STEM EDUCATION NEWSLETTER

Samtse College of Education, 2022

Volume 2

Inside this issue

COORDINATOR'S MESSAGE

Dear Reader,

The STEM Education Research Center (STEMERC) of Samtse College of Education (SCE) is pleased to present the STEM Education Newsletter for the year 2022.

STEMERC's core vision is to be the Center of Excellence for Research in STEM Education curricula, pedagogical practices, assessment techniques, and STEM disciplines by collaborating with national and international STEM education stakeholders. Apart from engaging in STEM-related initiatives and activities, the STEMERC is currently implementing an IDRC-funded consortium project titled Connected Learning for Teacher Capacity Building in STEM (CL4STEM) in collaboration with Ibrahim Badamasi Babangida University, Lapai (IBBUL), Nigeria, Open University of Tanzania (OUT), and the Tata Institute of Social Sciences (TISS) in India. Through this project, STEM teacher educators are supporting the capacity building of selected school STEM teachers of Samtse Dzongkhag and preservice postgraduate diploma in education (PGDE) teachers in content knowledge enhancement, use of innovative and inclusive pedagogies, and technology through the use of Open Educational Resources (OERs) curated by teacher educators. This issue has covered some of the activities organized as part of this ongoing consortium project.

We hope you will enjoy and benefit from reading the STEM Education Newsletter. We invite your feedback and suggestions for future improvements.

For an electronic copy of the newsletter, please go to http://stem.sce.edu.bt

Reeta Rai, PhD
Coordinator
STEM-ERC

STEM EDUCATION NEWSLETTER

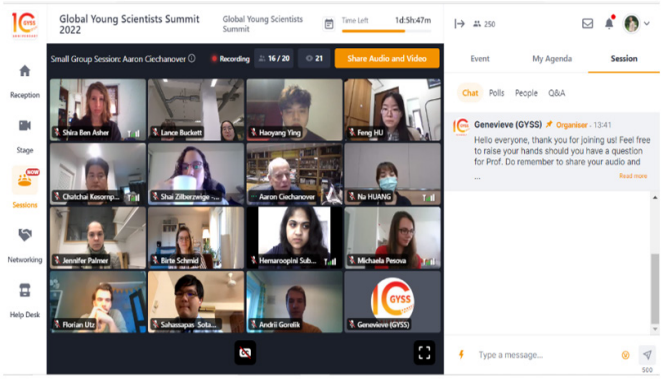
SCE STEM Student Teachers Participated in the 10th Anniversary of Global Young Scientist Summit

The 10th Anniversary Global Young Scientist Summit was organised by the National Research Foundation, Prime Minister's Office, Singapore in collaboration with the Ministry of Education, Singapore; Agency for Science, Technology and Research, Singapore; National University of Singapore; Nanyang Technological University, Singapore; Singapore Management University; and Singapore University of Technology and Design. Six STEM student teachers from Samtse College of Education attended the webinar virtually.

Summit Summary

The 10th Anniversary of the Global Young Scientist Summit (GYSS) was a virtual event conducted through hopin, which commenced on January 17th, 2022 with the opening address from Deputy Prime Minister and Coordinating Minister for Economic Policies of Singapore, Mr. Heng Swee Keat. The summit consisted of 21 speakers which included Nobel Laureates and world-renowned scientists. There were 6 panel discussions, 20 plenary lectures, and 19 research presentations from the young scientists. Small group sessions were also held during the

event, in which selected participants had the opportunity to interact with a scientist of their choice and build networks. Prof. Low Teck Seng and Prof. Bertil Anderson, the Co-Chairs of the GYSS Organising Committee, gave the closing remarks at the end of the 5-day event on January 21, 2022.



Retrospection on Panel Discussions

Out of 6 panel discussions that were conducted over the 5-day event, three have been briefly described below.

1. Has Scientific Research Fundamentally Changed: Prof Aaron Ciechanover, Prof Stefan Hell & Dr. Venki Ramakrishnan

Aaron Ciechanover
Nobel Prize in Chemistry
2004

Stefan W. Hell
Nobel Prize in Chemistry
2014

Venki Ramakrishnan
Nobel Prize in Chemistry
2009

Despite technological advancements, the panelists noted that there are still immutable in science. Prof. Aaron Ciechanover claimed that technology will not be able to answer fundamental problems.

One finding is that when the pool of resources available to academics shrinks, other opportunities would arise elsewhere. Prof. Stefan Hell predicted that industry and research will interact more frequently than in the past. As a result, some scientists are concerned that science's "industrialization" may force scientists to conform to a single manner of functioning. The panelists agreed, though, that scientists must build their own path forward. Dr. Venki Ramakrishnan said that there is no predefined way to undertake science.

2. Artificial Intelligence, Ethics, and Governance: Prof Cedric Villani, Prof. Leslie Valiant & Prof. Simon Chesterman

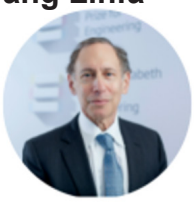
Cédric Villani
Fields Medal
2010

Leslie Valiant
Turing Award
2010

Simon Chesterman

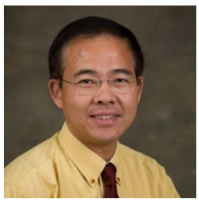
Prof. Leslie Valiant explained why artificial intelligence ethics has recently become a major topic of discussion. He said that although these issues aren't new, the ease with which machines can now analyse data elevates the issue. In truth, the problem isn't only about how to defend AI actions. Prof. Cédric Villani noted that we often emphasise asking, “Why should we trust this technology” and not enough attention to the company or the person. Finally, Prof. Simon Chesterman summed up the session by saying that he is less concerned about politicians being replaced by AI than AI dominating politics.

