hologram.
- Transparent plastic or glass sheets are cut and placed at a 45-degree angle to the mobile screen.
- The light emitted from the mobile phone's screen hits the angled glass surfaces.
- These glass sheets reflect the light at different angles, depending on their position, and direct the reflected image towards the viewer.
- As a result of the reflection, the viewer perceives a three-dimensional image that appears to float above the mobile screen, within the pyramid formed by the glass sheets.

Application

Holography has a wide range of applications in various fields, as outlined below:

- Entertainment: 3D holographic displays for concerts, movies, and gaming.
- Security: Anti-counterfeiting measures on credit cards, passports, and currency.
- Medical Imaging: 3D visualization of organs and tissues for diagnostics and surgery.
- Data Storage: High-capacity holographic data storage systems.
- Education and Training: Interactive 3D models for teaching and simulation.
- Telepresence: Real-time 3D communication for remote meetings.

Significance

The holographic working model demonstrates the practical implementation of light interference and diffraction principles. It highlights the potential of holography to create realistic 3D images, which can be used in various industries. This model also serves as an educational tool to understand the physics of light and the technology behind holograms.

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Automatic Street Light

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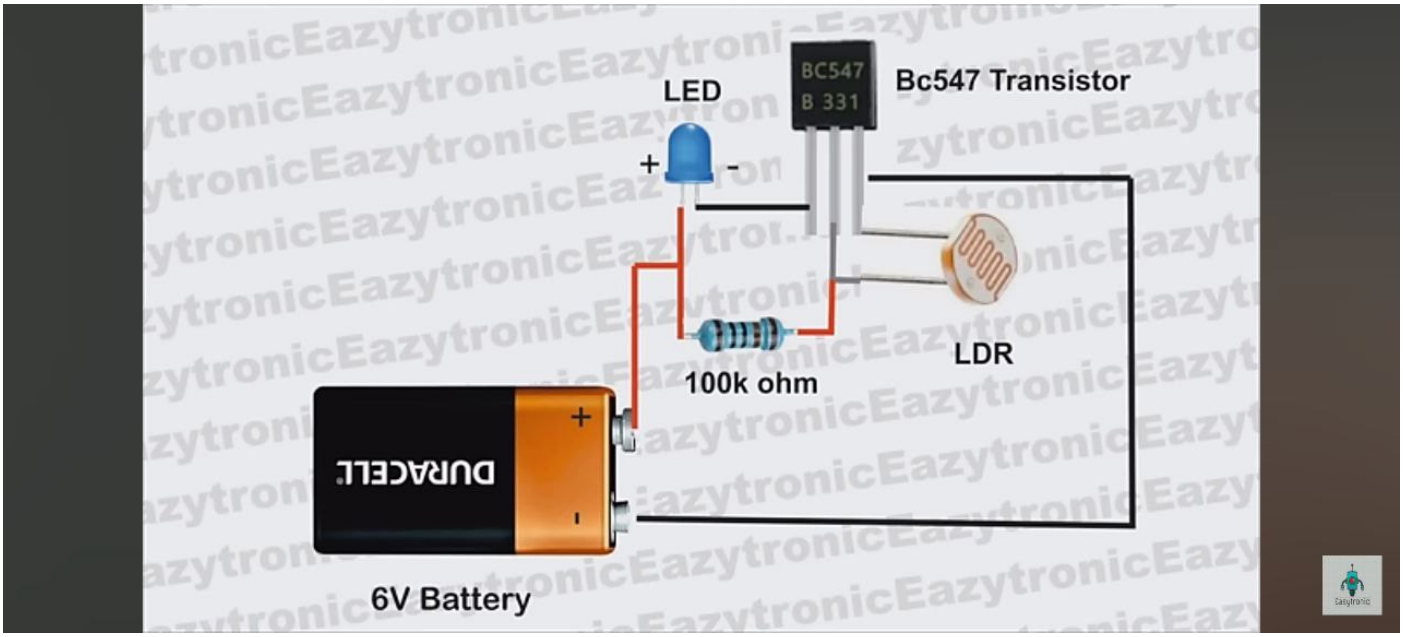
Introduction

Street lighting is essential for road safety, but due to negligence, it results in excessive energy consumption. Our project focuses on an automatic street lighting system that turns lights ON when darkness is detected and OFF when daylight appears. It uses the concept of potential divider, that is light-dependent resistor, to brighten lights depending upon the intensity of lights, reducing energy waste and manual operation. This system is a smart and efficient solution for urban and rural areas, helping conserve electricity while ensuring safety.

Circuit Diagram



Materials Used

LDR (Light Dependent Resistor)
Arduino board
LED lights
Power supply (battery)
Connecting wires

Procedure

Step 1: Connect the Battery to the Transistor

- Connect the negative (-) terminal of the battery to the right pin (emitter) of the BC547 transistor.

Step 2: Connect the 100kΩ Resistor and LDR

- Connect one end of the 100kΩ resistor to the positive (+) terminal of the battery.
- Connect one end of the LDR to the junction of the 100kΩ resistor and the right pin (emitter) of the transistor.

Step 3: Connect the Base of the Transistor

- Connect the middle pin (base) of the transistor to the junction of the LDR and the 100kΩ resistor.

Step 4: Connect the LED

- The positive (+) terminal of the LED is connected to the positive (+) terminal of the battery.
- The negative (-) terminal of the LED is connected to the left pin (collector) of the transistor

Working

The LDR continuously monitors the surrounding light. When the ambient light falls below a certain threshold, it triggers the relay to turn the streetlights ON. The motion sensor further detects movement and increases brightness when necessary. This method optimizes energy usage by keeping lights dim or OFF when not needed.

Result

The prototype perfectly demonstrates the application of a light-dependent resistor, which is dependent upon the intensity of light in its surroundings. When the intensity of light is low in the surroundings, the LDR turns the lights ON automatically and vice-versa.

Summary

Our automatic street light system provides an energy-efficient solution to street lighting by reducing unnecessary power consumption and manual operation. The LDR ensures that streetlights function only when needed. This project demonstrates how automation can contribute to sustainability and cost savings. We plan to include solar power for further energy efficiency in the future.

Reference

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Hydraulic Robotics Arms

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Milan Ghalley
Ramesh Tamang
Lhaki Seldon
Tshering Lhaki

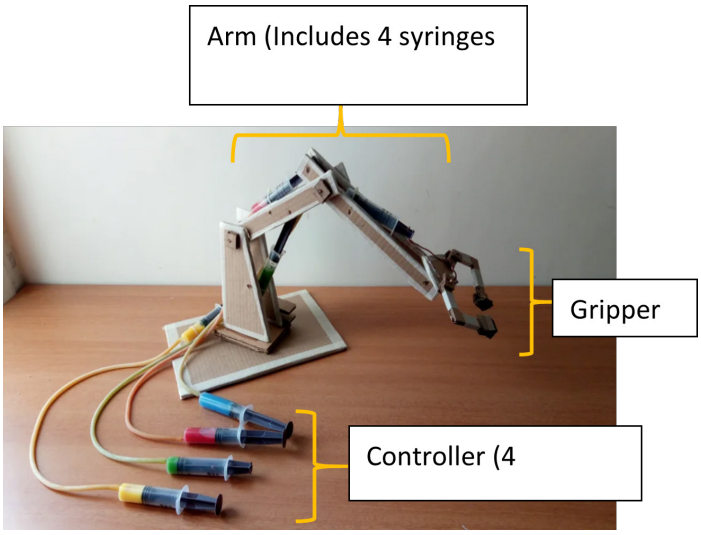
Introduction

Hydraulic robotic arms are mechanical devices powered by hydraulic systems to perform automated tasks with precision and strength. These robotic arms are widely used in automotive and agricultural industries due to their ability to lift heavy loads and operate in hazardous environment. They are also used in the medical field, such as in prosthetic limbs and in doll-catching machines.

This project is significant not only for its real-world applications but also for enhancing classroom learning. Students can learn about Pascal's Law, pressure, and fluid dynamics through hands-on demonstrations. By building the model themselves using readily available materials, they can collaborate in groups, engage actively in the learning process, and develop problem-solving abilities that will strengthen their critical thinking.

This project aims to explore the working principles, design, and functionality of a simple hydraulic robotic arm.

