STEM EDUCATION NEWSLETTER

Samtse College of Education, 2025

Volume 5

Inside this issue

MESSAGE FROM STEMERC HEAD

Welcome to Volume V of the STEM Newsletter! It's with great excitement that the STEM Education Research Centre (STEMERC) present this edition, having a wide range of insightful content aimed at fostering innovation, collaboration, and critical thinking within the realms of science, technology, engineering, and mathematics. In this issue, the content is broadly divided into four core segments that showcase the dynamism of STEM education and practice:

This issue is organised into four key sections that showcase the dynamic nature of STEM education and practice:

STEM Activities highlights two ongoing projects led by the STEM faculty at Samtse College of Education (SCE): Connected Learning for Teacher Capacity Building in STEM (CL4STEM) and Project PANOPTES. Both projects are making significant strides in integrating innovative STEM practices and offering fresh perspectives on STEM education. Additionally, projects developed by B.Ed. IT students are featured, demonstrating how they have creatively applied the principles of IT and Physics to bridge theoretical knowledge with real-world applications. These initiatives reflect the power of interdisciplinary collaboration and the exciting possibilities that arise when technology intersects with traditional STEM fields.

The **TPACK (Technological Pedagogical Content Knowledge)** section explores how integrating technology with pedagogy and content knowledge is reshaping the way STEM is taught and experienced. This section examines how TPACK frameworks can enhance teaching practices, empowering educators to engage and inspire students effectively.

The **Research** section features a fascinating study conducted by Chemistry students, which showcases the innovative use of spectrophotometric analysis to determine the alcohol percentage in local Ara, a traditional alcoholic beverage. This research demonstrates how scientific methods can be applied to analyse and understand the chemical composition of locally produced drinks, illustrating the intersection of science and culture, and emphasising the educational and impactful nature of such research.

Finally, the **Reflections** section offers personal insights from educators and students at SCE, providing valuable perspectives on the progress made in STEM and the path ahead. This section focuses on the challenges, opportunities, and the continued importance of collaboration in the STEM field.

Heartfelt appreciation goes to all contributors, collaborators, and readers for their unwavering support and dedication. Your involvement is vital in bringing this newsletter to life. As this volume is explored, may it spark new ideas, foster engaging discussions, and motivate everyone to push the boundaries of innovation and excellence in STEM education. Together, the journey of discovery and growth continues.

Happy reading!
For an electronic copy of the newsletter, please visit http://stem.sce.edu.bt

Karma Utha (PhD)
Head of STEMERC

CL4STEM TOT Workshop: Empowering Secondary School STEM Educators

Submitted by
Reeta Rai (PhD)
CL4STEM Country Coordinator

Introduction:
The Samtse College of Education (SCE), in collaboration with the Ministry of Education and Skills Development (MoESD), invited secondary school STEM teachers to register for a Training of Trainer (ToT) Professional Development (PD) workshop. As part of the CL4STEM project, this workshop aimed to enhance teachers' Knowledge, Attitudes, and Practices (KAP) by integrating technology and Universal Design for Learning (UDL) principles. Through this collaborative initiative, SCE and MoESD sought to revolutionize STEM education nationwide by equipping educators with the skills and tools necessary to inspire the next generation of STEM leaders. A total of 245 applications were received, and after joint evaluation by MoESD and SCE, 156 were selected for the ToT PD workshop.

The PD was launched jointly by SCE and MOESD by inviting all selected ToTs to participate in a launching workshop titled "CL4STEM ToT Workshop: Empowering Secondary School STEM Educators." This two-day workshop, held from 26th to 27th February 2024, was organised across four different venues: Thimphu, Gelephu, Phuntsholing, and Trashigang. A total of 149 selected teachers attended this event, representing a diverse group of educators committed to enhancing STEM education in Bhutan. The workshop was jointly resourced by teacher educators from SCE and officials from the MOESD.

Day 1 Highlights:
The programme began with self-introductions from both facilitators and participants, building a sense of community and collaboration. The recorded opening speech from SCE's President, who also serves as Project Lead, extended a warm greeting to all attendees and emphasised the PD's aim and objectives. This was followed by a message from the MoESD that reaffirmed the government's commitment to improving STEM education throughout the country. The project country coordinator then introduced the CL4STEM Consortium Project to the participants, providing an overview of the initiative's objectives and implementation plans.

Workshop sessions covered key themes crucial for effective STEM education. A session on Design Thinking encouraged participants to embrace innovative problem-solving approaches. Additionally, a hands-on activity focused on Reflective Teaching with Technology (RTICT) equipped participants with tools to incorporate technology into their teaching practices, promoting interactive and engaging learning environments.

Day 2 Highlights:

The second day of the workshop continued with sessions aimed at equipping teachers with practical strategies and resources. UDL was introduced to promote inclusive teaching practices catering to diverse learner needs. An orientation to Open Educational Resources (OER) provided insights into leveraging freely accessible educational materials for enhanced teaching and learning experiences. Furthermore, participants were guided through orientation sessions on lesson planning and reflection templates, equipping them with structured frameworks to enhance instructional planning and assessment practices. The participants were also familiarised on the use of Virtual Learning Environment (VLE) workshop features for peer assessments empowering teachers with digital tools for collaborative learning and assessment.

The CL4STEM PD event received significant attention from national television, newspapers, and the Asia Education Review website, highlighting its importance and impact on educational innovation. Media reported that the innovation has the potential to advance STEM education and foster collaboration among educators. Through extensive coverage, including televised segments, print articles, and online features, the CL4STEM PD event received recognition for its contribution to enhancing teaching practices and promoting STEM education in Bhutan

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CL4STEM Project equips STEM teachers with innovative teaching techniques

To enhance knowledge and skills in teaching STEM subjects amongst science and mathematics teachers, they are being equipped with the latest teaching techniques and the use of ICT tools. This is done through the Connected Learning for STEM project. For this, the Samtse College of Education in collaboration with the Education and Skills Development Ministry trained teachers from various schools for the last two days.

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Training the STEM Teachers
KP Sharma
A total of 156 STEM teachers are currently participating in a two-day training across four locations, aimed at enhancing their content knowledge, technology utilisation, and inclusive pedagogies in their profession.
https://kuenselonline.com/training-the-stem-teachers/
#STEM #teachers #profession #technology #MoESD #bhutan

commitment to advancing STEM education and empowering educators to nurture the next generation of innovators and problem solvers. As participants return to their respective schools, they are required to complete three subject-specific modules along with a common pedagogy module focused on subject-related Pedagogical Content Knowledge (PCK). Each module is designed to provide in-depth insights, resources, and activities tailored to specific STEM subjects to enhance their KAP. They will be expected to apply the newly acquired knowledge and strategies to inspire and engage students in the dynamic field of STEM. It is anticipated that teachers will dedicate 5 hours per week to complete this PD to acquire a Certificate with 100 hours of PD.

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By Asia Education Review Team , Tuesday, 27 February 2024

Bhutan Enhances STEM Education with Innovative Teacher Training

In Thimphu, Phuentsholing, Gelephu, and Trashigang, 156 committed STEM teachers are participating in a crucial two-day training focused on enhancing **Bhutan's education**. Rooted in His Majesty's vision for integrating **Information and Communication Technology** (ICT) into top-notch education, this initiative represents a significant step in elevating STEM education nationwide.

The training, meticulously organized by Samtse College of Education in collaboration with the Ministry of Education and Skill Development, aims to utilize Open Educational Resources (OER) to transform lesson delivery and spark student interest in STEM subjects. These indigenously developed OERs, aligned with national school curricula, embody technological pedagogical content knowledge (TPACK), universal design for learning (UDL), and higher-

Conclusion:

The CL4STEM ToT Workshop provided secondary school STEM educators a platform to come together and acquire the knowledge and skills needed to enhance their pedagogical skills, integrate inclusive technologies into their teaching practices, and fostering collaborative learning environments. The collaborative efforts between SCE, MoESD, and participating teachers underscored Bhutan's

Project PANOPTES: A Robotic Telescope

In 2010, Dr. Joshua Pepper and a team of astronomers at the University of Hawaii founded the PANOPTES (Panoptic Astronomical Networked Observatories for a Public Transiting Exoplanets Survey) project. This initiative was inspired by the success of the Kepler mission in 2009, which detected small planets orbiting other stars using the transit method. However, the Kepler mission had limitations, such as a single field of view and limited accessibility to the public. The goal of the project PANOPTES, as explained by Dr. Pepper, was to "provide the public with the tools and resources necessary to participate in scientific research, while also advancing our understanding of the universe and inspiring the next generation of scientists and explorers" (2019). The project is based on the concept of "citizen science," which involves the public in scientific research. To achieve its objectives, the project PANOPTES has built a network of low-cost, robotic telescopes that can be operated by amateur astronomers and citizen scientists. This makes it possible for anyone to contribute to the search for exoplanets, regardless of their background or experience. Overall, the project PANOPTES aims to democratise the discovery of exoplanets and to inspire and engage the public in science and astronomy.

According to the Royal Kasho on Education Reform, "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 Bhutanese,2021). In alignment with the Educational Reform, Ministry of Education and Skills Development (MoESD) in Bhutan making commendable efforts to initiate radical reforms in the education system, the reforms emphasize STEAM Education and preparing the youth for the digitized world of the 21st century. In order to acheive the dreams to achieve the quality education, the physics faculty and the students of Postgraduate Diploma in Education (PgDE) and Master of Education in Physics of Samtse College of Education were trained in building a robotic telescope and installed a PANOPTES unit on the roof of Karmaling hostel in the year 2023 with support from the USA Project PANOPTES team. In the following year 2024, again the physics faculty and PgDE students attended a five-day training workshop on how to analyse the pictures taken by the PANOPTES unit by determining light curves and analysing stars with the help of software and knowledge of Photometry. AstroImageJ is graphical user interface (GUI) driven, public domain, Java-based, software package for general image processing traditionally used mainly in life sciences fields. The image processing capabilities of ImageJ are useful and extendable to other scientific fields (Collins et al., 2017). American Association of Variable Star Observers (AAVSO) conceived and created the VSX in order to serve as an online medium through which variable star data is made available to the general public. The data is maintained, revised, and commented upon. To access this database, one need to have an account to verify, calibrate, and analyse the data on astronomical objects.