3. Preparing for the Next Pandemic: Prof. Thomas Cech, Prof. Robert Langer & Prof. Wang Linfa



Robert Langer
Millennium Technology Prize
2008

Thomas Cech
Nobel Prize in Chemistry
1989



Wang Linfa

The panel praised science's contribution in combating the Covid-19 outbreak, citing the benefits of mRNA technology. Prof. Thomas Cech stated, "Any of my young students in my laboratory may generate a novel vaccination sequence and express it within a week. Unfortunately, scientists still need to improve their ability to communicate with the press and policymakers." According to Prof. Robert Langer, "Science is essential" but pointed out, "political concerns are also quite relevant in this case." Prof. Wang Linfa believes that things would have been different if the world had acted more promptly in the first three weeks after COVID was detected in 2019. He said, "I believe, science itself cannot actually achieve much if we continue to use the current legal, political, and regulatory frameworks."

Peroration

My understanding of scientific breakthroughs has improved as a result of the summit. The panel discussions and plenary talks were interesting and would be extremely beneficial to my career growth. The talks given by young eager scholars from all over the world provided me with a lot of exposure. This would not have been possible without the help of many people. With this, I would like to express my gratitude to His Majesty, the Fifth King of Bhutan, for allowing young people to participate in such activities. Such opportunities would also help Bhutanese students develop a positive attitude toward science.

Sonam Changa, B.Ed IV Sci B, 2022

International Place-based Education Symposium: Educating for Gross National Happiness

Introduction

Samtse College of Education (SCE), in collaboration with Teton Science School (TSS), Wyoming, USA, and the Bhutan Youth Development Fund (BYDF), hosted a virtual International Place-based Education (PBE) Symposium: Educating for Gross National Happiness on March 12, 2022. The symposium's themes included: Place-based Educator Development; Promoting Authentic Partnerships; and Finding Hope and Understanding. The symposium was organized in two ways. One-week pre-symposium poster session through a website-based gallery walk depicting "Place-based Education in Action" followed by individual presentations during the live symposium session on March 12th, 2022. Bhutanese teacher educators and teachers displayed a total of 11 posters on the above-mentioned themes. During the live symposium session, nine presenters, including teacher educators, school teachers, and a group of primary school students, presented their work on PBE. Ms. Hunter C. Old Elk, Curatorial Assistant, Plains Indian Museum, Ms. Heather Bender, Native Education Outreach Specialist, and Mr. Nathan Doerr, Former Curator of Natural Science, Draper Natural History Museum from Wyoming, USA, resourced the panel discussion during the live symposium. The event drew a total of 378 participants, the majority of whom were Bhutanese teacher educators and school teachers. Mr. Chris Mouanoutoua, TSS's Professional Learning Program Administrator, coordinated the Zoom session technically.

Objectives:

The symposium was organised with the following objectives:

- share the current practices of PBE in Bhutanese schools and education institutions;
- advance PBE and education for Gross National Happiness by exposing more educators to the practices;
- create a platform for academics and PBE

practitioners to share the opportunities and challenges of applying PBE as an educational approach in the Bhutanese education system

Symposium Proceedings

Opening Session

Dr. Reeta Rai, Coordinator of the STEM Education Research Centre (STEMERC), launched the symposium by welcoming all participants on behalf of the organizing committees. This was followed by an opening address by Dr. Rinchen Dorji, President of SCE, who declared the symposium officially open at the end of his statement about the event. Ms. Leslie Cook, Head of Professional Learning, TSS, then delivered a welcome note, followed by Mr. Lhundup Dukpa, My Gakidh Village School Project, BYDF, with his welcome note to the participants.

Keynote Panel Discussion on Place, Culture, and Resilience with Hunter C. Old Elk, Heather Bender, Nathan Doerr

Ms. Shannon Shuptrine moderated an hour-long panel discussion on Place, Culture, and Resilience, which was resourced by Hunter C. Old Elk, Heather Bender, and Nathan Doerr.