Circuit Diagram



Materials used

Materials:	Tools:
Double corrugated cardboard	A pair of scissors
Eight 10mL Syringes	Drill
2m long tube	Knife
Toothpicks, popsicle sticks	Pencil
Fevicol (Woodworking adhesive glue)	Ruler
Water and paint	

Procedure

- We used pencil and ruler to sketch the parts of hydraulic robotic arms which includes base, body, arm support, forearm and gripper on cardboard.
- Then we labelled and cut the parts using a knife and scissors.
- We measured and marked the points on parts of hydraulic robotics arms and made a hole.
- Then we assembled the parts with toothpicks to ensure their places.
- We drilled a hole on four syringes around half a cm from the top to attach them to the arm.
- For the rotating platform, we had to cut a piece of cardboard with length and width little bigger than the support pieces and attached a syringe.
- We used popsicle sticks to construct a gripper.
- We then clipped the ends of the protruding toothpicks with small cardboards.
- Finally, we mixed four colours with water each in a bottle, and filled the four remaining syringes. Then we had to cut the tubing into four equal parts and attached one end to the controller and the other end to the one in the arm.
- 10. Lastly, our hydraulic robotics arm was completed.

Working

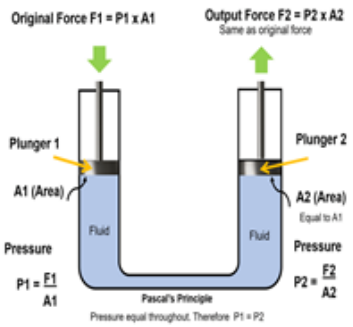
The robotic arm functions based on Pascal's Law, which states that pressure applied to a confined fluid is transmitted undiminished in all directions. When one syringe (controller) is pushed, the hydraulic fluid moves through the tube, transferring force to another syringe causing motion in the arm. Thus, the gripper uses these movements to grab, lift and move objects. By adjusting the amount of fluid displaced, precise movements can be achieved.

Force (F)= Pressure (P) x Cross sectional area (A)

Result

To view the results, we conducted a simple test. We used a hydraulic robotics arm to lift a plastic rectangular container and placed it on the designated spot. The project successfully demonstrated how hydraulic pressure can be used to control mechanical movements. The arm was able to lift small objects and perform basic gripping actions. The system showed smooth operation, with minor limitations such as fluid leakage, which can be addressed with better sealing methods.

Summary



This project provided hands-on experience in designing and understanding hydraulic systems. We learned the significance of fluid mechanics in robotics and automation. Future improvements could include integrating electronic controls for more precise movement and enhancing the arm's strength with more durable materials. Hydraulic robotic arms have immense real-world applications, from industrial automation to medical prosthetics. The project also demonstrated the importance of proper sealing techniques and pressure regulation in hydraulic system.

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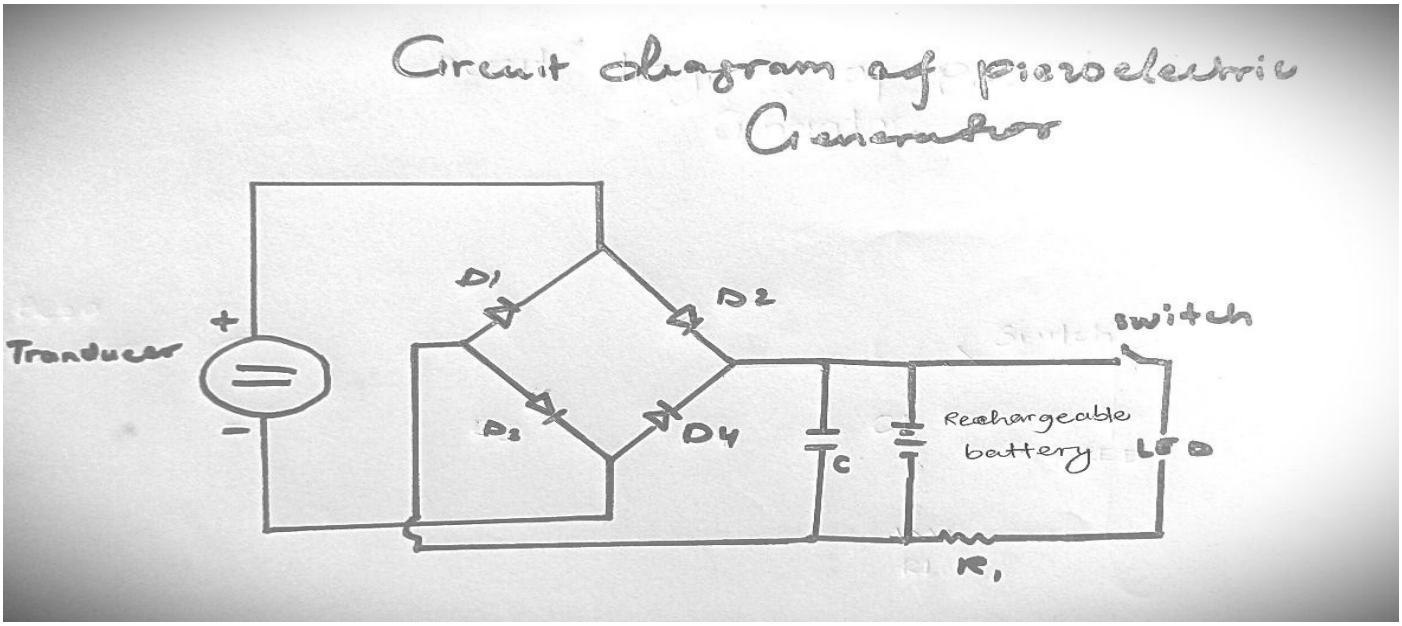
Piezoelectric Pathways: Turning Footsteps to Clean Energy

Kinga Lhaden
Tika Maya Rai
Karma Wangdi
Kinley Dorji
Pema Gyeltshen

Introduction

With increasing energy demands and the urgent need for clean solutions, innovative energy harvesting is essential. Piezoelectricity - electricity generated through mechanical stress offers a promising alternative. This project captures energy from pedestrian traffic, ideal for Bhutan's sustainability goals. Installed in high-footfall areas like Thimphu's Memorial Chorten, it powers LED lights or charging points. Beyond power generation, it raises awareness of clean energy, promotes energy conservation, and demonstrates how fundamental physics can drive sustainable urban development. By integrating green technologies into daily life, this project encourages public participation in renewable energy efforts and highlights the potential of smart infrastructure in creating an eco-friendly future.

Circuit Diagram



Materials Used

- Piezoelectric Disc
- Bridge Rectifier (Diodes)
- Capacitor (1000 µF, 25V)
- Resistor
- Rechargeable battery (3.7 V)
- Switch
- LED bulbs
- Connecting wires
- Cardboard Platform

Procedure

- We started by placing the piezo disc beneath the cardboard so that they could easily receive pressure when stepped on.

- Each disc was connected to a rectifier made from four diodes, to convert AC to DC current.
- A capacitor was connected to the DC output from the rectifier to store and regulate the initial charger.
- A resistor was directly connected to the LED bulb to control the current and prevent the bulb from burning out.
- A switch was placed between the battery and the LED bulb, allowing the energy stored in the battery to be released and used when necessary.
- The current was directed into a rechargeable battery, which stores energy for future uses.
- Finally, the LED bulbs were connected to the battery output, and the switch controlled when the LED would light up using the stored energy.
- The completed step was tested by stepping on the platform and observing how the LEDs responded based on energy generated.

Working Principle

The project is based on the piezoelectric effect, which is the ability of certain materials to generate an electric charge in response to applied mechanical stress. When people step on the footpath, the piezoelectric disc generates voltage. Since the voltage is alternating in nature, it is converted to DC with the help of a rectifier made of diodes. The capacitor helps store and smooth the flow of energy and the resistor helps regulate current flow to the LED bulb, preventing any damage. The switch controls the release of stored energy in the battery to the LED, ensuring that energy is only used when necessary. The amount of energy generated and stored is directly proportional to the amount of pressure applied.

Result

The prototype effectively demonstrates the application of piezoelectric energy generation. Whenever pressure was applied to the footpath platform, the system provided enough energy to supply a LED bulb. Each footfall regardless of intensity and frequency, resulted in a consistent and immediate illumination.

Trail	Pressure type applied	LED response	Voltage Output
1	10 steps	Dim Glow	~ 3.2 V
2	20 steps	Moderate Glow	~ 5.7 V
3	30 steps	Steady Glow	~ 9.0 V

Summary

Through this project, we have learned about how useful basic scientific principles like piezoelectricity can be applied in meaningful and practical ways. It was truly fascinating to see how something as simple as walking generates electricity. This also helped us boost our knowledge on circuit design, regulating current using resistors and how to use diodes to make a rectifier to turn AC to DC current.

In future, we would like the Bhutanese government to invest in building piezoelectric footpaths and even roads using more numbers and higher quality of piezo discs so that it would help us get more clean energy. The project directed us on how small innovative ideas like this can lead to national level energy conservation.