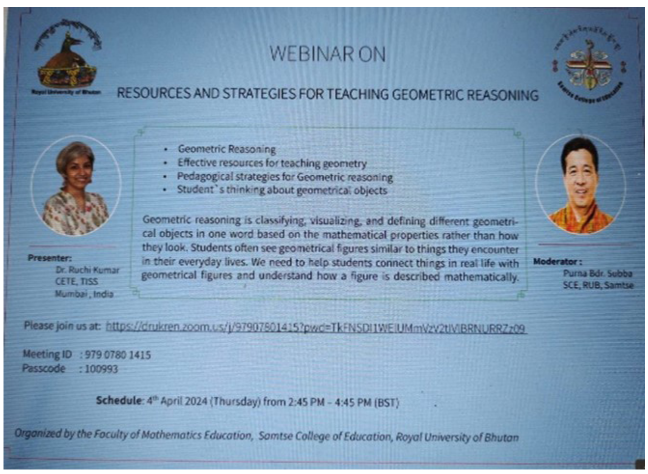
The Project PANOPTES has contributed significantly to the world of astronomy, notably in the hunt for exoplanets. As of now, there are three project PANOPTES units in Bhutan, and the faculty and students are trained to use them for science projects. One such idea is to extend the network of observatories and the number of telescopes used, which would cover a larger region of the night sky and allow for more efficient data collecting for scientific study (Mahaffy et al., 2020). Bhutan is well positioned to lead and contribute to original science projects, and leverage the PANOPTES units to train students in STEM, Astronomy and Space Science and Technology.

Enhancing Geometric Reasoning in Bhutan: Insights from a Professional Development Webinar

Submitted by
Purna Bahadur Subba
(Webinar organizer cum moderator)

A webinar "Resources and Strategies for Teaching Geometric Reasoning" was organized on April 4, 2024, by Dr. Ruchi Kumar, Assistant Professor at the Centre for Excellence in Teacher Education (CETE) of Tata Institute of Social Sciences (TISS), Mumbai, India. Mr. Purna Bdr Subba was the moderator. The activity was planned to enhance the professional capacity of mathematics teacher educators, pre-service student teachers, and secondary school mathematics teachers in Bhutan. The primary objective was to share best practices in teaching mathematics and foster a lifelong learning commitment. This webinar was one of the ongoing upscaling activities of the CL4STEM project at Samtse College of Education (SCE).

198 of the participants in the webinars were 's SCEpre-service mathematics students and faculty, and Bhutan's secondary school mathematics teachers. The session focused on the utilitarian use of resources and teaching geometric reasoning at the primary and middle-secondary levels. During the webinar, Mr. Subba led a discussion with Dr. Kumar on various topics related to teaching, learning, and assessment in mathematics education. Dr. Kumar agreed to conduct the session on the topic "Resources and Strategies for Teaching Geometric Reasoning," highlighting successful classroom strategies and resources.



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Participants provided reflective thoughts, highlighting the impact of the webinar on professional growth:

Kinley Dem: The webinar was very helpful to primary and lower secondary mathematics teachers, particularly liked the introduction of innovative digital tools to enhance student understanding and enjoyment.

Sonam Phuntsho: Despite missing the beginning, enjoyed the presentation and found it helpful, and the emphasis on practical applications encouraged further exploration of geometric thinking.
Ugyen Lhamo and Sonam Choki: Discussed how suitable software tools can be applied for high school instruction and suggested considering other sources than popularly recognized ones like GeoGebra.

Sangay Wangmo: Emphasized employing concrete examples from reality and formative assessment to embed the geometry principles in the students' minds.

Tshering Choden and Kailash Pradhan:
Appreciated the interactive style of teaching and using real-world examples to create interest among the students.

Chhavi Wangmo and Kuenga Wangmo: Expressed interest in applying the discussed strategies, particularly in creating interactive learning spaces.
Sonam Pemo and Sonam Chodey: Highlighted the effectiveness of some tools and techniques to make geometry classes more engaging and relevant.
Dorji Seldon and Bhagirath Adhikar: Discussed the new strategies presented and actual utilization of technology in instruction of geometric reasoning.
Dema Lhamo and Pema Gyelmo: Noticed the enabling potential of ICT in enabling the progress of the students through geometric reasoning.

Namgay Pem and Sonam Choki: Called for hands-on applications and activities in geometry sessions.
Tshering Yangzom and Yadu Prasad Ghimire: Focused on the interactive nature of the webinar that promoted communication, collaboration, and effective integration of ICT tools.

Conclusion and Recommendations

The webinar "Resources and Strategies for Teaching Geometric Reasoning" was a well-organized activity that richly enhanced the professional learning of Bhutanese mathematicsematics teachers. Through the collaborative efforts of SCE, Royal University of Bhutan (RUB), and Dr. Ruchi Kumar from TISS, the session effectively addressed the need for innovative methods of teaching geometry.

The participants' feedback attests to the positive impact of the webinar, particularly regarding the introduction of digital tools, hands-on uses, and interactive practices. The webinar fostered a culture of collaboration and active participation among teachers and encouraged the adoption of innovative practices to improve students' participation and understanding of geometric reasoning.
SCE is encouraged in the future to organize similar professional development workshops with a focus on:

1. Extending Resource Set: Incorporating a broader collection of digital instruments other than GeoGebra.

2. Practical Applications Augmentation: Adding additional real-life instances to geometry lessons.

3. Facilitating Collaborative Learning: Fostering the sharing of ideas between mathematics teachers.

4. Utilising ICT: Extending the study of how technology can be used to enhance the development of geometric reasoning.

By sustaining this impetus, mathematics teachers can further improve their practice, eventually aiding students' grasp and appreciation of geometry.

International Observe the Moon Night (IOMN) Event

Submitted by
Astronomy Club

The International Observe the Moon Night (IOMN) is a yearly global initiative aimed at encouraging people worldwide to observe the Moon, typically in September or October. The event's objective is to bring together a diverse audience—ranging from families and students to astronomy enthusiasts and clubs—to foster a shared sense of global unity. IOMN not only promotes curiosity about space but also fuels enthusiasm for lunar exploration, uniting participants through a common, international event.

The Astronomy Club actively took part in this event on 17 and 18 September 2024, hosting an in-person gathering on the College campus. The primary goal was to enhance awareness of space and foster an appreciation for the beauty of the Moon, Earth's only natural satellite. Club members invited students and staff to join in this global celebration. Our participation in IOMN helped strengthen our connection to this worldwide celebration of lunar observation.

Observation has always been a key scientific skill, playing a vital role in numerous groundbreaking discoveries throughout history. By making detailed observations, employing all five senses, staying objective, comparing results, repeating experiments, and verifying findings with others, scientists use observation as a powerful tool to advance their understanding of the world. Events like IOMN not only encourage engagement with space but also help individuals indirectly refine their observational skills.

On the night,17 September, 2024, under clear skies, around 25 participants joined the club members from 8.30 PM to 10.00 PM to observe the Moon. The following evening, 18 September, a full moon illuminated the sky from 7.30 PM to 10.00 PM, drawing an even larger crowd of 75 participants. Many participants captured photos of the Moon, and the event concluded with a group photo of the club members. This two-night event was a great success, with live Moon-watching sessions providing unique opportunities for exploration.

For many participants, it was their first time viewing the Moon through a telescope, and they were in awe of its beauty. Some captured pictures of the Moon both with and without the use of a telescope, while others learned to use star-tracking apps to locate celestial bodies like stars, planets, and the Moon. Whether through telescopes, apps, or simply with the naked eye, the experience of observing the Moon was fascinating for everyone.
IOMN offers a rare opportunity to directly engage with the Moon, allowing participants to observe its craters, mountains, and other surface features up close.

This hands-on experience often sparks curiosity and prompts questions about the Moon's formation, its relationship with Earth, and its role in the solar system. The event encourages participants to think beyond their immediate observations, inspiring them to explore topics such as lunar geology, the phases of the Moon, its influence on tides, and the potential for future lunar exploration. By fostering a sense of wonder, IOMN ignites deeper scientific inquiry and encourages critical thinking.

Webinar on The Impact of OERs on the Professional Development of STEM Teachers: A case of Bhutanese Physics Teachers

Submitted by
Ugyen Pem
Karma Utha (PhD)

On 29th August 2024, physics educators from Samtse College of Education hosted a webinar titled "The Impact of OERs on the Professional Development of STEM Teachers: A Case of Bhutanese Physics Teachers." The event was attended by 35 school physics teachers from various schools, along with a curriculum officer from the Ministry of Education and Skills Development. The webinar was part of the Connected Learning for STEM (CL4STEM) project, which aims to build the capacity of secondary STEM teachers using Open Educational Resources (OERs). This project is funded by the International Development Research Centre (IDRC), Canada, through the Global Partnership for Education Knowledge and Innovation Exchange (GPE-KIX).

The OERs focused on three modules: 'Force and Motion,' 'Work, Energy, and Power,' and 'Electromagnetism.' These resources were designed for physics teachers in seven schools under Samtse Dzongkhag. Over five months, 20 teachers participated, including five in-service teachers, five newly qualified teachers (NQTs) with less than five years of experience, and 10 pre-service teachers on field practicum. The OERs aimed to enhance teachers' Subject Matter Knowledge (SMK), Pedagogical Content Knowledge (PCK), and

General Pedagogical Knowledge (GPK).