Summary of the Keynote Panel

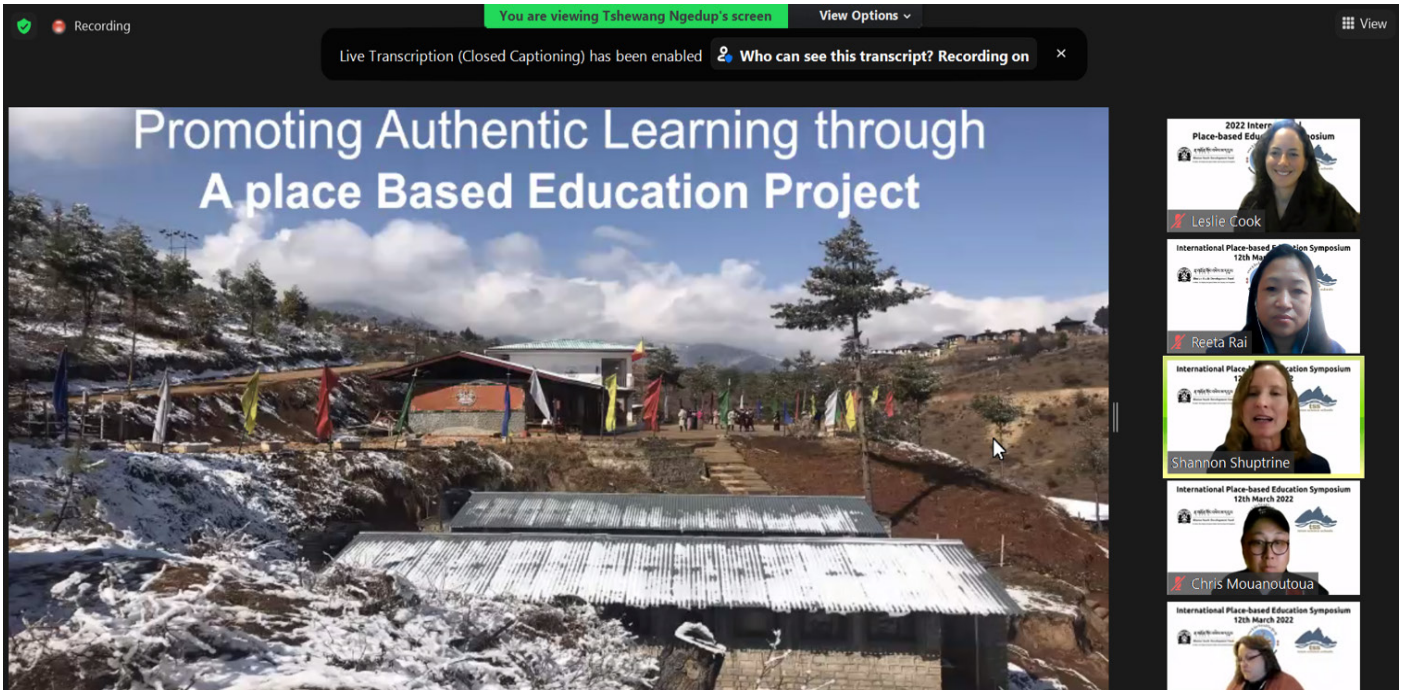
This panel focused on the Greater Yellowstone Ecosystem and discussed how 'the story of resilience begins with place, demonstrated in the awareness and observation of the diverse landscapes we call home.' As the landscape of the Greater Yellowstone Ecosystem has changed due to natural phenomena and the impact humans have had on the landscape, adaptation has occurred in the plants, animals, and people and their cultures. This resilience in the face of change continues to be a defining feature of tribal communities as threats to sovereignty, land, food sources, and educational self-determinism continue today. Indigenous communities (500 plus in the US) were the first stewards of this landscape and their languages, spirituality, and cultures are all rooted in this interconnectedness to the land.

During the 150th anniversary of the creation of Yellowstone National Park, it is important to acknowledge that the creation of the park came with the colonization of the lands and people. It is a complicated history of forced displacement of indigenous stewards that existed for thousands of years before the creation of the park. The park is an important ecosystem and landscape we must protect in the face of climate change and habitat loss. There is also a need to reconnect indigenous people with this landscape and the cultural and spiritual role their knowledge plays in our collective histories, present day, and futures. The indigenous knowledge connected to this place is rich and storied and part of the very land itself. Our panelists discussed ways we can all support a return to traditional knowledge and indigenizing education in our stewardship of the Greater Yellowstone Ecosystem, and all lands.

Musical Break

Following the panel discussions, participants were entertained by a music video created by one of the SCE's post-graduate classes. The music video was created in honor of Bhutan's 114th National Day, and it depicted the history of Bhutanese Monarchs and students' sense of nationalism, patriotism, and loyalty to our Kings' selfless leadership and sacrifices for the country's sovereignty. The video included the song's lyrics in English to make it more inclusive. Participants were then assigned to two parallel presentations in the Zoom breakout rooms.

Track 1 - Finding Hope & Understanding, Promoting Authentic Partnerships & Place-based Educator Development



Track 1, which comprised four presenters, was moderated by Ms. Shannon Shuptrine. The presenters' names and presentation titles are listed below.

Theme: Finding Hope and Understanding	
Name and address	**Title of the presentation**
Kinley Zam, Teacher, My Gakidh Village School, Talhogang Primary School Punakha	The school that Nurtures Locally Rooted and Globally Competent Citizens
Shannon Shuptrine, School coach with Place Network of TSS, Mountain River School	Mountain River School Peace Project
Theme: Place-based Educator Development	
Tshewang Ngedup, Teacher, Olathang Primary School, Paro.	Taking PBE to Teachers and School leaders
Diwash Sundas, Teacher Samtse Lower Secondary School, Samtse,	Bhutan Use of Place-Based Education in Secondary Geography Education: A Study in Western Bhutan

The theme of Track 1 was “Finding Hope and Understanding.” This session was inspirational and hopeful as we heard from educators about rethinking the educational model to better help our children to “fly” with a holistic and student-centered approach to learning and growing. Educators shared concrete examples of how schools are using the PBE framework to engage and motivate students and connect them to the greater community. These exam-

ples demonstrated how place-based projects can be directly connected to students' health and wellness while academic learning is also taking place. We also learned from the presenters why educational reform is important for our collective future and were exposed to the data on the efficacy of PBE. This session allowed participants to think theoretically about the opportunities PBE provides while also seeing concrete examples of this model in action.