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Smart Bin Prototype

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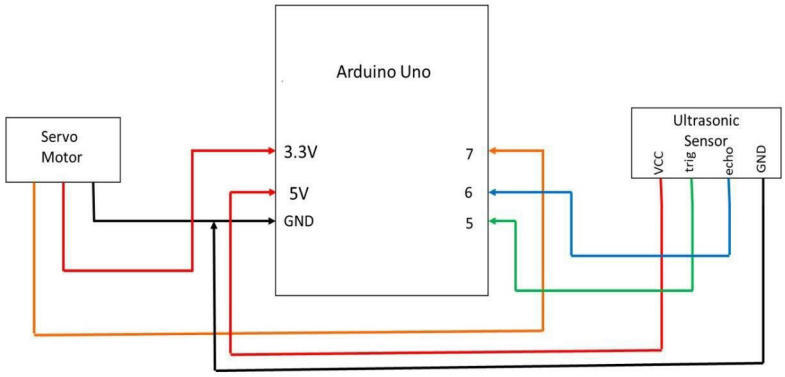
Dawa Jimba
Jetsun Pema
Jigme Choida

Introduction

There is increasing concern about waste management in urban areas, where overflowing bins pose risks to public sanitation and contribute to environmental pollution. The Smart Bin project uses an Arduino Uno, an ultrasonic sensor, and a servo motor to create an automated waste disposal system. When someone brings waste near the bin, the sensor detects it and the lid opens automatically without any physical contact, ensuring better hygiene and convenience. It is suitable for use at homes, offices, and in public domains.

Circuit Diagram



Materials Required

Arduino Uno, Ultrasonic Sensor, Servo Motor, Jumper Wires, Waste Bin.

Procedure

- **Setting Up the Components**
  First, the ultrasonic sensor is fixed to the bin facing outward so it can detect approaching motion. Then, the servo motor is attached to the lid in a way that allows smooth movement. The lid must be positioned properly to ensure it can open and close freely without any obstruction.
- **Wiring of Components**
  Connect the components at their various ends with jumper wires.
- **Writing and Uploading the Code to Arduino**
  Open the Arduino IDE on the computer, then connect the Arduino Uno to the computer by USB. Select the Board (Arduino Uno) and the port from Arduino IDE and upload the code to Arduino.
- **Testing and Tuning**
  Connect the Arduino to a USB power source. When you place your hand near the sensor, the lid will open automatically and then close again after a few seconds.

Working

The Smart Bin combines an ultrasonic sensor, an Arduino Uno, and a servo motor to enable automatic, contact-free garbage disposal. The ultrasonic sensor continuously emits sound waves to measure objects within a certain range. When it detects an object, such as a hand, it sends a signal to the Arduino Uno.

The Arduino processes this information and activates the servo motor to open the bin lid. The lid remains open for a few seconds before the Arduino sends a signal to close it. The code should be optimised for the detection range and response time to prevent false triggers and ensure the system operates efficiently. Thus, it allows waste to be disposed of hygienically without any physical contact.

Result

The Smart Bin prototype effectively demonstrated a system for automatic, contact-free waste disposal. The ultrasonic sensor accurately detected objects around the set range to trigger the servo motor opening the lid. The Arduino control mechanism responded well; lid opening and closing were timely with very minimal lag. System testing showed consistency, with opening and closing of the lid happening as expected.

Adjustments were made to the detection range of the sensor to avoid false triggering, while the servo was calibrated for smooth operation. Power consumption was tuned for maximum battery life. Thus, it proved to be an efficient and reliable solution for hygienic, contactless waste disposal, combining precise sensing, responsive control, and optimized operation to ensure consistent and convenient performance.

Summary

We developed a Smart Bin that uses IoT, motion sensors, and ultrasonic technology with Arduino to open its lid automatically, promoting hygienic, contact-free waste disposal. The project helped us learn sensor integration, Arduino programming, and automation. Future improvements may include solar power and a notification system to track bin capacity and prevent overflows.

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Digital Literacy in Bhutan

Dorji Choden
BEd ICT Sec D

In today's fast-changing world, technology has become part of almost everything we do, whether it is learning in school, shopping online, applying for jobs, or staying connected with family and friends. The ability to use these technologies wisely is known as digital literacy. It is not just about switching on a computer or using a mobile phone. It also means knowing how to search for information, evaluate what is true or false, use online services safely, and even create content.

For Bhutan, a small Himalayan country that is modernizing while trying to preserve its traditions, digital literacy is seen as a key tool to bridge the gap between rural and urban areas, and to connect its people with opportunities in education, business, and governance.

Government Efforts

The Bhutanese government has recognized that without strong digital skills, citizens may be left behind in the global economy. To address this, the government launched the National Digital Strategy (NDS 2024). This strategy sets an ambitious target: by 2029, more than 400,000 Bhutanese citizens should be digitally literate and able to use essential online services. These include government e-services, mobile banking, video-conferencing for work and study, and access to reliable information online.

By creating a digital society, the government hopes to make services faster and more accessible. For example, applying for official documents, paying bills, or even consulting with a doctor online could become much easier once more people have the skills to use these services.

Digital Literacy in Schools

Education is at the heart of Bhutan's digital literacy efforts. The Ministry of Education and Skills Development has introduced the Education Technology Framework (ETF), which provides schools with a roadmap on how to use technology in teaching and learning. ICT (Information and Communication Technology) has been made a compulsory subject from Pre-Primary to Class XII, which means that every student in Bhutan will graduate with some level of digital knowledge.

Most schools in the country now have ICT labs and internet connections. However, challenges remain, some schools only have a single computer lab, meaning hundreds of students have to share limited time on the machines. In rural schools, connectivity issues or unstable electricity make it difficult to run ICT classes effectively.

Teachers are also being trained to adapt to the digital era. Many have attended programs that introduce them to coding platforms like Scratch, Micro: bit, and even basic Python programming. These skills not only improve their own confidence but also allow them to pass on practical digital knowledge to their students. International organizations like UNICEF and the European Union are supporting Bhutan by funding better internet connections, providing digital devices, and developing local teaching materials.

Wider Training and Partnerships

Beyond schools, digital literacy programs are reaching other parts of society. For example, the Financial Institutions Training Institute (FITI) has partnered with the International Computer Driving License (ICDL) program to train professionals in certified digital skills. This helps Bhutanese workers improve their employability both within the country and internationally.

There are also efforts to include groups who are often left behind. Programs have been created for youth with disabilities, giving them the chance to learn skills that open up opportunities for online work and independence.

Similarly, training initiatives for women and girls encourage them to participate in the digital economy and reduce gender gaps in technology use. These efforts show that digital literacy is not only about technology, but also about creating fairness and opportunities for all members of society.

Interestingly, Bhutan has also begun introducing digital literacy in monastic institutions. Monks and nuns, who play a vital role in preserving Bhutan's spiritual and cultural heritage, are now being trained to use digital tools. Some monasteries have computer labs where monks learn basic computer skills, typing, and

online communication. Training sessions also cover how to use the internet for research, prepare digital archives of religious texts, and connect with global Buddhist communities through virtual platforms.
This exposure is important because it allows monks and nuns to share Buddhist teachings through social media, YouTube, TikTok, and digital publications, making religious knowledge more accessible to young people. For instance, some monasteries stream live prayers and teachings, especially during the COVID-19 pandemic, when physical gatherings were limited.

By bringing digital literacy to monastic schools, Bhutan ensures that modernization does not leave behind its spiritual community. It also demonstrates that technology can support, not replace traditional values, by helping religious institutions preserve scriptures, reach wider audiences, and keep young monks and nuns engaged with both spiritual and modern education.

Challenges in Bhutan

While progress is being made, Bhutan still faces significant challenges. One of the main issues is the digital divide, the gap between those who have easy access to technology and those who do not. In urban areas like Thimphu, students and workers can access high-speed internet, smartphones, and computers. But in remote villages, connectivity is slow or nonexistent, electricity can be unstable, and many families cannot afford digital devices.

Affordability is another barrier. A good smartphone or laptop can cost several months of income for a low-income family. Internet data is also expensive for many Bhutanese, which prevents students from using online resources at home. This inequality means that while some students are learning advanced digital skills, others may fall behind simply because they lack the tools to practice.

There are also challenges in the education system. Not all teachers are comfortable using digital tools, especially those who grew up without technology in their environment. While training programs are available, they require time, resources, and continuous follow-up to be effective.

Finally, Bhutan is experiencing the global challenge of misinformation on social media. As more people use Facebook, TikTok, and other platforms, it has become easy to spread rumors, false news, or even harmful content. This shows that digital literacy must include not just technical skills, but also media literacy, the ability to think critically about the information people consume and share online.