Dr. Karma Utha opened the session, welcoming the participants and introducing the background of the impact study conducted by the physics educators. Ms. Ugyen Pem then presented the study's key findings, focusing on the impacts of OERs in three main areas:

i. Knowledge and Professional Practice

The OERs contributed to content enrichment and positively impacted teaching practices, particularly in:

- Activity-based learning
- Technology integration
- Incorporation of Universal Design for Learning (UDL) principles and Design Thinking

Overall, OERs enhanced professional practices and improved teacher engagement with students.

ii. Classroom Teaching Practices

In Subject Matter Knowledge (SMK), 75% of teacher participants demonstrated a strong understanding, with a few showing an accomplished level of mastery. However, 25% required further development in SMK.

In Pedagogical Content Knowledge (PCK), 61% of participants showed a very good understanding of pedagogical strategies, while 39% needed support in this area.

In General Pedagogical Knowledge (GPK), 68% of participants demonstrated a strong understanding, with a few at an accomplished level. However, 32% required further enhancement in GPK.

Overall, participants developed a good understanding of SMK, PCK, and GPK, which should positively influence their teaching effectiveness. A small percentage, with accomplished levels in these areas, could potentially serve as mentors to support their colleagues. However, 25% to 39% of teachers, primarily pre-service and newly qualified, needed additional support, particularly in the modules "Work, Energy and Power" and "Electromagnetism."

Time management was identified as a major challenge, with pre-service teachers particularly noting that field practicum and school mandates left them with limited time to engage with the OERs.

iii. Community of Practice (CoP)

The CoP effectively encouraged both social and situated learning. Participants appreciated the CoP for clarifying doubts and sharing best practices, with most discussions focusing on communication and administrative issues. However, teacher participants tended to stay on the periphery, engaging mainly with teacher educators through personal chat. Teacher educators had to actively encourage more involvement within the CoP.

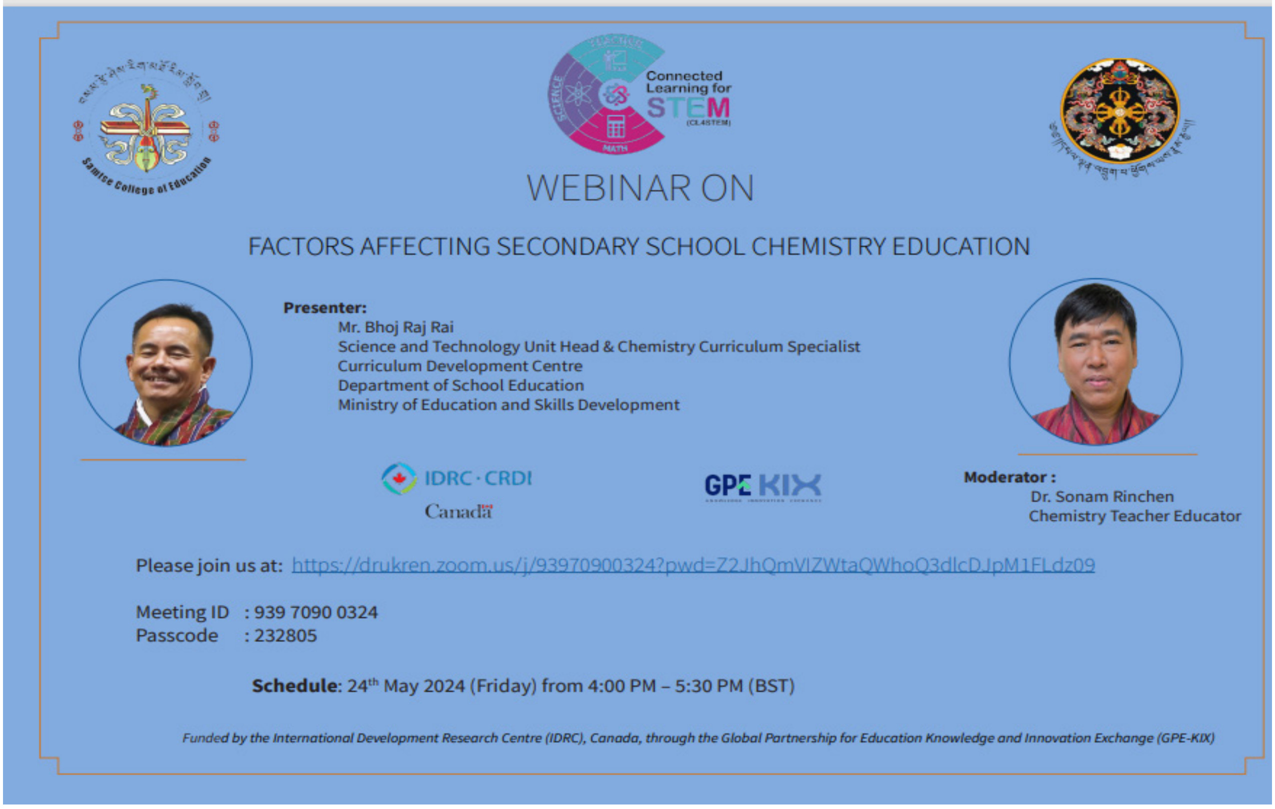
Following the presentation, a Q&A session was held, where Dr. Karma Utha addressed questions about the past, present, and future of OERs for STEM teachers' professional development. A key question concerned the time commitment required. Dr. Karma explained that the three OERs are currently offered sequentially, with participants expected to complete them within a set timeframe. However, future iterations may offer more flexible timing options.

In conclusion, Dr. Karma expressed gratitude on behalf of the physics teacher educators and the CL4STEM project team for the attendees' active participation.

The webinar was well-received, with participants engaging throughout the session. Feedback highlighted the value of the content and the expertise of the speakers, with many expressing interest in future events.

Webinar on Factors Affecting Secondary School Chemistry Education

Submitted by
Sonam Rinchen (PhD)



As part of the ongoing CL4STEM project, the Chemistry Group of Samtse College of Education (SCE) hosted an enlightening webinar on the factors affecting secondary school chemistry education on May 24, 2024. The event was attended by chemistry teachers from various schools, chemistry teacher educators, and secondary preservice chemistry teachers from SCE. Mr. Bhoj Raj Rai, Science and Technology Unit Head and Chemistry Curriculum Specialist serving in the Ministry of Education and Skills Development (MOESD), resourced the webinar.

Mr. Rai's presentation focused on the challenges associated with teaching and learning chemistry in schools, drawn from his extensive experience visiting schools and interacting with teachers and students. He identified several key challenges, including:

- Chemistry being taught as an abstract concept
- Lack of mathematical and technical skills among students
- Insufficient prior knowledge
- Low levels of motivation and engagement
- Inadequate assessment practices
- Limited teacher preparation resources

The presentation was well received both by the teachers and lecturers, who found it to be full of insights and highly educational especially the practical strategies suggested by Mr. Rai.

Mr. Rai recommended several strategies to make the teaching and learning of chemistry more enjoyable and effective:

1. Relate Chemistry to Real-Life Examples and Applications
2. Contextualize Teaching by connecting with the students' experiences and environments.
3. Consistent Use of Technical Vocabulary
4. Develop Laboratory Skills

5. Connect Theory to Practice
6. Use Differentiated Instruction
7. Scaffold Learning
8. Activate Students' Prior Knowledge
9. Use Formative Assessment to monitor and support student learning.

The participants from the schools expressed that the webinar not only highlighted the challenges in teaching chemistry but also equipped teachers with a host of strategies to enhance their teaching practices. The insights gained from the webinar are expected to significantly benefit the participants in their efforts to improve chemistry education in their respective schools.

MEASURING TEMPERATURE AND HUMIDITY USING ARDUINO

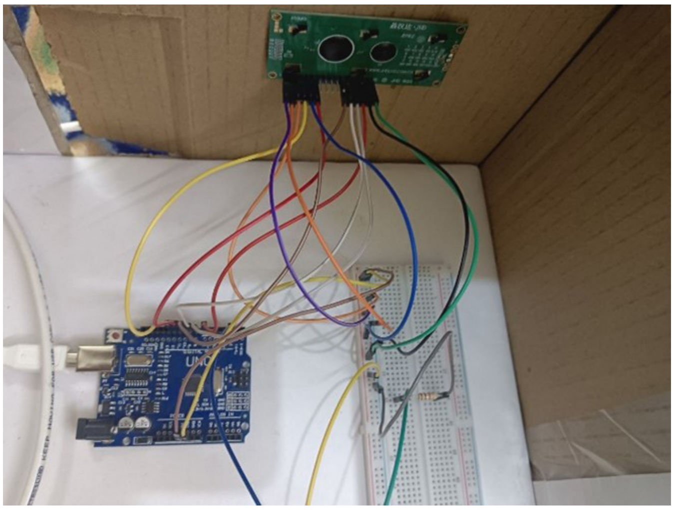
Submitted by
Chhimi Seldon
Dorji Lhazom
Suzal Gurung
Kelzang Choden
Pabitra Yakha
Sherab Wangdi
Kunezang Choki
Tenzin Peldon
Tenzin Phuntsho
Sonam Zangmo
Pema Rinchen
Karma Utha (Tutor)

Introduction

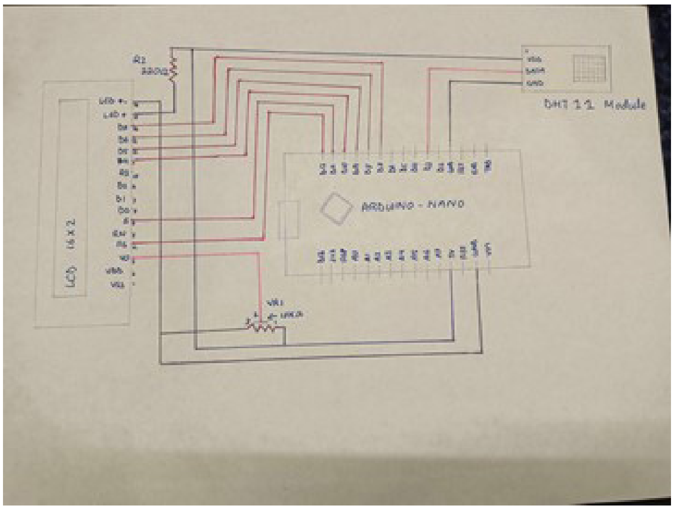
Monitoring environmental conditions is essential in fields like agriculture, climate control, and healthcare. This project leverages an Arduino microcontroller and a DHT11 sensor to create a cost-effective solution for real-time temperature and humidity monitoring. Accurate data from this system is vital for optimising agricultural productivity, enhancing building energy efficiency, improving comfort, and ensuring patient safety in healthcare settings. The project highlights how accessible environmental monitoring technology can positively impact various industries.