Track 2, which comprised four presenters, was moderated by Ms. Leslie Cook. The presenters' names and presentation titles are listed below.

Theme: Place-based Educator Development	
Dr. Kinley, Dr. Reeta Rai, Samtse College of Education, and Mr. Ugyen Dorji, Principal Tendruk Central School, Samtse Bhutan	Implementing Design Thinking in Bhutanese Higher Secondary School Classrooms
Sangay Penjor, Teacher, Tendruk Central School	Using Design thinking as a pedagogy; experience from the classrooms of Tendruk
Dr. Nandu Giri, Dr. Kinzang Dorji, and Alexander Sivitskis, Samtse College of Education.	An investigation of the implementation of Place Based Education and its relationship with Educating for GNH at the Samtse College of Education
Mani Raj Thapa, Teacher, Tsirang Central School	Community as Classroom for learning geography in Middle Secondary School

The presenters in Track 2 connected with the theme around the facilitation and support of place-based educator development projects connected with SCE. Two of the presentations centered around training for teachers and classroom implementation of design thinking. Important takeaways from these two sessions include that design thinking practices can promote deeper engagement, learning, and collaboration among teachers and students. The other presentations from Track 2 highlighted efforts to integrate PBE into teaching in secondary schools and at SCE. Key takeaways from these sessions include the need for taking “small steps” for implementation, knowing that many of the practices are new and take time to implement. Across all presentations, the presenters shared the value and benefits of PBE and see many linkages between place-based learning and education for Gross National Happiness.

Final Presentation in the Main Room on the Theme - Promoting Authentic Partnerships

Sonam Cee Yangchen, Tenzin Wangmo, and Jigme Rangjung Rangdel, students from Olathang Primary School, Paro, presented their PBE project on People and Environment. The project's concept was to manage solid waste through an interdisciplinary approach to PBE. Mr. Tshewang Ngedup, their science teacher, mentored them.