Opportunities for the Future

Despite these difficulties, Bhutan has a strong foundation to build on. The government's commitment through policies like the NDS and ETF provides a clear direction for the future. With support from international partners such as UNICEF and the EU, Bhutanese schools are receiving better equipment, internet, and teacher training.

Young people in Bhutan are also showing increasing interest in coding, robotics, and digital projects. Competitions, hackathons, and after-school ICT clubs are encouraging students to be creative and innovative with technology. If nurtured, these interests could create a new generation of tech-savvy Bhutanese capable of contributing to both the local economy and the global digital marketplace.

Conclusion

Digital literacy is no longer optional; it is a basic skill for the 21st century. In Bhutan, it is being treated as a national priority, with policies, programs, and partnerships aiming to equip citizens with the knowledge and confidence to use technology in their daily lives. Schools are teaching ICT, teachers are being trained, and organizations are creating opportunities for adults, women, and people with disabilities.

However, Bhutan must continue to address its challenges: the rural-urban divide, the high cost of devices and data, and the need for stronger teacher capacity. Equally important, citizens must learn not just how to use technology, but also how to use it wisely and responsibly.

If Bhutan continues its efforts and ensures that no one is left behind, digital literacy can become a powerful tool to improve education, strengthen governance, and create new opportunities. In doing so, Bhutan will be able to embrace modernization while staying true to its values of equality, community, and Gross National Happiness.

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Evolution, Identification and Classification of Flowering Plants

Kinley
Assistant professor

On 18th August 2024, the M.Ed. Biology programme of Samtse College of Education (SCE) successfully organised a webinar on the theme “Evolution, Identification and Classification of Flowering Plant”. The session was facilitated by Associate Professor Margaret Chen, from the Faculty of Plantation and Agrotechnology, Universiti Teknologi Mara, Sarawak Branch, Malaysia.

The webinar brought together a diverse group of participants, including M.Ed. Biology students, B.Ed. Biology students, Biology faculty of SCE, as well as practising biology teachers from the field. The wide representation enriched the session, creating a shared space for both pre-service and in-service educators to engage with advanced knowledge in botany.

Over the course of one hour, the resource person delivered an engaging and insightful presentation. She covered a wide range of topics including:

- Practical scenarios and strategies for classifying plants;
- The historical development of plant taxonomy and its evolution over time;

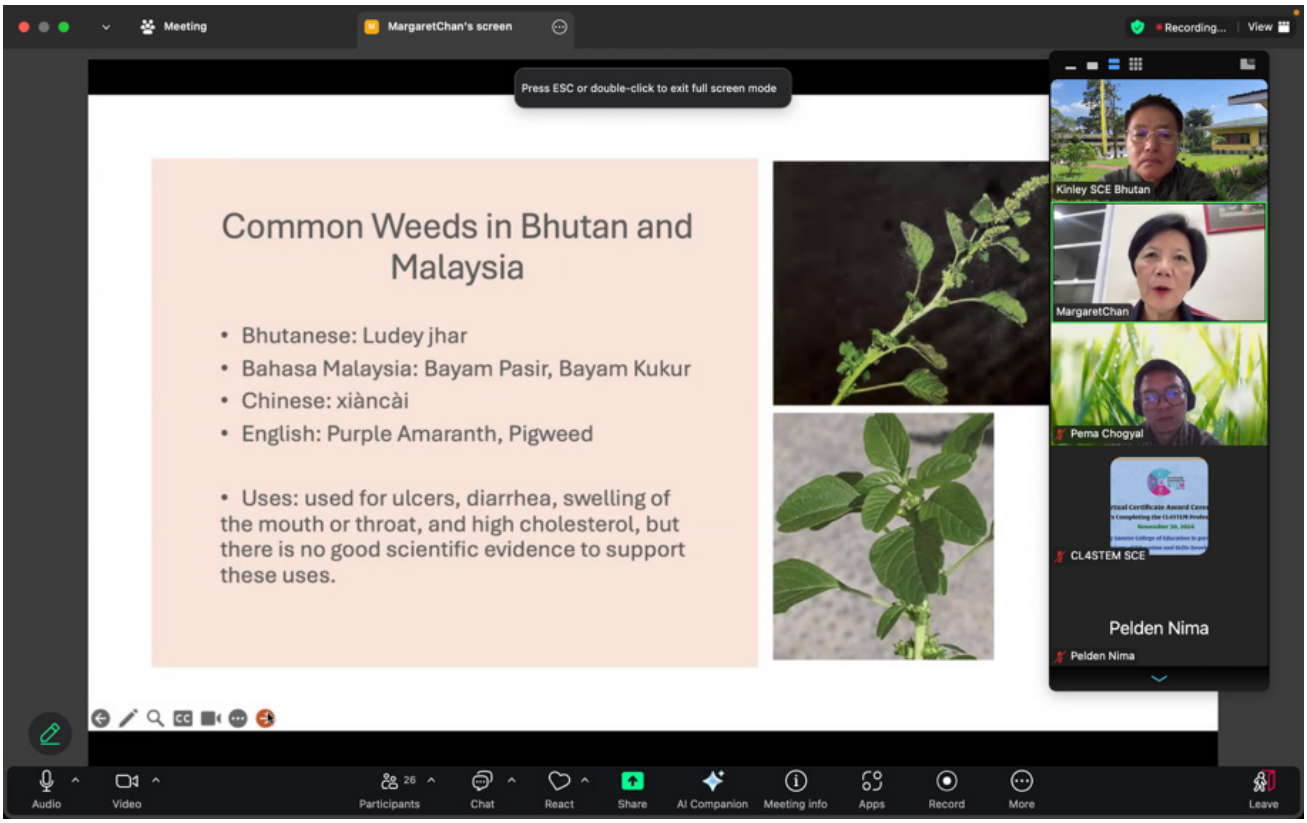
- The systematic process of classification and its scientific underpinnings;
- The preparation and significance of herbarium specimens in taxonomy.

In addition to the theoretical aspects, she shared vivid examples from her own teaching practice, illustrating how she guides students in identifying and classifying plants. She also showcased samples of her research work in the area of plant classification, thereby bridging the gap between classroom learning and real-world scientific application.

The subject of plant systematics and taxonomy is often regarded as one of the more challenging areas of botany due to its technical nature and reliance on detail. However, the speaker simplified complex concepts with clarity, making the presentation not only accessible but also engaging. Her ability to integrate historical perspectives, scientific rigour, and practical illustrations provided participants with a comprehensive understanding of the subject.

Feedback from participants indicated that the session was both meaningful and inspiring. Many expressed appreciations for the way difficult concepts were broken down into understandable elements, which deepened their interest in the subject. Some participants also reflected that the knowledge gained would be highly beneficial in their own teaching practices and classroom interactions with students.

Overall, the webinar was a valuable academic experience that enriched participants' knowledge of flowering plant taxonomy and systematics. It provided both theoretical grounding and practical insights, reaffirming the importance of plant classification as a foundation for understanding biodiversity and advancing botanical studies.



Pedagogical Content Knowledge that effectively leverage in teaching and learning: Selected Examples.

Kinley (PhD)
Karma Utha(PhD)
Thinley Wangchuk
(Tutors for PDY505)

Pedagogical Content Knowledge (PCK), introduced by Shulman in the 1980s, represents the integration of pedagogy and subject matter, addressing both the 'what' and 'how' of teaching. Shulman identified PCK as the missing paradigm in educational research, emphasising its role in elevating teaching to the level of recognised professions such as medicine, law, and engineering.

Educational reform reports from that period highlighted two recurring themes: the professionalisation of teaching and the recognition of teaching as a profession deserving higher status (Shulman, 1987). Shulman argued that clearly defining and enhancing teacher education and performance standards was essential to make teaching "a more respected, more responsible, more rewarding, and better rewarded occupation" (p. 3). This urgency prompted a deeper search for the underlying knowledge base of effective teaching (Shulman, 1986a, 1986b, 1987).

Good teaching, however, goes beyond helping students memorise facts; it requires fostering meaningful connections between ideas, applying knowledge to real-life contexts, and reflecting on understanding (Gunter, Estes, & Schwab, 1999). In this regard, Shulman (1987) proposed seven essential knowledge bases for effective teaching: (i) content knowledge, (ii) general pedagogical knowledge, (iii) curriculum knowledge, (iv) pedagogical content knowledge, (v) knowledge of learners and their characteristics, (vi) knowledge of educational contexts, and (vii) knowledge of educational ends, purposes, and values. Similarly, Smith and Neale (1989) suggested that teachers must possess subject matter knowledge, content knowledge, instructional strategy knowledge, and an understanding of students to teach successfully.

Building on Shulman's conception of PCK, the following sections present examples from Biology, Geography, History, and Mathematics, as developed by M.Ed. students, to illustrate how PCK can be effectively leveraged in teaching and learning.