Real-world applications of this system include automating irrigation and climate control in agriculture, improving HVAC systems for better energy efficiency, and monitoring indoor air quality to prevent moisture-related issues like mould.

This simple yet effective Arduino-based solution demonstrates the practical value of technology in solving everyday challenges and improving operational outcomes.



Circuit Diagram



Materials Used

Arduino IDE: Software to write, upload, and monitor code.
DHT Sensor Library: Necessary library to retrieve data from the DHT sensor.
Arduino Board (Uno)
DHT11 Sensor
10KΩ, 220 Ω Resistors
Breadboard
Jumper Wires
I2C LCD Display (16x2)

We assembled the circuit by placing the DHT11 sensor on a breadboard. We connected the sensor's VCC pin to the 5V pin on the Arduino for power. Next, we linked the data pin of the DHT11 to digital pin 2 on the Arduino. To stabilise the data flow, we added a 10KΩ pull-up resistor between the VCC and data pins and connected the sensor's GND pin to the Arduino's GND pin.

Once the circuit was set up, we opened the Arduino IDE to write the code. We imported the DHT sensor library to enable communication between the sensor and the Arduino. We then defined the DHT11 sensor type and specified the data pin in the code. We wrote the program to read the temperature and humidity values from the sensor and display them either on the Serial Monitor or an LCD. After writing the code, we uploaded it to the Arduino board by clicking the "Upload" button in the IDE. To test the setup, we opened the Serial Monitor to check the real-time temperature and humidity readings. We verified that the sensor was functioning correctly by checking the displayed values or ensuring the LCD showed the correct data.

The circuit, assembled on a breadboard, allowed us to easily test and adjust the system for real-time environmental data collection. Using the DHT11 sensor, the Arduino microcontroller processed the data and displayed it on either the LCD screen or the Serial Monitor.

The DHT11 sensor has three essential connections:

- **Pin 1 (VCC):** We connected this pin to the 5V pin on the Arduino for power.
- **Pin 2 (Data):** We linked this pin to digital pin 2 on the Arduino for data transmission, stabilised by a 10KΩ pull-up resistor.
- **Pin 4 (GND):** We connected this pin to the GND pin on the Arduino.

We integrated an LCD display with the Arduino to visually present the temperature and humidity values. By using the I2C interface, we simplified the wiring process, requiring only two communication lines (SDA and SCL). A 220Ω resistor was used to control the backlight brightness of the LCD and prevent overheating. The Arduino code was set up to display the environmental data in an easy-to-read format.

Results

The project successfully demonstrated the ability to monitor and display real-time temperature and humidity data using the DHT11 sensor and

Arduino microcontroller. The sensor provided accurate readings, which were displayed on the Serial Monitor and an LCD screen, confirming the system's functionality.

Conclusion

This Arduino-based environmental monitoring system effectively showcases how accessible technology can be applied in various fields, such as agriculture, HVAC, and indoor air quality management. By enabling real-time data collection, it supports informed decision-making and enhances efficiency, demonstrating the practical benefits of microcontroller-based solutions.

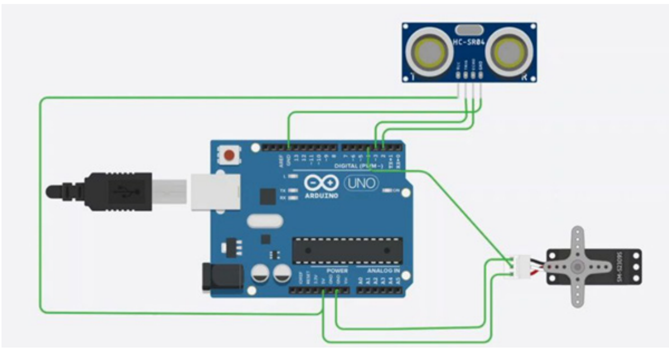
Smart Dustbin Using Arduino and Ultrasonic Sensor

Submitted by
Chimi Wangmo
Dechen Tshomo
Dorji Choden
Jigme Wangchuk
Nima Tashi
Passang Dema
Sangay Choden
Sonam Dechen
Tashi Lhamo
Tshering Pem
Tenzin Choden
Ugyen Pem (Tutor)

Introduction

In today's world, waste management is becoming a growing concern, especially in urban areas. A smart dustbin, equipped with an automatic lid that opens and close. By eliminating the need for users to touch the bin, it helps reduce the spread of germs, especially in high-traffic areas. It’s also a step towards creating smarter, more sustainable environments, where technology helps people manage everyday tasks more effectively. This project involves building a prototype smart dustbin using an Arduino UNO, a servo motor, and an ultrasonic sensor to create an automatic waste disposal system.

Circuit Diagram



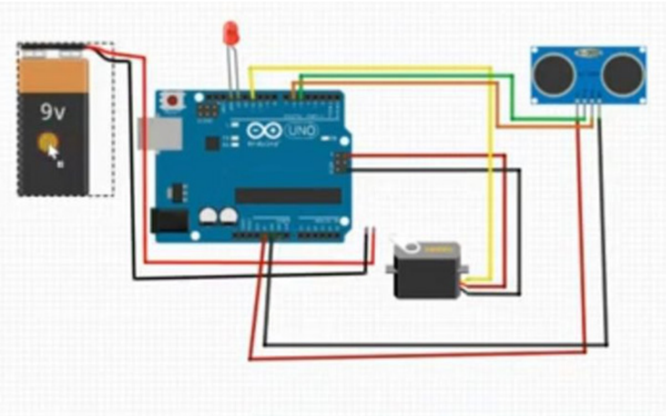


Figure: Circuit Diagram (source: https://www.youtube.com/watch?v=7UStiMiKlTI)

Materials Used

- Arduino UNO
- Ultrasonic Sensor (HC-SR04)
- Servo Motor
- USB Cable
- Jumper Wires
- Double Battery Holder with DC Power Jack and Switch
- Lithium-Ion Cell
- Dustbin

Procedure

To set up the components, we connected the ultrasonic sensor to the Arduino for both power and data transmission. We also connected the servo motor to the Arduino to control the movement of the dustbin lid.

Next, we used the Arduino software to write a program that instructs the ultrasonic sensor to check for nearby objects. The program was designed so that if an object was detected within 20 cm, it would signal the servo motor to open the lid and then close it again after one second.

Once the code was ready, we connected the Arduino to our computer with a USB cable and uploaded the program to the board.

For powering the system, we used a double battery holder with a lithium-ion cell and turned the system on using a switch.

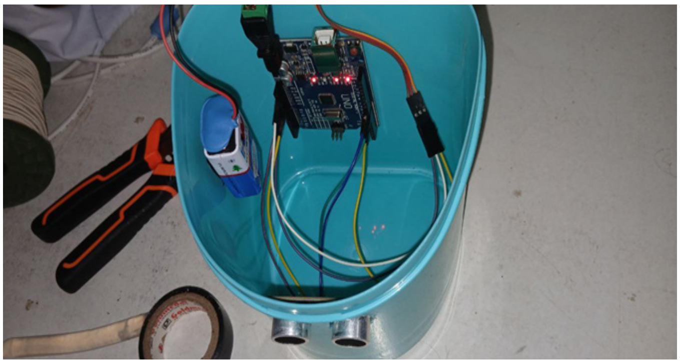
To test the system, we placed an object in front of the ultrasonic sensor to simulate waste. When the object was detected within the set range, the servo motor activated and opened the dustbin lid automatically.

Result

The smart dustbin system works by using an ultrasonic sensor to detect the presence of objects (waste) to be discarded. When the sensor detects an object, it sends a signal to the Arduino UNO, which then activates the servo motor to open the dustbin lid. This system promotes hygiene, helps maintain cleanliness, and reduces the environmental impact of manual waste disposal in parks, shopping malls, and hospitals.

Summary

In summary, this project is a small but impactful step toward improving how we manage waste, contributing to cleaner and more hygienic surroundings, while also integrating technology into everyday life. In the future, this prototype design can be improved by adding features to check how full the bin is and alert users when it needs emptying.



Future Eco-Smart Power System

Submitted by:
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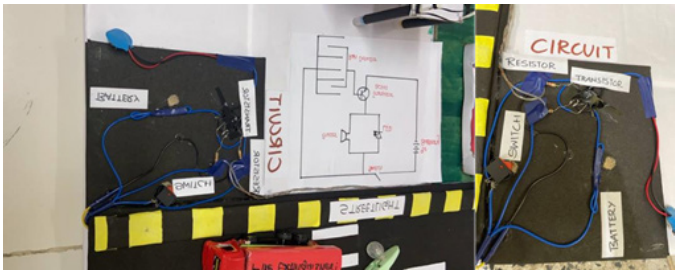
Introduction.
The Future Eco-Smart Power System combines a windmill-powered street light with a manually operated rain detector, offering a sustainable off-grid lighting solution tailored for home use.