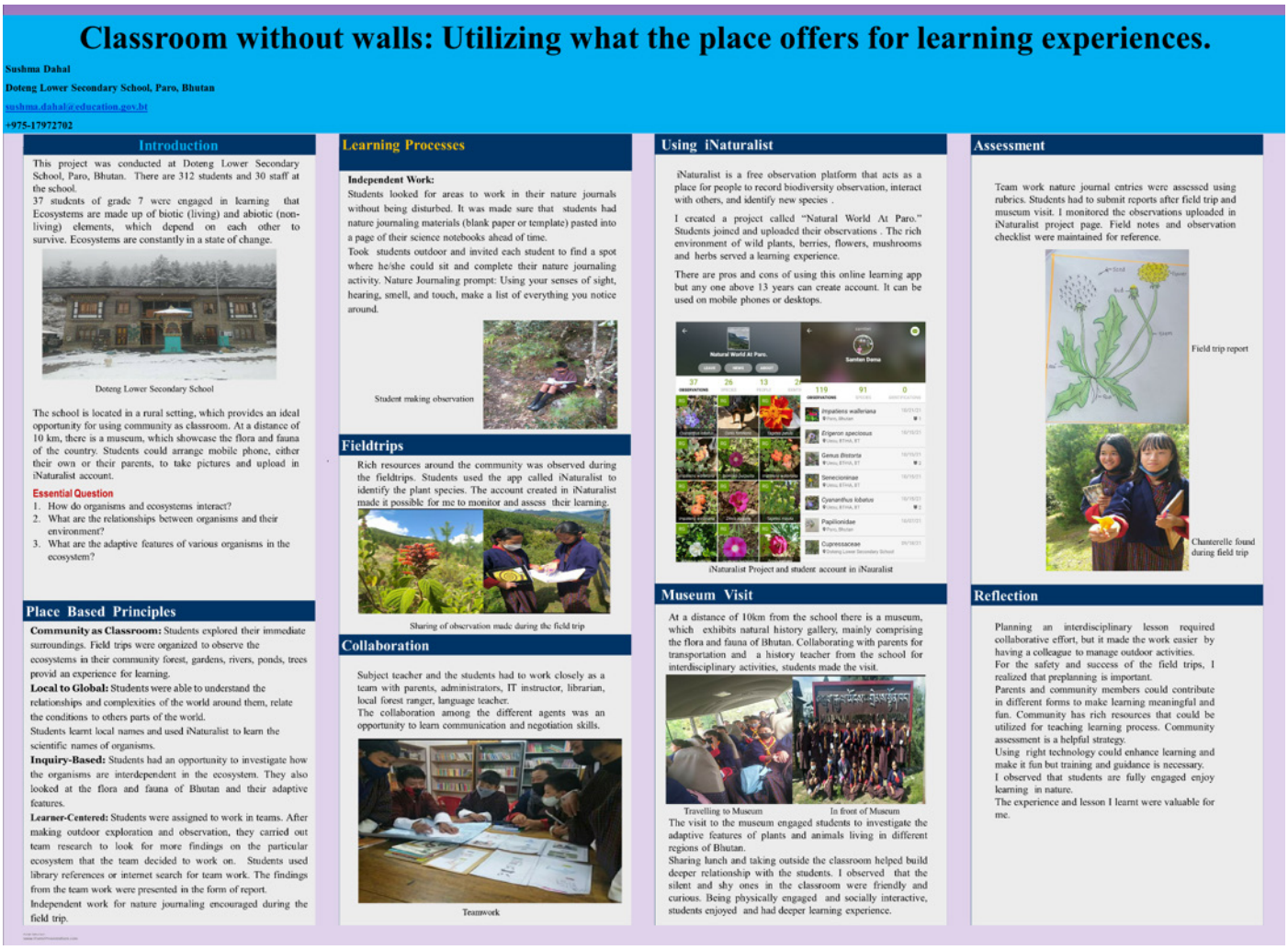
People's Choice Awards

All Symposium attendees were given the oppor-

tunity to vote for the best presentation and poster using a Zoom poll.

Ms. Sushma Dahal, a teacher at Doteng Lower Secondary School, Paro, was awarded the best poster from the Place-based Educator Development theme for her poster titled: *Classroom without walls: utilizing what the place offers for learning experiences*. Mr. Tshewang Ngedup, a teacher at Olathang Primary School, received the best award in PBE through Interdisciplinary Approach for the theme of Promoting Authentic Partnerships.

The students' group from Olathang Primary school led by Ms. Sonam Cee Yangchen won



Classroom without walls: Utilizing what the place offers for learning experiences.

Sushma Dahal
Doteng Lower Secondary School, Paro, Bhutan
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Introduction

This project was conducted at Doteng Lower Secondary School, Paro, Bhutan. There are 312 students and 30 staff at the school.
37 students of grade 7 were engaged in learning that Ecosystems are made up of biotic (living) and abiotic (non-living) elements, which depend on each other to survive. Ecosystems are constantly in a state of change.

Doteng Lower Secondary School

The school is located in a rural setting, which provides an ideal opportunity for using community as classroom. At a distance of 10 km, there is a museum, which showcase the flora and fauna of the country. Students could arrange mobile phone, either their own or their parents, to take pictures and upload in iNaturalist account.

Essential Question

1. How do organisms and ecosystems interact?
2. What are the relationships between organisms and their environment?
3. What are the adaptive features of various organisms in the ecosystem?

Place Based Principles

Community as Classroom: Students explored their immediate surroundings. Field trips were organized to observe the ecosystems in their community forest, gardens, rivers, ponds, trees provid an experience for learning.
Local to Global: Students were able to understand the relationships and complexities of the world around them, relate the conditions to others parts of the world.
Students learnt local names and used iNaturalist to learn the scientific names of organisms.
Inquiry-Based: Students had an opportunity to investigate how the organisms are interdependent in the ecosystem. They also looked at the flora and fauna of Bhutan and their adaptive features.
Learner-Centered: Students were assigned to work in teams. After making outdoor exploration and observation, they carried out team research to look for more findings on the particular ecosystem that the team decided to work on. Students used library references or internet search for team work. The findings from the team work were presented in the form of report.
Independent work for nature journaling encouraged during the field trip.

Learning Processes

Independent Work:
Students looked for areas to work in their nature journals without being disturbed. It was made sure that students had nature journaling materials (blank paper or template) pasted into a page of their science notebooks ahead of time.
Took students outdoor and invited each student to find a spot where he/she could sit and complete their nature journaling activity. Nature Journaling prompt: Using your senses of sight, hearing, smell, and touch, make a list of everything you notice around.

Student making observation

Fieldtrips

Rich resources around the community was observed during the fieldtrips. Students used the app called iNaturalist to identify the plant species. The account created in iNaturalist made it possible for me to monitor and assess their learning.

Sharing of observation made during the field trip

Collaboration

Subject teacher and the students had to work closely as a team with parents, administrators, IT instructor, librarian, local forest ranger, language teacher.
The collaboration among the different agents was an opportunity to learn communication and negotiation skills.

Teamwork

Using iNaturalist

iNaturalist is a free observation platform that acts as a place for people to record biodiversity observation, interact with others, and identify new species .

I created a project called "Natural World At Paro." Students joined and uploaded their observations . The rich environment of wild plants, berries, flowers, mushrooms and herbs served a learning experience.

There are pros and cons of using this online learning app but any one above 13 years can create account. It can be used on mobile phones or desktops.

iNaturalist Project and student account in iNaturalist

Museum Visit

At a distance of 10km from the school there is a museum, which exhibits natural history gallery, mainly comprising the flora and fauna of Bhutan. Collaborating with parents for transportation and a history teacher from the school for interdisciplinary activities, students made the visit.

Travelling to Museum In front of Museum

The visit to the museum engaged students to investigate the adaptive features of plants and animals living in different regions of Bhutan.
Sharing lunch and taking outside the classroom helped build deeper relationship with the students. I observed that the silent and shy ones in the classroom were friendly and curious. Being physically engaged and socially interactive, students enjoyed and had deeper learning experience.