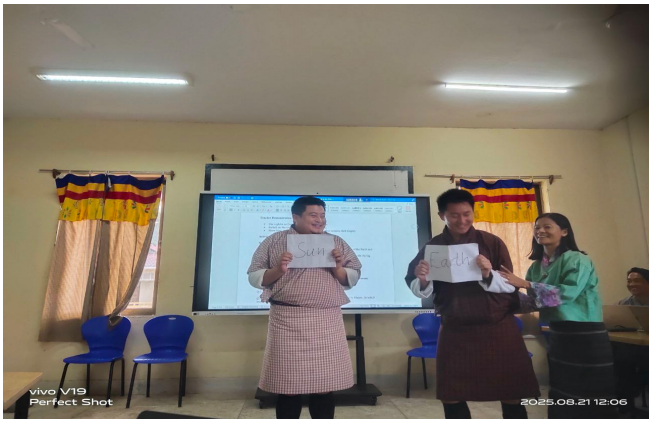
Geography lesson on Motion of the Earth

Activity: 1 - Teacher Demonstration on Rotation. (2 minutes)

- Use a globe as Earth and a torchlight as the Sun.
- Switch on the torch and slowly rotate the globe.
- Show how one side faces light (day) and the other remains dark (night).

Activity: 2: Revolution Role Play (2 minutes)

- Here, the teacher will look for two volunteers who will take the role of the Earth and the Sun. The teacher provides a tag reading 'Earth and Sun.'
- The child with the tag Sun will stand still at the centre, while the child with the tag Earth will show rotation and revolution simultaneously.
- The rest of the children will observe and try to understand the motion
- The teacher will ask children to share their observations



Geography Lesson on the topic Dilations

Demonstration: [Tr. Demonstrate how to dilatate a shape through experiment on Formation of Shadows using an Opaque Object]
Teacher will place a flashlight on the table, pointing toward a white wall or screen. An opaque object (like a toy or cardboard cutout) will be positioned 20 cm in front of the light source.
Teacher will turn on the flashlight and ask students to observe the shadow formed on the wall. The height of the shadow will be measured and noted.
Teacher will move the object to 40 cm and then 60 cm from the light source. At each position, students will observe how the shadow grows larger. Measurements will be taken and compared.

History lesson on the arrival of Zhabdrung
Direct Teaching - Show the video about of Zhabrung's arrival to Bhutan. Lecture using PPT, images and maps about Zhabdrung's arrival to Bhutan
Role Play: Teacher assigns roles to students based on historical records of individuals that participated in the event. Instruct students on role play activity. Let students discuss on how to go with the act. Then Act.

Biology lesson on effect of light intensity on the rate of photosynthesis
Demonstration: Teacher will demonstrate how to set up the two identical photosynthesis experiment to the students.

Place water plants in beakers with water and sodium bicarbonate; Keep one under bright light; Keep another under dim light.

Observation and record: Divide students in two groups and ask students to observe and record the number of bubbles in given interval of time in both setups.

Result discussion: Teacher and student will gather together to plot the graph on the board and interpret the data obtained from the experiment.

Simulation: A link to Olab will be provided in google classroom. Students in group of five students will perform the task together.

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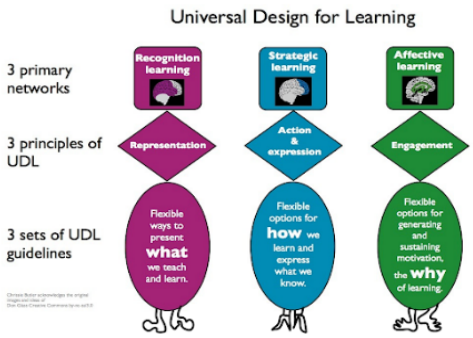
Samtse College of Education Launches UDL and Technology in STEAM Education Course

Cheki wangmo
BEd ICT Sec B

On 14th September 2025, Samtse College of Education (SCE) launched a professional development course titled “Transforming Pedagogy with Technology and the Universal Design for Learning Approach in STEAM Education.” The workshop gathered educators and participants to engage in meaningful conversations about how technology and Universal Design for Learning (UDL) can transform teaching and learning.



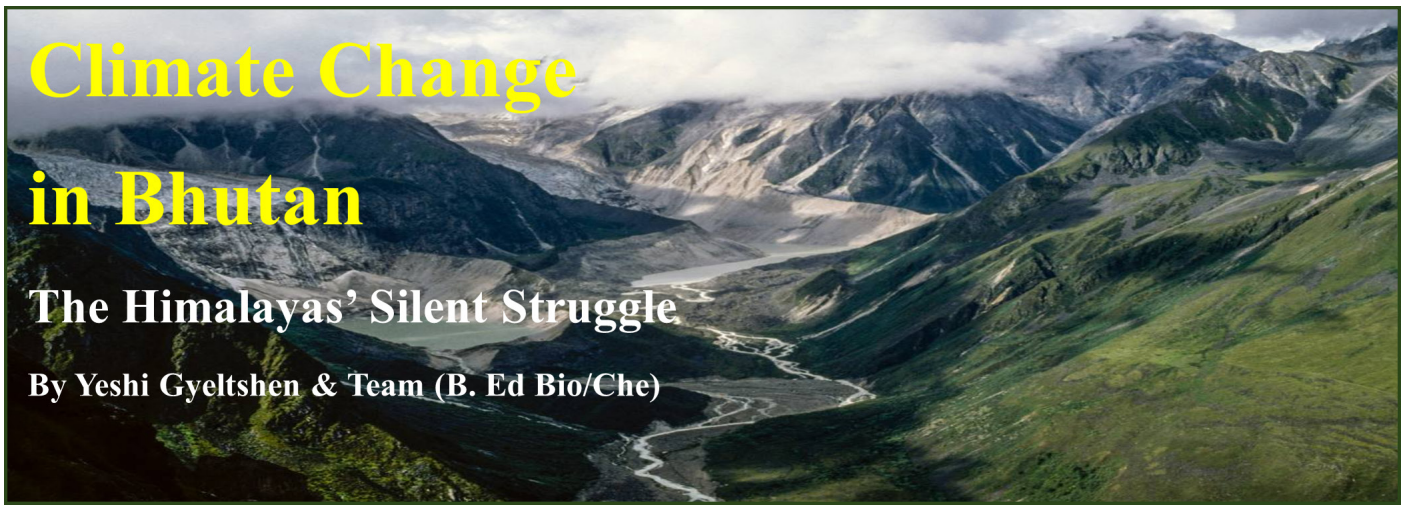
This initiative is part of the Connected Learning for Teacher Capacity Building in STEM (CL4STEM) project, funded by the International Development Research Centre (IDRC), Canada, under the GPE-KIX program. It is being implemented in collaboration with Ibrahim Badamasi Babangida University, Lapai (Nigeria), the Open University of Tanzania, and with technical support from the Tata Institute of Social Sciences (TISS), India. The involvement of international partners brought in diverse perspectives and a sense of shared commitment to inclusive education.

Throughout the sessions, participants explored how UDL ensures that all learners are given equal opportunities to succeed. The discussions emphasize the importance of designing flexible lessons that accommodate different learning needs and using technology as a tool to make learning more engaging and accessible. Presentations, group discussions, and interactive activities allowed everyone to reflect on current practices and consider new, innovative approaches.

The atmosphere of the workshop was both engaging and inspiring. Ideas flowed freely as participants shared experiences and insights, showing how inclusive pedagogy and technology can work hand in hand. A recurring theme was the belief that teaching is not only about delivering knowledge but about creating a supportive environment where every learner feels valued and motivated.

Workshops like this are a reminder that education is constantly evolving. By embracing new strategies and technologies, SCE continues to strengthen its role as a leading institution in preparing educators for the future. The launch of this course marks an important step forward, reinforcing the idea that inclusive and technology-enhanced teaching is no longer an option, but a necessity in today’s classrooms.

The professional development workshop was more than just a training program; it encouraged participants to rethink education in a way that is inclusive, innovative, and impactful. It set the tone for a future where teachers are not only skilled but also equipped with the vision to transform learning for every student.