Designed for areas like Samtse Dzongkhag, where wind levels are moderate, this project highlights the potential of renewable energy despite limited wind resources. The manually operated rain detector enhances the system's versatility, allowing users to switch off the light during rainfall or when additional lighting is unnecessary, thereby conserving energy. Its straightforward design, devoid of complex sensors, makes it accessible for households that seek practical energy solutions without advanced technology. Ultimately, the Eco-Smart Power System serves as a model for sustainable lighting in rural and semi-urban communities, promoting energy efficiency, self-sufficiency, and environmental awareness through the integration of traditional renewable energy and user-friendly controls.

Circuit Diagrams



Materials Used

For circuit:
1. Resistors: 1k ohm (2pieces)
2. Transistors: BC547 (2 pieces),
2N2222A (1 piece)
3. Capacitor: 100μ (2pieces)
4. LEDs: any colors (5 to 6 pieces)
5. Wires
6. Switch: 3 pieces
7. Buzzer: 1to 2 pieces
8. Battery: 9V (3 pieces)
9. DC- motor: 1 piece

For model making:

1. Cartoons
2. Glue gun
3. Super glue

Procedure

1. Street Light Circuit and Wind mill

To begin assembling the circuit, we connected the base of the 2N2222A transistor to an 11kΩ resistor, and its collector to the emitter of the BC547 transistor. We then connected the emitter of the 2N2222A transistor to a second 1kΩ resistor, which we attached to the positive terminal of the switch, battery, and LED. The resistor connected to the base of the 2N2222A was linked to the negative terminal of the switch and battery.

Next, we connected the negative terminal of the LEDs to the collector of the BC547 transistor. The positive terminals of the LEDs were connected to one terminal of the DC motor, the positive terminal of the capacitor, and the switch. The negative terminals of the LEDs were then connected to the other terminal of the DC motor, and from there to the switch. Finally, we connected the positive terminal of the street light to the positive terminal of the DC motor, and the negative terminal of the street light to the negative terminal of the DC motor, completing the circuit.

2. Rain Detector Circuit

We started by securing the blade to an ice cream stick, allowing it to act as a sensor when water falls on it. We then connected the blade to the base of the transistor to trigger the switching mechanism when it comes into contact with water. The emitter of the transistor was connected to the ground (negative terminal) of the battery, while the collector was linked to one terminal of the buzzer. The other terminal of the buzzer was connected to the positive terminal of the battery.

To control the power flow, we placed a switch in the circuit, allowing us to turn it on or off as needed. We then tested the circuit by dripping water onto the blade. If the buzzer sounded, we confirmed that the circuit was complete and functioning correctly. Finally, we secured all connections to ensure stability and reliability of the setup.

Working

Street Light Circuit and Windmill:

The street light circuit, powered by a DC motor acting as a windmill generator, functioned effectively. When the DC motor was manually activated, it generated sufficient power to light up the connected LEDs, demonstrating the circuit's capability to harness wind energy for lighting. The 2N2222A and BC547 transistors managed the switching mechanism, controlling the flow of current to the LEDs. The capacitor provided stable power storage, ensuring the LEDs remained illuminated briefly even when the wind source was paused. Additionally, the street light circuit continued to operate as designed when connected to a backup power source, ensuring consistent lighting during periods of insufficient wind.

Rain Detector Circuit:

The rain detector circuit responded accurately to water contact. When water was applied to the blade attached to the ice cream stick, it acted as a trigger for the BC547 transistor, activating the buzzer. This manual rain detection mechanism worked as expected, producing an audible alert whenever moisture was detected on the sensor and particularly helpful for people with disabilities or mobility challenges by alerting them to rain conditions, making it easier to take precautions without needing to check the weather visually or step outside. The switch in the circuit allowed for easy control over the power flow, adding convenience for user operation. All connections remained stable, and the circuit consistently produced reliable alerts during testing.

Results

Street Light Circuit and Windmill.

The street light circuit operated effectively, powered by a DC motor acting as a windmill generator. Manual activation of the motor generated sufficient power to illuminate the connected LEDs, showcasing the circuit's ability to harness wind energy. The 2N2222A and BC547 transistors managed current flow, while the capacitor ensured stable power, keeping the LEDs lit briefly even during wind interruptions. The circuit also functioned well with a backup power source, providing consistent lighting.

Rain Detector Circuit.

The rain detector circuit reliably responded to moisture contact. When water fell on the blade attached to an ice cream stick, it triggered the BC547 transistor, activating the buzzer to provide an audible alert. The switch allowed for easy control over the power flow.

All connections remained stable, and the circuit consistently delivered accurate alerts during testing.

Summary

Street Light Circuit.

Powered by a DC motor serving as a windmill generator, the circuit illuminated LEDs effectively when manually activated. The 2N2222A and BC547 transistors controlled current flow, while a capacitor provided stable power, allowing the LEDs to remain lit briefly during wind interruptions. The circuit also maintained functionality with a backup power source.

Rain Detector Circuit.

This circuit featured a blade sensor attached to an ice cream stick, which triggered a buzzer when it detected moisture. The system included a switch for easy power control, and all connections remained stable during testing.

LED Dice: Create a digital dice that displays a random number of dots (LEDs)

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Introduction

Ever thought about creating a digital version of a dice? In an era where technology integrates seamlessly with traditional tools, creating digital dice bridges the gap between classic games and modern innovation. This project focuses on building a digital LED dice using an Arduino microcontroller, a versatile tool for prototyping electronic devices. The LED dice simulates a traditional dice by lighting up a random number of LEDs, representing numbers from 1 to 6, when a button is pressed.

The significance of this project lies in bridging theoretical concepts with practical applications. It demonstrates the use of microcontrollers, programming, and electronic components to create an interactive device. Such projects enhance technical skills and deepen understanding of randomness, logic implementation, and circuit design. Potential applications include game development, educational tools, and smart device prototypes.

Circuit Diagram

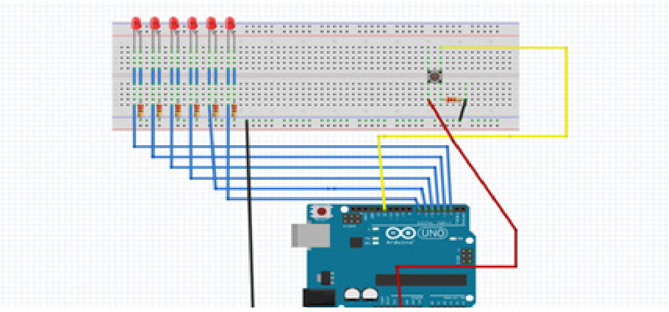

Figure 1: *LED dice circuit diagram*

Source: https://youtu.be/Qtt5dE4TtE8

Materials Used

The following components were used:

- Arduino Uno
- Six LEDs
- Six current-limiting resistors (220Ω–330Ω)
- Push button
- 10kΩ pull-up resistor (to stabilize button input)
- Breadboard and jumper wires

Procedure

To set up the breadboard, we placed the Arduino board near the breadboard for easy connections. We inserted six LEDs into the breadboard, spacing them apart for clarity. Then, we added resistors (220Ω–330Ω) in series with the anodes (longer legs) of each LED.

Next, we connected the six LEDs to digital pins 2 through 7 on the Arduino:

- Pin 2 → LED 1
- Pin 3 → LED 2
- Pin 4 → LED 3
- Pin 5 → LED 4
- Pin 6 → LED 5
- Pin 7 → LED 6

We then connected the cathodes (shorter legs) of the LEDs to ground (GND).

For connecting the button, we attached one side of the push button to digital pin 12 and the other side to ground (GND). We used a 10kΩ pull-up resistor between pin 12 and the positive voltage (VCC).

Once the components were set up, we connected the Arduino to our computer via USB. Using the Arduino IDE, we uploaded the code to enable the dice functionality. The key functions in the code included:

- buildUpTension(): This function simulates the dice "shaking" by sequentially lighting up the LEDs.
- showNumber(): This function lights up the LEDs to represent the dice roll result.

Finally, we verified the circuit connections and pressed the button to ensure the dice rolled properly, with the correct number of LEDs lighting up. If there were any issues, we debugged and adjusted the system as needed.

Working

Pressing the button triggers the buildUpTension() function, creating a rolling effect by sequentially lighting up the LEDs. The Arduino generates a random number (1–6) using the random() function. The showNumber() function then lights up the corresponding number of LEDs to display the dice roll result. The pull-up resistor stabilizes the button signal, avoiding floating inputs when the button is idle.

Result

The LED dice worked as intended:

- Pressing the button triggered the rolling effect, followed by a random display of LEDs representing numbers 1–6.
- Multiple trials confirmed its reliability with no significant errors observed.

Observation:

Figure 2: *Process and function of LED dice*

Summary

This project combined hardware and software to simulate a dice using an Arduino. It offered insights into:

- The importance of circuit design and stabilization using pull-up resistors.
- Effective use of randomness and sequential lighting.
- Code optimization to ensure smooth functionality.

Future Enhancements:

- Replace the button with a motion sensor to enable dice rolls when shaken.
- Add features such as sound effects or multiple dice displays for greater engagement.

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Designing Biology Lessons to Leverage Pedagogical Content Knowledge (PCK)

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Introduction

Pedagogy is the cornerstone of effective teaching and learning, transcending mere instructional actions to encompass the holistic approach to education. It emphasizes the interconnectedness between teaching and learning processes, extending beyond the classroom setting to encompass how we conceptualize, discuss and organize educational activities. At its core, pedagogy underscores the importance of merging subject matter expertise with pedagogical content knowledge. While mastery of content is crucial, it's equally vital for educators to possess the skills to effectively convey this knowledge to learners (Shulman, 1986).