Assessment

Team work nature journal entries were assessed using rubrics. Students had to submit reports after field trip and museum visit. I monitored the observations uploaded in iNaturalist project page. Field notes and observation checklist were maintained for reference.

Field trip report

Chanterelle found during field trip

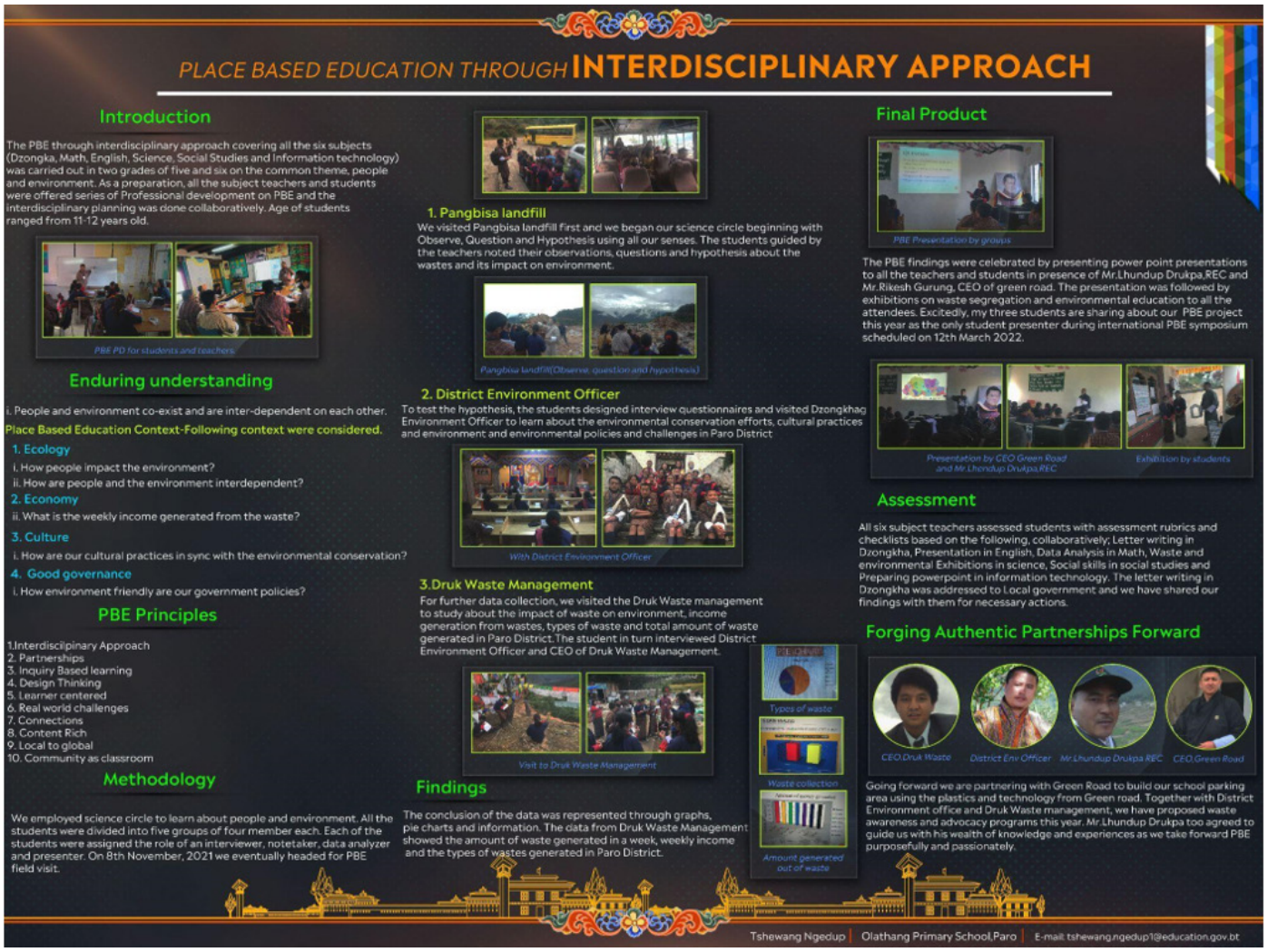
Reflection

Planning an interdisciplinary lesson required collaborative effort, but it made the work easier by having a colleague to manage outdoor activities.
For the safety and success of the field trips, I realized that preplanning is important.
Parents and community members could contribute in different forms to make learning meaningful and fun. Community has rich resources that could be utilized for teaching learning process. Community assessment is a helpful strategy.
Using right technology could enhance learning and make it fun but training and guidance is necessary.
I observed that students are fully engaged enjoy learning in nature.
The experience and lesson I learnt were valuable for me.

the best presenter award for the theme Promoting Authentic Partnerships. Likewise, Dr. Kinley and his team from SCE won the best presenter award on the theme Place-based Educator Development. The awardees were congratulated and informed that they would soon receive their certificates and awards.

Closing Session

Dr. Reeta Rai thanked the distinguished panelists, poster and paper presenters, as well as the audience, on behalf of the organising committee, for their contributions to making the symposium a huge success. She emphasised the importance of continuing to discuss PBE after the symposium. She stated that it was the first symposium organised primarily for Bhutanese teacher educators and teachers to share their practices in PBE. She stressed the importance of creating regular platforms for educators to



discuss their professional practices.