Bhutan is carbon-negative — but not climate-proof

Tshogay Wangmo
Yangzom
Tshering Dema
Kinley Zangmo
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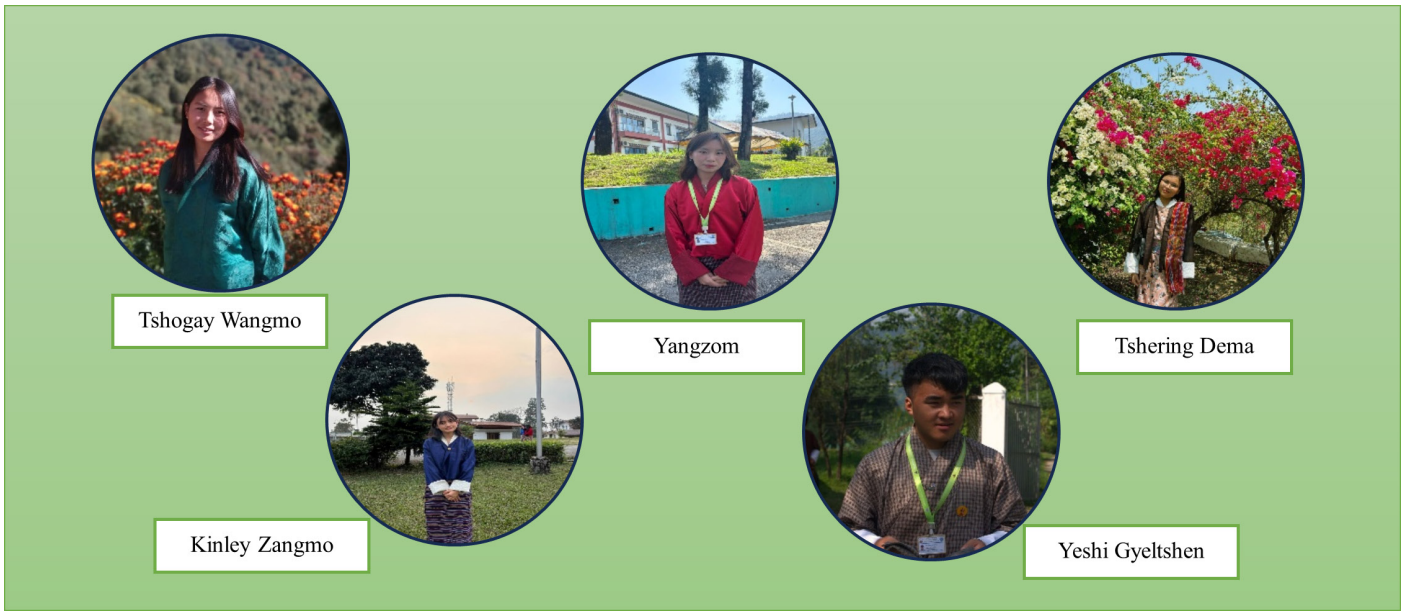
Introduction

Bhutan has been recognised globally in the Eastern Himalayas in terms of a very strong dedication to environmental sustainability. Bhutan has one of the highest percentages of forest cover, more than 70 percent of its land area, and the country's constitution guarantees that forest coverage is maintained. Yet the Bhutanese are not immune to the effects of climate change, which in their case is manifested in the form of intense heat.



Shrinking Glaciers, Looming Threats

The Gangju La and Thana Glaciers are melting at alarming rates, losing millions of tons of ice. Bhutan has lost approximately 17 gigatons of glacier ice across 630 km^2 (2004–2021).

This increases the risk of GLOFs (Glacial Lake Outburst Floods), like the devastating 1994 flood that damaged Punakha Dzong and nearby communities.

Effects on the Agriculture and Biodiversity

Bhutan farmers are facing threats of unseasonal rainfall, drawn out droughts, and increased pests. Conventional farm activities are overemphasised, which cuts into harvest standards and threatens indigenous herbs and biodiversity. Forest fires and landslides events are nowadays regular phenomena during such weather extremes.

Hazards and Health

Climate change is not only physical danger, mental strain, water-borne illnesses and heat illness are increasing. The most affected groups are found in the rural areas and especially among susceptible groups.

Bhutan-proactive Response

- Constitutional Protection: forest cover contention set with 60 percent
- Policy on Climate Change (2020) and National Adaptation Plan (2023)
- Early Warning Systems (EWS) of severe weather
- Green Infrastructure Projects in built-up areas
- Class 7 Science Curriculum Climate education in schools

What We May Do

- Foster climate-based agriculture
- Make youth more eco-leaders
- Promote green business
- Increase local management of forests
- Take up low-carbon lifestyles

Conclusion

Being small in size does not mean Bhutan has a small voice. The nation initiatives provide an example on global equilibrium between nature and development. Conserving Bhutan mountains will be protecting the spiritual and ecological pulse of the Himalayas.

Lead Poisoning: A Silent Crisis in Bhutan

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Introduction

Lead (Pb), a heavy metal with atomic number 82, is a naturally occurring toxic metal found in the Earth's crust. It has historically been used in various industries, including construction, cosmetics, paints, pipes, and gasoline. Despite its utility, lead is a toxic element that poses severe health risks, particularly to children and pregnant women. Its widespread use has caused extensive environmental contamination, human exposure, and significant public health problems globally, and Bhutan is no exception.

Exposure to lead can result in irreversible developmental, cognitive, and physiological harm. Recent studies reveal alarming levels of lead exposure (Lhaki et al., National Blood Lead Level Survey, 2024) among Bhutanese children and women, urging immediate national attention and action. Limited public awareness, cultural practices, and the use of unregulated traditional products compound the issue. This article explores the chemistry of lead, its health implications, the findings from Bhutan's first national blood lead level survey, and the steps being taken to combat this growing threat.

Chemistry and Toxicity of Lead

Lead (Pb), atomic number 82, is a post-transition metal in Group 14 of the periodic table. It is dense, soft, malleable, and corrosion-resistant. In chemistry, it most commonly exists in the +2 oxidation state, forming compounds like lead (II) oxide (PbO) and lead (II) nitrate (Pb $(NO_3)_2$). Though industrially useful, lead is biologically non-essential and mimics essential metals like calcium and zinc in the body, disrupting vital processes in the nervous system, kidneys, and blood.

Understanding Lead Poisoning

Lead poisoning occurs when lead builds up in the body over time, typically through ingestion or inhalation. There is no safe level of lead in the blood. It is particularly dangerous because symptoms often appear only after significant harm has been done. In children, even small amounts can cause developmental delays, learning disabilities, irritability, and behavioural problems. Adults may experience high blood pressure, joint and muscle pain, and memory issues. Pregnant women exposed to lead face increased risks of miscarriage and premature birth, and may unknowingly harm the development of the foetus.

Lead Poisoning in Bhutan: A Growing Concern

While industrial lead exposure is more commonly associated with developed countries, Bhutan faces its unique threats due to different sources of lead exposure in Bhutan (Lhaki et al., National Blood Lead Level Survey, 2024), such as:

- Traditional products like jinlab, sindoor (vermilion), and herbal medicines.
- Old household items—painted surfaces, copper utensils, and toys.
- Water contamination from aging pipes.
- Cultural and religious practices involving unsafe products.
- Limited awareness and weak regulation of consumer goods.

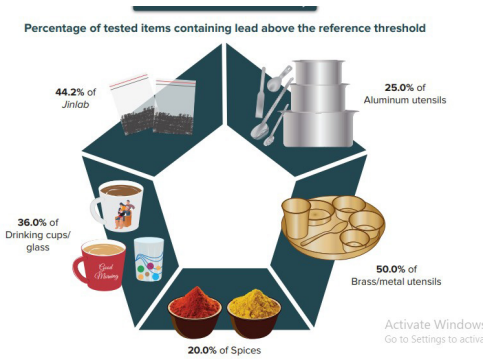
National Blood Lead Level Survey

The 2024 National Blood Lead Level Survey (Lhaki et al., National Blood Lead Level Survey, 2024) conducted by the Ministry of Health with support from, United Nations Children's Fund (UNICEF), World Health Organization (WHO), International Partnership for Sustainable Advances in Health and Development (IPSAHD), and Khesar Gyalpo University of Medical Sciences of Bhutan (KGUMSB). The study sampled over 3,000 children and nearly 130 pregnant/breastfeeding women. Which revealed an alarming statistic:

- 76% of Bhutanese children had blood lead levels (BLLs) at or above 3.5 µg/dL.
- 86% of children in monastic institutions had elevated BLLs.
- 59% of pregnant or breastfeeding women showed concerning BLLs.

Not only that, the survey also found the contents of lead in different items such as:

- 44.2% in Jinlab
- 50% in brass/metal utensils
- 36% in drinking cups/glasses
- 25% in traditional handmade pots
- 20% in spices and food
- 9% in toys
- 3.3% in soil
- 0.8% in paints
- 75.2% of religious items
- 60.7% of latch/bolt locks/door knobs



National Responses

Recognising the seriousness of the situation, Bhutan's government has begun taking steps (Lhamo, 2025):

- Formation of a national task force on lead poisoning.
- Integration of lead education into medical training at KGUMS.
- Nationwide public awareness campaigns using print, radio, and social media.
- Training of health workers to recognise and treat lead-related health issues.