The fusion of content and pedagogical knowledge is imperative for fostering meaningful and impactful learning experiences. Educators must adeptly blend these two elements, leveraging their understanding of both subject matter and effective teaching methodologies. By doing so, they can facilitate engaging and transformative learning environments where students can thrive. Ultimately, successful teaching hinges on the seamless integration of content expertise and pedagogical insight, ensuring that educational objectives are met and learners are empowered to reach their full potential (Shulman, 1987).

Beetham and Sharpe (2013) stated that the transformation of post-compulsory education can be achieved through a reconsideration of pedagogical practices, particularly in the context of rich electronic and mobile technologies. They assert that despite criticisms, the term "pedagogy" remains relevant as it encompasses the essential guidance needed for learning, which is not limited to childhood. Furthermore, they emphasize the essential dialogue between teaching and learning, reclaiming the idea of teaching from negative associations. Pedagogy, they argue, involves both ways of doing and ways of knowing, emphasizing the need for a dialogue between theory and practice. They advocate for a rethinking and redoing of pedagogy, aligning theoretical arguments with real-life examples of practice and providing practical tools for teachers to translate ideas into thoughtful practices for the future.

According to Shulman (1986) Pedagogical Content Knowledge (PCK) refers to the unique knowledge of teaching possessed by teachers, blending pedagogy and subject content knowledge. He describes the importance of teachers' knowledge of subject matter, students, and pedagogy in making the subject matter understandable. PCK encompasses the essential content topics and effective forms of representation within a subject area. It also includes impactful analogies, illustrations, examples, explanations, and demonstrations. Shulman's PCK conception consists of two main elements: how teachers represent the content knowledge and their knowledge about the difficulties faced by students while learning a particular topic in the content.

PCK is a multifaceted and interconnected concept, frequently intersecting with various other knowledge realms like subject matter expertise, curriculum understanding, pedagogical insights, and comprehension of students (Magnusson et al., 2006). The amalgamation of these domains is crucial for successful science instruction, enabling educators to adapt content knowledge to cater to the diverse capabilities and backgrounds of learners. Mishra and Koehler (2006) suggested a fresh type of PCK, known as Technological Pedagogical Content Knowledge (TPCK), highlighting the significance of educators' competencies in utilizing technology proficiently within their teaching methodologies.

Leveraging PCK in Biology

Leveraging pedagogical content knowledge (PCK) in biology education involves integrating deep understanding of both biology content and effective teaching strategies. PCK in biology requires a strong grasp of the subject matter, including core concepts, principles and current research wherein teachers need to deeply understand the content they are teaching to effectively convey it to students. In the context of biology, PCK includes knowledge about students' conceptions and preconceptions, and the knowledge about strategies to overcome them (Fischer et al.,2021).

According to Shing & Mohd (2015), the concept of Pedagogical Content Knowing (PCK) emphasizes the importance of teachers's understanding of their students as a central role in teaching. Effective biology educators must understand the common misconceptions and learning difficulties students face in learning biological concepts. By recognizing these challenges, teachers can develop targeted instructional strategies to address them. PCK also involves designing learning experiences that are engaging, relevant and effective in facilitating student learning. This may include incorporating hands-on activities, real-world examples and technology to enhance understanding.

According to Fischer et al., 2021, research on biology teachers' professional knowledge has shown that CK (content knowledge) is an important prerequisite for effective teaching, but CK alone is not sufficient to enable teachers to perform diagnostic activities that lead to adaptive teaching and interventions in learning. Teachers with strong PCK recognize that students have diverse learning needs and abilities. They tailor their instruction to accommodate these differences, providing multiple entry points and scaffolding as needed to support all learners.

Assessments in biology should align with both content objectives and pedagogical approaches. Teachers with PCK design assessments that accurately measure student understanding while also providing opportunities for reflection and growth. Incorporating technology effectively into biology instruction requires pedagogical knowledge to ensure that technology enhances learning rather than distracts from it. Teachers with strong PCK select appropriate digital tools and resources to support and enhance biology instruction.

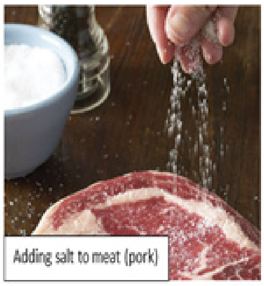
Finally, leveraging PCK in biology education requires a commitment to lifelong learning and professional development. Teachers stay abreast of current research, pedagogical trends, and advancements in biology to continually improve their practice and support student learning.

The following are examples of selected topics in biology leveraging PCK:

1. Activation of prior knowledge

While teaching on the topic ‘Osmosis for 12th grade, one may employ the following visuals of real-life experiences (shrivelling of fingers when exposed to water for longer period, adding salt to meat, pickles, vegetables, cheese, dead bodies, sprinkling salt to leeches) to prompt recall of osmosis-related practical experiences, relevance and application of osmosis in everyday situations. This will help learners to make connections between what they already know and what they are learning, enhancing comprehension and retention by making learning more meaningful and relevant to students’ existing experiences and understanding.

Shrivelled finger



Adding salt to meat (pork)

Adding salt to leeches

Adding salt to cheese

Adding salt to vegetables

Gargling with salt water to reduce sore throat

2. Demonstration

While teaching the topic Transpiration for class XI students, teacher may demonstrate using the example cited below;

1. Place a plastic bag over a potted plant and secure it with a rubber band. Leave it for a few minutes and observe condensation inside the bag to demonstrate transpiration.

2. Let the students watch a video using the ink provided below to understand transpiration and factors affecting transpiration and ask questions to students. https://youtu.be/5jJLfwTkGe8.

3. Demonstrate the rate of transpiration and let them perform in groups.


3. Analogies

Using analogies will help to relate reflexes to familiar concepts. It will act like a bridge between known concepts and new information, making it easier for students to grasp abstract or complex ideas. They help in transferring understanding from familiar contexts to the new topic.

For example:

1. During the start of the lesson, I will call one student in the front and I will pretend to hit the student in the eye. The student will quickly close or blink the eyes as a reflex action. This activity can serve as an analogy before starting the lesson.

2. Pulling our hands away immediately after touching a hot or cold object is a classic example of a reflex action.

4. Simulations

Explore and learn more about monocot and dicot stems and roots by using the following link. *https://amrita.olabs.edu.in/?sub=79&brch=17&sim=192&cnt=1*

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THE POWER OF CODING

Submitted by Duptho Wangmo
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In today's digital age, coding stands as the cornerstone of innovation, driving advancements across all sectors of society. From powering smartphones to managing complex databases, the impact of coding is ubiquitous, shaping the way we live, work, and interact.

At its essence, coding is the language of computers, enabling humans to communicate with machines through a series of instructions. However, its significance transcends mere syntax; coding fosters problem-solving skills, logical thinking, and creativity, making it a fundamental skill in the STEM landscape.

One of the most fascinating aspects of coding lies in its ability to transform abstract ideas into tangible solutions. Take, for example, the development of algorithms – sets of instructions designed to perform specific tasks. Whether it's sorting data, predicting outcomes, or optimising processes, algorithms form the backbone of countless technologies, driving efficiency and innovation across industries.

Furthermore, the world of coding is constantly evolving, with new languages, frameworks, and tools emerging at a rapid pace. From Python and Java to machine learning and blockchain, staying abreast of these advancements is crucial for aspiring coders and seasoned professionals alike.
Moreover, the interdisciplinary nature of coding fosters collaboration and innovation across STEM fields. By integrating coding principles with disciplines such as biology, physics, and engineering, researchers can leverage computational techniques to tackle complex challenges, from genetic sequencing to climate modeling.

In essence, coding is not merely a technical skill but a catalyst for creativity, problem-solving, and societal impact. As we navigate the digital frontier, embracing coding as a cornerstone of STEM education and innovation is paramount, empowering individuals to unlock the full potential of technology and drive positive change in the world.

In conclusion, the power of coding extends far beyond the confines of computer screens and lines of code. It represents a gateway to innovation, a tool for problem-solving, and a language of the future. By embracing coding as a fundamental pillar of STEM education and research, we can harness its transformative potential to shape a brighter, more technologically empowered tomorrow.

Determining the Alcohol Percentage in Local Ara using Spectrophotometric Analysis

Lham Tshering
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Chimi Zam
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Ms. Kezang Choden

Background

Bhutan has a rich tradition of brewing local alcoholic beverages, which plays an integral part in the country's cultural and social life. Some of the notable Bhutanese local alcoholic drinks are ara, bangchang, singchang, and changkhae.

Ara is one of the most popular and widely consumed alcoholic drinks in Bhutan. It's a traditional spirit distilled from various grains such as rice, maize, millet, and wheat. The process of making ara involves fermentation of the grains followed by distillation. It can be consumed in different forms – plain, cold, warmed, or heated with fried eggs. Ara is often served during religious ceremonies, festivals, and social gatherings.

Ara being such a popular drink in the society, it is important to know its alcohol percentage from different sources. There are very limited published studies that determined the concentration or percentage of alcohol in ara. People speculate the concentration to be anywhere between 14 – 50% depending on various factors such as the type of grain used, fermentation time, distillation process, and whether it is home-brewed or commercially produced.

Spectrophotometric Analysis of Alcohol Percentage in Ara

Spectrophotometry is an essential analytical technique widely used for determining the concentration of substances within solutions, including the alcohol percentage in beverages and other samples. This method's popularity is due to its accuracy, efficiency, and non-destructive nature. It is based on the principle that different compounds absorb light at specific wavelengths and percent absorbance correlates to the concentration of the compound. Present a picture of a spectrophotometer

Visible spectrophotometry typically involves colorimetric methods where ethanol reacts with specific reagents to produce a color change. One common approach is the dichromate method, where ethanol is oxidized by potassium dichromate in acidic conditions, resulting in a measurable color change from orange to green. The orange color is due to the chromate ion (Cr2O72-) in the reactant and the green color is caused by the chromium (III) ions (Cr3+) in the product.