Reported by Dr. Reeta Rai, Ms. Leslie Cook, and Ms. Shannon Shuptrine

Webinar on Teaching STEM in Southeast Asia, Making HEADway

The STEM teacher educators of Samtse College of Education, attended the practitioner-focused webinar series titled “Teaching STEM in Southeast Asia, Making HEADway,” organized by the HEAD Foundation in Singapore. Mr. Vignesh Naidu, Director, of the HEAD Foundation, stated in his opening remarks that, STEM education, while not a new concept, is still in its infancy in many Southeast Asian classrooms. He continued by stating that STEM education can play a critical role in preparing students to thrive in a rapidly changing world and that it goes beyond content knowledge to develop the necessary skills and identities for learners to thrive in rapidly changing communities, workplaces, and the global economy.

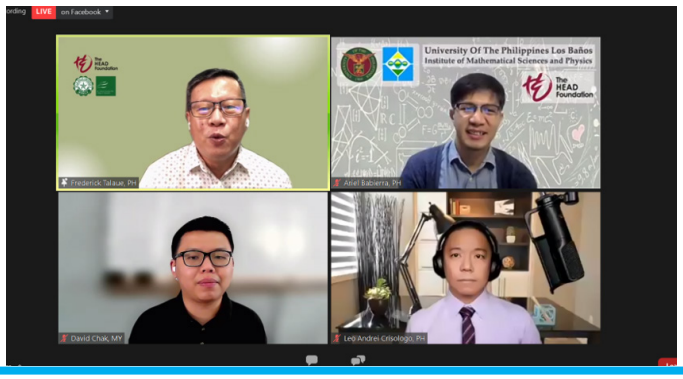
The main goal of the webinar series was to share best practices as well as relevant, actionable strategies and tips for educators to adapt to their contexts. Similarly, STEM educators were expected to accomplish the following objectives through the webinar series:

- How to introduce bite-sized STEM lessons in their classrooms;
- How to transform STEM pedagogy and leadership practices in their schools, and
- How schools can establish and leverage networks within the community and with industries to strengthen STEM teaching practices.

10th March 2022, Session 1: Applying STEM Pedagogies

Figure 1

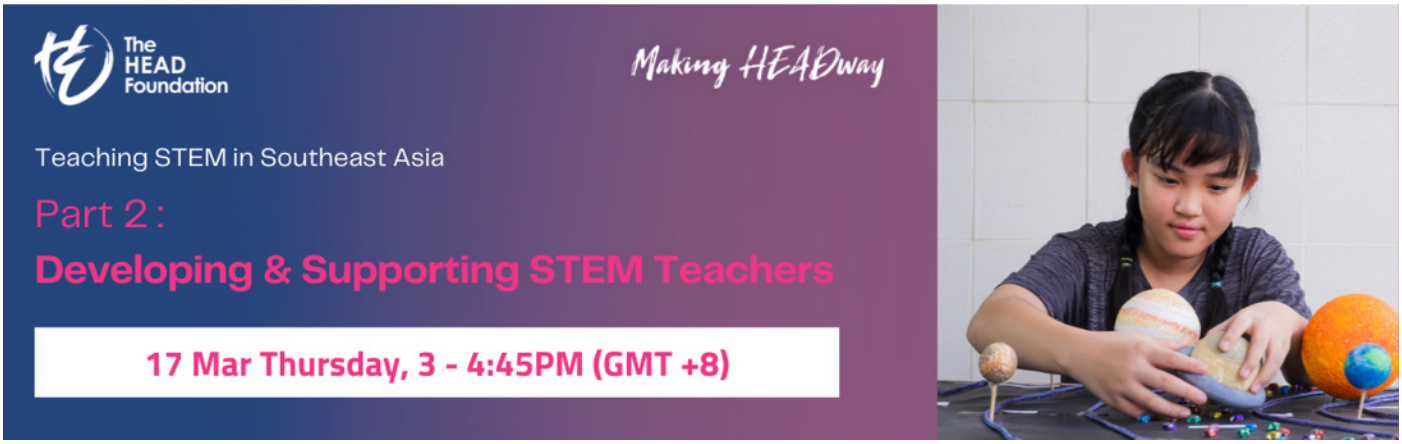
Keynote speakers for the first session of the webinar series on Applying STEM Pedagogies



The participants learned that despite the fact that STEM is an integrated approach to teaching, not all Southeast Asian classrooms have dedicated class time or are fully equipped to teach STEM as an integrated subject. The panelists in this session shared ideas for incorporating STEM instructional approaches into existing or enriching classes to help learners understand STEM-related issues around them and even pursue STEM careers in the future. The following were some of the session's key takeaways:

- Mathematical teaching can be made more realistic by employing mathematical models to solve real-world problems;
- STEM lessons should serve as a platform for examining truths;
- To learn any STEM knowledge and skills, soft skills such as creativity, critical thinking, problem-solving, teamwork, leadership, digital literacy, work ethics, communication skills, professional attitude, writing skills, and so on are required;
- STEM lessons can be made effective even in the absence of scientific resources or tools by engaging students in relevant societal problem-solving activities that allow students to value STEM knowledge and skills from a humanistic perspective;
- Educators should learn how to design STEM instruction and assessment based on constraints and challenges;
- Some of the common STEM pedagogies referenced by the panelists included guided learning, project-based learning, problem-based learning, and design thinking;
- It is time for educators to shift their focus from using technology to developing technology for effective STEM teaching, learning, and assessment.