Despite these efforts, ongoing challenges include weak product regulation and limited public awareness, particularly in rural and culturally conservative communities.

Individual Action

At the individual level, prevention starts with awareness and action:

- Maintain hygiene: Regular handwashing and dusting reduce exposure.
- Filter drinking water: Use certified filters and let taps run before use.
- Eat healthy: Diets rich in calcium, iron, and vitamin C reduce lead absorption.
- Check the environment: Test old homes, paint, and utensils for lead.
- Avoid risky products, particularly unverified traditional medicines and cosmetics.
- Get regular blood lead level testing for children and pregnant women.

Conclusion

Lead poisoning is a silent but dangerous health threat in Bhutan. The 2024 national survey shed light on the widespread exposure, especially among children and pregnant women. If left unaddressed, the cognitive, physical, and emotional damage can affect not just individuals but the entire nation's development. Fortunately, efforts are underway to fight this crisis through education, policy reform, and personal responsibility. With continued action and awareness, Bhutan can prevent further harm and secure a healthier future for its people.

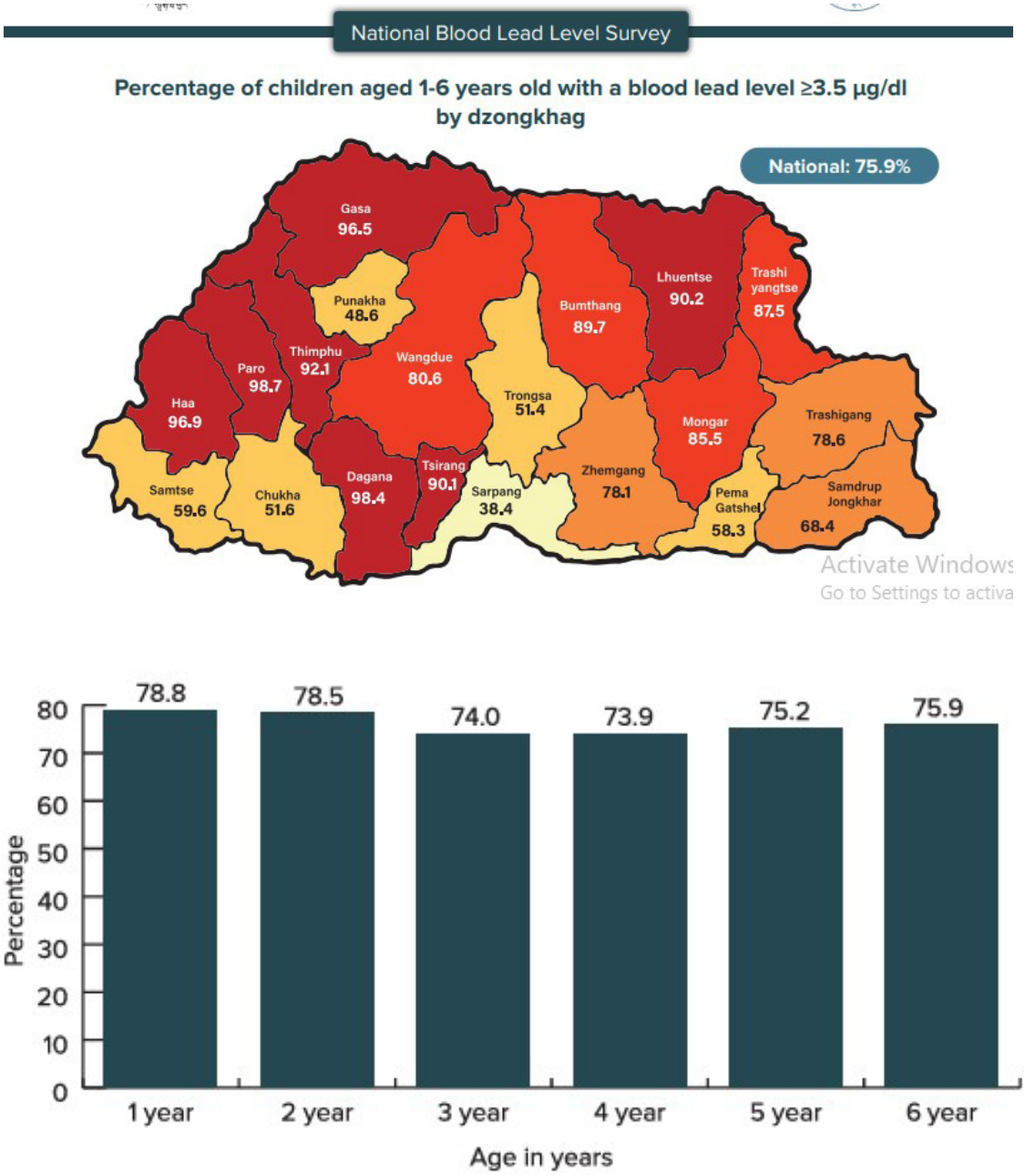


Figure 4.2: Percentage of children 1-6 years old with a blood lead level ≥3.5 µg/dL by age [National Blood Lead Level Survey 2024].

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Investigating Kitchen waste management practices in self-catering and mess of Samtse College of Education

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Introduction

Samtse College of Education is one of the tertiary institutes for teacher training under the Royal University of Bhutan located in the core of Samtse Dzongkhag. The college has around 800 trainees consisting B.Ed, PGDE and M.Ed which makes up a large population in the campus.

All the M.Ed trainees are residing in the self-catering hostel and contribute for the production of kitchen waste. Similarly, the number of trainees availing the college mess facilities also increased and lead to production of more kitchen waste. The waste is produced from twelve different kitchens in the self-catering hostel was an alarming issue. Having no proper segregation of the waste and timely disposal are the two main problems.

All the wastes (Degradable and Non-degradable) are duped in one bin leading to decay within short period of time. The irregularity of the Municipal truck for waste collection is another issue which use to collect every after two days, but then the trainees are away for class. However, the waste of college mess is cared by cooks by the way of taking as cattle's feed and rest they dump in truck regularly. If we don't act now, there will be lots of problems for the environment and human beings later. Therefore, it is important for the concern authority to make timely intervention and put place with certain rules and regulations to curb down the waste productions.

Objectives:

- Identify the types of wastes generated in the self-catering hostel
- Assess the techniques of waste segregation in the campus.
- Design effective waste segregation methods
- Develop mathematical model to manage waste in Self-catering hostel in the college campus
- Interact with the concern community people

Methods

Data Collection: Quantitative data was collected 3 times in a week, preferably at the end of day to collect large amount of data. Degradable and non-degradable waste was recorded in mass for the quantitative data analysis. Qualitative data was collected through semi-structured interview and participants were selected using randomly sampling. Participants were mess staff and students from self-catering. To ensure credibility of the data, finding from quantitative data was triangulated with semi- structured interview.

Instruments used: Plastic bags, Calculator, Spring balance, Pen and note book

Procedural Steps

- Identify the location of the hostel and mess kitchen to carry out the practical
- Collect and weigh the waste for seven times after every two days.
- Maintain the record separately for degradable and non-degradable in the table form
- Study the patterns of the amount of degradable and non-degradable waste and develop mathematical model
- Plot the data using appropriate graph

Wastes collected:

Degradable waste: Potato pills, Beans, Onion pills, Chillies, Pumpkin, Radish, Bottle guard, Carrot, Eggplant, Carton

Non-Degradable waste: Plastic, Oil cane, Cheese cover, Sauce bottles, Tins

Pictures of wastes collection

Sl. No	Date	Kitchen Waste					
		Self-Catering		College Mess		Self-catering+Mess	
		Degradable (kg)	Non-degradable (kg)	Degradable (kg)	Non-degradable (kg)	Total Degradable (Kg)	TotalNon-Degradable (kg)
1	13/4/21	9.1	1.2	29.5	2.5	38.6	3.7
2	15/4/21	9.3	1.5	30	2.4	39.3	3.9
3	17/4/21	10	1.3	30	2.8	40.0	4.1
4	19/4/21	10.6	1.5	30.1	2.8	40.7	4.3
5	21/4/21	10.4	1.3	31	3.2	41.4	4.5

6	23/4/21	10.6	1.6	31.5	2.6	42.1	4.2
7	25/4/21	10.8	1.9	31.6	2.4	42.4	4.3
Total Mass						284.5	29.0