3C2H5OH + 8H2SO4 + 2K2Cr2O7 → 3C2H5OH + 2Cr2(SO4)3 + 11H2O + K2SO4

The green color shows peak absorption at 595 nm as has been mentioned in several studies and this method has been effectively used to quantify ethanol in beverages, showing reliable results (Sriariyanun et al., 2012).

Primary Objective

To determine the alcohol percentage in traditional Bhutanese ara, spectrophotometric analysis was used, employing the dichromate method.

Materials

- Traditionally prepared local ara samples from three different sources
- Potassium dichromate ($K_2Cr_2O_7$)
- Spectrophotometer
- Concentrated sulphuric acid (H_2SO_4)
- Distilled water
- 99.9% v/v ethanol

Methods

Preparation of Dichromate Reagent

The dichromate reagent was prepared by dissolving 8 g of potassium dichromate ($K_2Cr_2O_7$) in 40 mL of distilled water. To this solution, 54 mL of concentrated sulphuric acid (H_2SO_4) was added slowly to create an acidic environment. Subsequently, 6 mL of distilled water was added to adjust the total volume to 100 mL. The reagent was then allowed to cool to room temperature before use.

Calibration Curve Preparation

1. The absorbance of the dichromate reagent was measured and recorded as the blank.

2. Ethanol solutions of varying concentrations (6.25%, 12.5%, 16.67% and 25% v/v) were prepared by diluting 99.9% v/v ethanol with distilled water.

3. For each ethanol concentration, 3 mL of the ethanol solution was mixed with 3 mL of the dichromate reagent. The mixture was thoroughly mixed for 10 minutes.

4. The resulting solution was transferred to a cuvette, and its absorbance was measured using the spectrophotometer.

5. Steps 3 and 4 were repeated for each ethanol concentration.

6. A calibration curve was constructed by plotting absorbance against the corresponding alcohol percentage.

Sample Preparation and Spectrophotometric Analysis

1. For each ara sample, 3 mL of the sample was mixed with 3 mL of the dichromate reagent. The mixture was thoroughly mixed for 10 minutes.

2. The solution was transferred to a cuvette, and its absorbance was measured using the spectrophotometer.

3. Steps 1 and 2 were repeated three times for each ara sample to ensure accuracy and reproducibility.

4. The absorbance values obtained were used to determine the alcohol percentage in the ara samples by referencing the previously constructed calibration curve.

Figure 1
The researchers: from left Dechen Wangmo, Sonam Choden, Lham Tshering, and Chimi Zam

Results and Discussion

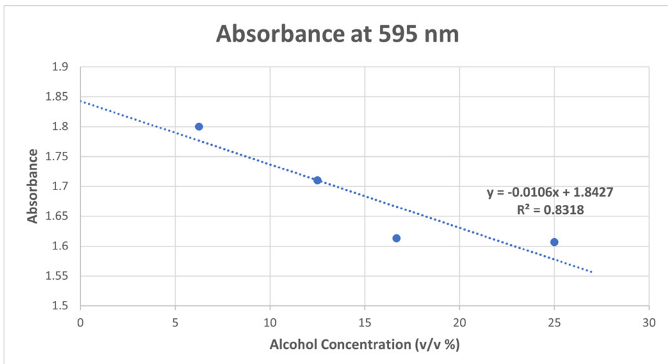
After measuring the absorbance of the standard concentrations, recorded in Table 1 as follows:

Table 1: Absorbance for Calibration Curve

Alcohol Concentration (% v/v) (x)	Absorbance (595 nm) (y)
6.25	1.8
12.5	1.71
16.67	1.613
25	1.607

Using the absorbance data from Table 1, a graph was plotted on alcohol concentration (x) vs absorbance (y) curve as shown in Graph 1.

Graph 1: Calibration Curve



From the calibration curve, the equation for the line of best fit was determined:
y = -0.0106x + 1.8427 ………… (Equation 1)

….. where y is the absorbance at 595 nm and x the alcohol concentration.
The R^2 value of 0.8318 for the line of best fit of the calibration curve means that the line of best fit shows a strong positive correlation between the independent and the dependent variables.
Rearranging Eqn. 1 to determine concentration from the measure absorbance:
x = (y-1.8427)/ (-0.0106) ………… (Equation 2)

After measuring the absorbances of the ara samples, data were recorded in Table 2.

Table 2: Average Absorbances of the Ara Samples

Ara Sample	First Replicate	Second Replicate	Third Repli cate	Average absorb ance
1	1.557	1.540	1.556	1.551
2	1.587	1.584	1.614	1.595
3	1.613	1.653	1.615	1.627

Using the respective measure average absorbances from Table 2 and Equation 2, finally determined the %v/v concentrative of each of the ara samples as carried out in Table 3.

Table 3: %v/v Alcohol Concentrations of the ara samples

Ara Sample	Average absorbance	Concentration (%v/v)
1	1.551	27.491
2	1.595	23.340
3	1.627	20.349

The %v/v concentrations of ara samples 1, 2 and 3 were 27.491%, 23.340% and 20.349% v/v respectively.

Future Implication

The findings from this study on the alcohol content in traditional Bhutanese ara have significant future implications.

Utilizing spectrophotometric analysis provides a reliable method for assessing alcohol levels, essential for quality control and consumer safety. This approach can be applied to other traditional beverages, promoting standardization and consistency. The variability observed in alcohol content highlights the need for further research to optimize production parameters, potentially leading to standardized brewing protocols. This can enhance the quality and economic value of ara, offering greater commercial opportunities. Additionally, establishing clear guidelines for alcohol content can protect consumers and support responsible drinking. The insights gained can also inform educational programmes, fostering improved brewing practices and cultural preservation.

Conclusion

This study successfully determined the alcohol percentage in locally produced ara samples using spectrophotometric analysis. By applying the dichromate method, the ethanol content in three different ara samples was accurately measured. The calibration curve created from standard ethanol solutions provided a reliable basis for calculating the alcohol content in the Ara samples, with a strong correlation (R^2 = 0.8318) between absorbance and ethanol concentration.

The alcohol concentrations for the ara samples were found to be 27.491% v/v, 23.340% v/v, and 20.349% v/v. These results indicate significant variability in alcohol content among different sources of Ara, reflecting the influence of factors such as grain type, fermentation duration, and distillation processes.

In conclusion, spectrophotometry proved to be an effective and precise method for assessing the alcohol percentage in traditional Bhutanese ara. This technique can be employed for quality control and standardization of locally produced alcoholic beverages, ensuring consumer safety and preserving cultural heritage. Future studies could expand on this work by exploring the impact of different fermentation and distillation parameters on the alcohol content of ara.

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Insights from the International Science Education Conference (ISEC 2024): Advancements in Chemistry Education

Submitted by
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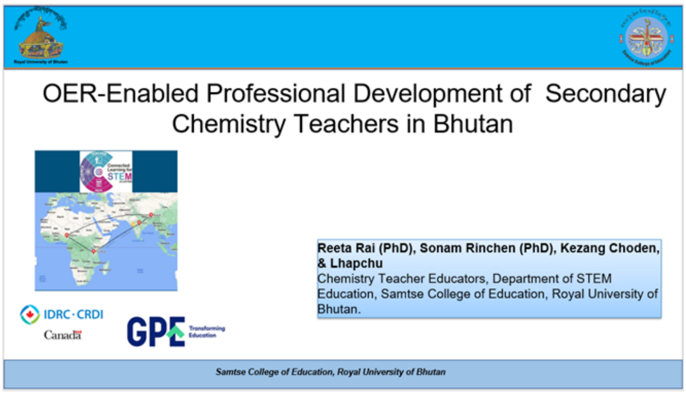
The Bhutan CL4STEM Chemistry team presented a paper titled "OER-Enabled Professional Development of Secondary Chemistry Teachers in Bhutan" at the International Science Education Conference (ISEC 2024), held from June 24-26, 2024. The conference was organised by the National Institute of Education, Nanyang Technological University in Singapore. The attendees included science and mathematics educators, researchers, and preservice teachers from 20 countries, representing various educational institutions, research organizations, and government bodies. The conference provided a diverse and international perspective on science education, emphasising widespread global interest and investment in it.



The sessions included keynote speeches, oral and poster presentations, and workshops. The keynote speakers were renowned experts in science education and delivered keynote speeches focused on the theme "Science Education's Responses to the Post-Truth Era." They highlighted the role of science education in navigating a world where objective facts are often overshadowed by emotion and personal belief, as exemplified by the varied responses to COVID-19 and the rise of deep fakes enabled by generative AI. The discussions emphasised the need for science education to adapt and equip individuals with the critical thinking skills necessary to discern truth in this challenging landscape. Oral presentations covered a wide range of topics such as teachers' professional development, curriculum and policy, assessment and evaluation, multimedia and technological integration in classrooms, science in informal settings, the nature of science, and innovative teaching methods.

Some of the oral and poster presentations that focused on chemistry education were:

1. Using Microscale Chemistry to Foster Students' Inquiry Skills

2. Examining Students' Understanding of 'Chemistry of Life' Using a Multidimensional Framework for Conceptual Change

3. Re-examining the role of language in Chemistry in the senior secondary curriculum of Hong Kong with Content and Language Integrated Learning (CLIL) Approach

4. Developing Critical Thinking Using Blended Learning with Microscale Experiments for Upper Secondary Chemistry

5. S.M.A.R.T. habits in a Junior College (JC) chemistry class

6. The Development of Problem-Solving Ability in Chemistry Proposition on the Topic of Stoichiometry by Using 5E's Learning Cycle Model and FOPS Strategy for Mathayomsuksa 4 Students

7. Concept Maps - An effective tool to help chemistry teacher students to interconnect chemical topics?

8. The Development of Problem - Solving Ability by Using Situation Based Learning with the 6 Thinking Hats Technique of Mathayomsuksa 5 Students in Chemistry

9. Students' and Lecturers' Views on Green and Sustainable Chemistry in Higher Education

10. Approaches to Enhance Understanding of Fundamental Research on Chirality through Immersive Virtual Reality

In summary, the conference highlighted a transformative shift in chemistry education, emphasizing innovative strategies to enhance student learning and engagement. The integration of microscale experiments, blended learning, and techniques like the 5E's Learning Cycle Model with the FOPS strategy demonstrates a commitment to fostering deeper understanding and critical thinking. Addressing misconceptions, improving conceptual grasp through CLIL, and incorporating tools like concept maps reflect a holistic approach to chemistry education. Additionally, the focus on Green and Sustainable Chemistry and immersive virtual reality illustrates a forward-thinking perspective on integrating sustainability and advanced technology. Collectively, these advancements underscore the ongoing evolution of chemistry education, aimed at better preparing students for future scientific challenges.