Tabulation of data collection

Graphical and Mathematical interpretation of the data

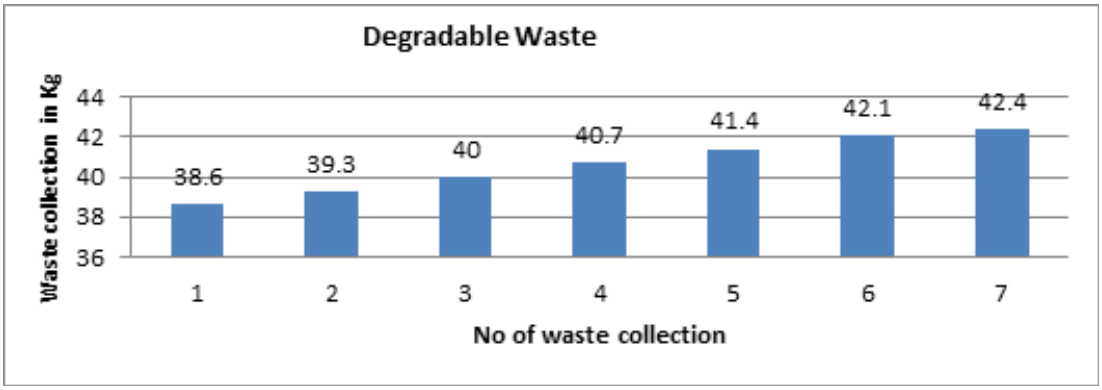

Table of CD

Total Degradable waste (kg)	Common Difference
38.6	0.7
39.3	0.7
40.0	0.7
40.7	0.7
41.4	0.7
42.1	0.3
42.4	

$Analogically\ C.D = 0.7$

$Statiscally\ C.D = \frac{5\times0.7+0.3}{6} = \frac{38}{6} = 0.633 \approx 0.6$

So, 0.7 shows $\frac{6}{7} \times 100 = 85.7\%$. we have taken the CD as 0.7

Mathematical Model: Formulation of Pattern

We use algebra to study the rules that describe the relationship of the observation after every 2 days with the common difference of 0.7kg. Through observation, we notice that we can describe this pattern by the rule y=mx+b Where, y is the mass of degradable waste (kg), m is the common difference and x is the number of observations.

When x=1, y=38.6, 38.6=0.7×1+b→b=38.6-0.7=37.9
When x=2, y=39.3, 39.3=0.7×2+b→b=39.3-1.4=37.9
When x=3, y=40, 40=0.7×3+b→b=40-2.1=37.9
When x=4, y=40.7, 40.7=0.7×4+b→b=40.7-2.8=37.9
So, the value of b is 37.9

A table of values can be generated from pattern/rule, y=0.7x+37.9 as shown below;
When x=1,Y_1=0.7×1+37.9=38.6
When x=2,Y_2=0.7×2+37.9=39.3
When x=3,Y_3=0.7×3+37.9=40.0
When x=4,Y_4=0.7×4+37.9=40.7
When x=5,Y_5=0.7×5+37.9=41.4

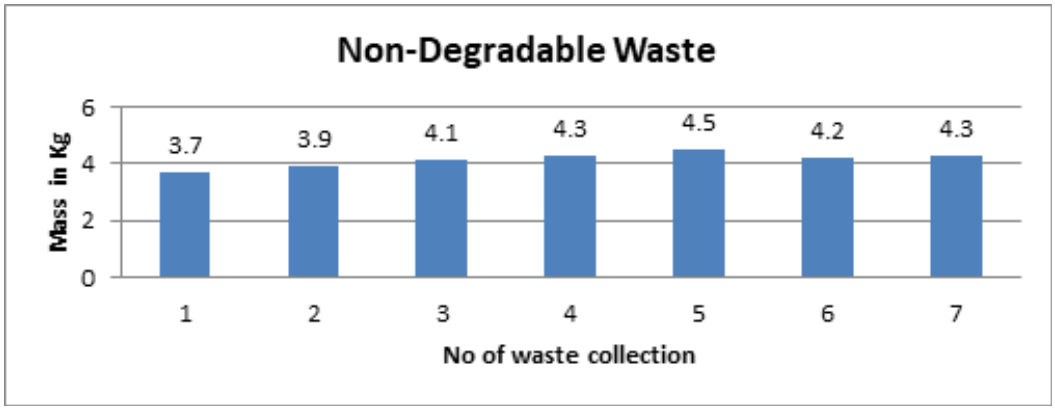

Table of CD

Total Non-Degradable waste (kg)	Common Difference
3.7	0.2
3.9	0.2
4.1	0.2
4.3	0.2
4.5	0.2
4.2	0.1
4.3	

$Analogically\ C.D = 0.2$

$Statiscally\ C.D = \frac{5\times0.2+0.1}{6} = \frac{1.1}{6} = 0.1833 \approx 0.2$

For Non-Degradable waste also used algebra to study the rules that describe the relationship of the observation after every 2 days with the common difference of 0.2kg. Through observation, we notice that we can describe this pattern by the rule. y=mx+b Where, y is the mass of degradable waste (kg), m is the common difference and x is the number of observations every after 2 days.

When x=1, y=3.7, 3.7=0.2×1+b→b=3.7-0.2=3.5
When x=2, y=3.9, 3.9=0.2×2+b→b=3.9-0.4=3.5
When x=3, y=4.1, 4.1=0.2×3+b→b=4.1-0.6=3.5
When x=4, y=4.3, 4.3=0.2×4+b→b=4.3-0.8=3.5
So, the value of b is 3.5

A table of values can be generated from pattern/rule, y=0.2x+3.5 as shown below;
When x=1,Y_1=0.2×1+3.5=3.7
When x=2,Y_2=0.2×2+3.5=3.9
When x=3,Y_3=0.2×3+3.5=4.1
When x=4,Y_4=0.2×4+3.5=4.3
When x=5,Y_5=0.2×5+3.5=4.5
Therefore, we noticed that there is increasing pattern relationship between the number of days and mass of degradable and non-degradable wastes, we can use algebraic equation to describe the relationship.

Quantitative Data Analysis

Analysis of degradable waste: In the beginning, the quantity of waste 36.8 kg and increased steadily up to 42.4kg by the end of 2 weeks. There is a positive correlation between the waste generated and the number of days. There are slight increase in the production of waste over the observation period.

Analysis of non-degradable waste: In the beginning, the quantity of waste 3.7 kg and increased steadily up to 4.3kg by the end of 2 weeks. There is a positive correlation between the waste generated and the number of days. Initially there was increased in the production of waste up to 5th observation and decreased after that.

Qualitative Date Analysis: From the semi-structured interview, it was found out that two types of waste are being generated from the self-catering hostel and college kitchen mess, i.e., degradable and non-degradable waste. Both degradable and non-degradable waste was dumped in the municipal truck on timely basis, except for some vegetable peels from the college mess was used as the domestic animal feeds. It was understood that if the municipal truck doesn't show up on time, they face challenges of managing the waste.

Result and Discussion: We made a visit to Self-Catering hostel and College Mess for SEVEN times after every TWO days. The collected wastes from the self-catering and college kitchens were measured at the end of the day for the large amount of data. The main waste produced were waste of vegetables and others like, papers, plastics, bottles, sacks, cartons and food items.

We practically went around and measured, recorded and computed all the findings. We measured seven times after every two days and found that the mass of wastes gets increased significantly. Through the mathematical model that we have designed, we can predict the mass of the waste for that particular time period.

Finding: There is constant increase of production of degradable and non-degradable waste forming linear pattern. Mathematical equations is as follows:

Degradable waste: $y = 0.7x+37.9$ **Non-degradable waste :** $y = 0.2x+3.5$
The data shows that, there is production of more waste towards the end of the month. There is a significant difference in the degradable and non-degradable waste being produced from the Mess and self-catering hostel.

Conclusion

To conclude on the research project on waste management in self-catering hostel and the kitchen mess of Samtse College of education, the project was completed successfully using two forms of data: quantitative and qualitative data. It was a fantastic opportunity for the three of us to learn about the waste that is created and how it is managed. However, since all of the waste was dumped together, we had difficulty calculating the waste produced by the mess.

We used the data we collected to see the mathematical formulation, and it was discovered that a linear pattern was created. We can extrapolate the mass of waste that will be produced from that linear pattern.

STEM EDUCATION NEWSLETTER

Samtse College of Education, 2026

Volume 6

“We must make STEM subjects part of their (children/students) everyday language….In preparing our youth for the future, we must take advantage of available technologies, adapt global best practices, and engineer a teaching-learning environment suited to our needs. Technology is the argument of our time and a major indicator of social progress. The irony in our context is the absence of technology in classrooms for a generation of students who are exposed to, and live in the digital age. To ensure that teachers are not disconnected from their students, professional development of teachers should integrate technology, digitalization, artificial intelligence, and automation.”

(His Majesty King Jigme Khesar Namgyel Wangchuck, 2020)