The conference was highly informative and offered valuable networking opportunities for the team. Members have decided to follow up with potential collaborators and implement new concepts discussed at the conference. Inspired by a poster presentation on Green and Sustainable Chemistry by academics from the University of Kassel, Germany, a module on Green and Sustainable Chemistry has been developed for B.Ed. Secondary programme at Samtse College of Education. This module is crucial for promoting sustainable practices among future generations. Additionally, the group gained insights into various chemistry education topics for potential research.

SCE Biology Team Reflections of participating in the ISEC 2024 Singapore - 24th - 26th June, 2024

Submitted by
Kinley (PhD)
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Ran Singh Tamang

The International Science Education Conference (ISEC) 2024 in Singapore presented a rich array of topics that underscored the evolving landscape of science education globally. The diversity of subjects covered provided attendees with deep insights into both historical and contemporary issues, as well as future directions in the field. During the two days besides presenting our own research work titled "Enhancing Biology Education: A Transformative Approach to Correcting Misconceptions with Interactive Video Lessons for High School Students", the team had the opportunity to attend ten individual presentations besides the keynote addresses and poster presentations. The following is a brief outline and reflection of the presentations we attended.

The Characteristics of Inquiry in the Course of Study in Japan: This presentation offered a compelling examination of how inquiry-based learning has evolved in Japan. Understanding the historical context is crucial as it allows educators to appreciate the foundational principles that continue to shape inquiry-based learning today. It also offered a lens through which to view the future trajectory of educational reforms and pedagogical innovations.;

The Role of Memory in Learning STEM Subjects: Memory plays a pivotal role in learning, particularly in STEM education, where the retention and application of complex concepts are essential. The insights gained here are invaluable for developing strategies that not only improve student performance but also foster a deeper understanding of STEM subjects. An activity the presenter implemented to test our short term memory was very interesting which we see can be immediately applied in our classroom as a part of gaining attention and arousing curiosity in the beginning of the class.;

Science and Pseudoscience: Why Do People Trust Them?: Exploring the reasons behind public trust in Science and Pseudoscience, this session tackled a critical issue in contemporary society. This understanding is vital for educators and policymakers as they work to promote scientific literacy and critical thinking skills, helping students discern credible information from misinformation.;

Growing Teacher Professionals in a Post-C19 World: Customized Online PD on DifferentiatedInstruction for an International School: The COVID-19 pandemic has reshaped professional development (PD) for educators. This presentation focused on customized online PD programs tailored to differentiated instruction, demonstrating how technology can be leveraged to meet diverse educational needs. The insights provided here are relevant for envisioning continuing professional growth.;

The Impact of Experienced Teachers and Science Educators Collaboration on Preservice Science Teachers' Development: This presentation highlighted successful collaborative models and their positive impact on teacher preparation.;

Science Education and the Richness of Human Social Life: It underscored the importance of integrating social and ethical considerations into Science education, preparing students to navigate and contribute to a diverse and interconnected world.; **Using ChatGPT to Brainstorm Students' Inquiry-Based Learning:** This presentation demonstrated how AI can support and enhance the creative and critical thinking processes in students. The potential applications of ChatGPT in education are vast, offering new tools for teachers to foster engagement and deeper inquiry among students.;

Enhancing Flipped Classroom Learning in Higher Education in Singapore Through the Socratic Methodology: A Synergistic Approach: It was very inspiring to learn that the integration of these methods promotes active learning and critical thinking, making it a powerful strategy for enhancing student engagement and comprehension in higher education settings. Among others this was one pedagogical approach that we are looking forward to use it in our classrooms immediately.;

Impact of Technology-Enhanced Learning (TEL) on Students' Achievement and Scientific Literacy in Science Education: A Meta-Analysis: A meta-analysis on the impact of TEL provided comprehensive insights into how technology influences student achievement and scientific literacy. This study made us rethink about an opportunity to enhance our studies on the impact of online learning by getting more specific like theirs.;

Applications of Artificial Intelligence in the Analysis of Visitors' Experience at a Science Centre: This presentation showcased innovative approaches to using AI for personalized and interactive educational experiences, setting a precedent for future advancements in informal Science education. Further, the presentation also allowed us to understand that AI can also be used for research purposes by educators without being a technology expert.

Visit to Robotics in Education Centre at Singapore: Visiting the robotics in education facilities in Singapore was an enlightening experience that showcased the forefront of educational innovation. Singapore has positioned itself as a global leader in integrating robotics into the educational curriculum, providing a model that many other countries can aspire to. One of the most impressive aspects of the visit was witnessing students engaged in hands-on learning.

Robotics education in Singapore emphasizes experiential learning, where students actively build, program, and test robots. This method cultivates critical thinking, problem-solving skills, and creativity. By working on real-world challenges, students learn to apply theoretical knowledge in practical scenarios, which enhances their understanding and retention of concepts.

Singapore's commitment to robotics education is evident in the advanced resources and facilities available to students. Singapore is preparing its youth to thrive in a rapidly changing technological landscape. The skills and knowledge gained through robotics education are directly aligned with the demands of the 21st-century job market.

The SCE Biology team expresses sincere gratitude to the College and the CL4STEM project for offering the opportunity to engage in this enriching learning experience. For example, Mr. RanSingh Tamang described attending the conference as highly valuable. He specifically highlighted his appreciation for Ekan Potatdemir's presentation, which explored strategies for enhancing long-term memory in STEM education, such as memory reactivation and mixed-unit multiple-choice questions. He also observed that the findings on enhanced information retention and performance variation over time, presented by Ekan Potatdemir, offered valuable insights for content-intensive Biology modules in the B.Ed. Secondary Science programme.

Similarly, he noted that Low Beng's exploration of flipped classroom methodologies emphasised the benefits of self-directed learning and increased student engagement in higher education. His practical strategies, such as using Socrative for interactive assessments and reflective exercises, offered innovative approaches to foster independent learning and active participation. Mr. RanSingh also noted that the insights gained from these two presentations will enable him to improve his own teaching practices especially the student engagement in learning.

Conclusion

The insights gained from ISEC 2024 in Singapore will significantly enhance teaching and research efforts in science education. The conference presentations deepened our understanding of the field's complexities and opportunities, offering fresh perspectives that can inform curriculum development, pedagogical strategies, and policy formulation. The emphasis on innovation, collaboration, and critical thinking will guide us in fostering a more dynamic and forward-thinking educational environment. The visit to robotics in education facilities demonstrated Singapore's exemplary approach to integrating technology in learning, which can serve as a model for other educational systems. By incorporating these practices, we can enhance our teacher training, resource allocation, and inclusivity in our own programmes. The focus on hands-on learning and future-ready skills observed in Singapore will be pivotal in preparing students to thrive in a technology-driven world. This experience will shape our approach to education, ensuring it is transformative and geared towards meeting future challenges and opportunities.

Navigating the Blogosphere: A Student's Journey into IT Education

Submitted by
Chimi Seldon
B.Ed. Secondary in IT A

Without a doubt, my foray into the worlds of IT education and blogging has been nothing short of an exhilarating adventure, seamlessly blending into the tapestry of my academic endeavours. As a dedicated student navigating this ever-shifting landscape, I've found myself fully immersed in the captivating realms of coding and technology, driven by an insatiable thirst for knowledge and discovery. I warmly extend an invitation for you to join me on this voyage as I unveil the intricacies of my journey, each twist and turn intricately linked to an ongoing ICT assignment that acts as a guiding light on my educational path.

My journey into IT education wasn't meticulously planned; it all started with a simple curiosity about technology's impact on our lives. As I dipped my toes into coding languages like Python, something clicked. It wasn't just about crafting lines of code; it was about unlocking the digital prowess needed to thrive in today's world.

Starting a blog felt like a natural step forward. It became a space where I could pour out my thoughts, document my learning journey, and connect with others who shared my passion. Through my blog, I have explored into a variety of topics, from sharing coding tutorials to pondering the role of technology in shaping the future of education.

Blogging isn't just about sharing content; it's about building connections and fostering communities. Engaging with readers and fellow bloggers has been incredibly enriching, opening my eyes to new perspectives and forging friendships that transcend geographical boundaries. The blogosphere isn't just a platform; it's a virtual classroom where ideas flourish, knowledge is exchanged, and collaboration thrives.

As a student navigating the blogosphere and the world of IT education, my ultimate mission is simple: to empower others to embark on their own learning journeys. Whether it's through sharing step-by-step tutorials, dissecting the latest tech trends, or simply offering words of encouragement, my goal is to ignite the spark of passion in fellow learners. By sharing my experiences authentically, I hope to inspire curiosity, foster creativity, and cultivate a love for learning in others.

In conclusion, my journey into IT education and blogging has been filled with many moments of learning, growth, and valuable connections. As I continue navigating this ever-changing landscape, I look forward to the chance for my experiences to inspire others and contribute to the progress of education. I sincerely thank you for joining me on this journey, and I am excited about the endless possibilities that await us in the world of blogging and beyond.

https://sites.google.com/rub.edu.bt/seldons-bag/home

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"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)