17th March 2022, Session 2: Developing and Supporting STEM Teachers

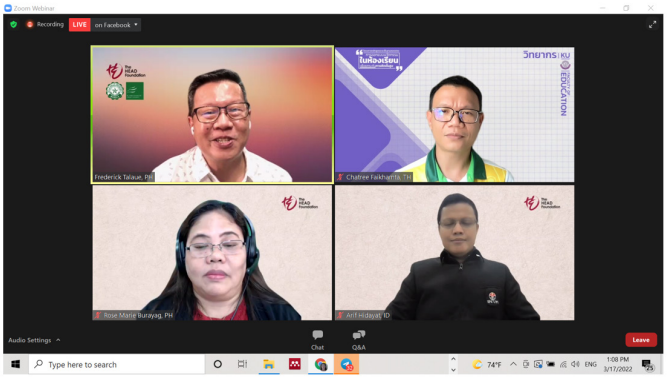


This session was focused on developing and supporting STEM teachers for the enactment of STEM goals, pedagogies, assessments, and professional growth. Dr. Arif Hidayat, Associate Professor at Universitas Pendidikan in Indonesia, spoke about teacher leadership in STEM curriculum improvement and shared how Indonesian STEM teachers revised and redesigned STEM curricula and implemented the STEM Quartet model in 17 districts involving science and math teachers with the support of meri-STEM@NIE Singapore. This entire revision was labelled as a 2021 STEM movement, with participants including teacher educators, school STEM teachers, university STEM centres, the Ministry of Education, and the Board of Education. He reminded the participants that in order to give equal emphasis to the acronym of STEM all the teachers should collaborate and plan the lessons together so that there will be a fruitful connection among the disciplines.

The participants also learned from other panellists that implementing new teaching approaches can be both exciting and challenging. Teachers face challenges in implementing new ways of teaching that are aligned with STEM education goals. Participants also learned how to transform STEM pedagogy and leadership practices in their schools and institutes, as well as how to share and mobilise resources to support learning and development in their respective professional communities.

Figure 2

Keynote speakers for the second session of the webinar series on Developing and Supporting STEM Teachers



Associate Professor Dr. Chatree Faikhamta in Science Education at Kasetsart University's Faculty of Education, Thailand, shared his experiences with STEM teaching and teacher training in Thailand. He mentioned that in Thailand, teachers are trained as reflective practitioners through action research. According to him, action research and writing a critical reflective journal can help teachers improve their professional practice by identifying the strengths and weaknesses of their teaching. He also stated that STEM lessons should emphasize social problem-solving. Similarly, the participants were reminded that formative assessments of students in STEM lessons will assist them in a deeper understanding of the concepts taught.

24th March 2022, Session 3: Creating a STEM Ecosystem

Figure 3

Keynote speakers for the third session of the webinar series on Creating a STEM Ecosystem

Participants learned that STEM learning ecosystems are typically made up of University academics, private organizations, school teachers, and stakeholders that work together to create powerful learning opportunities in STEM engagement for young minds or students. A well-developed STEM ecosystem will enable students to learn and practice STEM through mentorships, industrial attachments, fairs, and expos, and will strengthen their critical thinking and creativity in solving real-world problems.

STEM education is promoted in many countries as a strategy for developing critical thinkers, problem solvers, and innovators, and an ecosystem is required to make this possible. Through the STEM ecosystem, we can create purposeful networks to bring STEM into classrooms while also allowing students to practice outside of the classroom by engaging them in meaningful and relevant activities and projects.

Panelists discussed how STEM ecosystems have been formed in Malaysia, the Philippines, and Thailand, and how they are assisting students in discovering their innovative talents, creativity, and critical thinking, which ultimately benefits the common citizens.

Professor Dato' Dr. Noraini Idris, President, of the National STEM Association of Malaysia reminded participants that all young people must be prepared to think deeply and critically in order to become innovators, educators, researchers, and leaders capable of addressing the nation's and the world's most pressing challenges. According to her, the STEM ecosystem will provide young minds with high-quality STEM learning opportunities and prepare them to be 21st-century problem solvers, innovators, and inventors. She also shared her experiences of engaging high school students in a Mini Theatre STEM Competition to identify and unearth the students' STEM talents and skills. According to her, students were given opportunities to demonstrate their talents such as cooking, repairing electrical or electronic equipment, and agricultural activities such as gardening, all of which are closely connected to the core of STEM Education. She concluded the session by saying, "collaborations with stakeholders, parents, teachers, industry experts, strategic organisations, and institutions will be a great boost in our efforts in promoting the STEM Agenda."

Reported by Dr. Reeta Rai

Webinar on Sharing the Findings of the STEM Education Situation Analysis in Selected Schools

An IDRC-funded project, Connected Learning for Teacher Capacity Building in STEM (CL-4STEM) of Samtse College of Education carried out a Situational Analysis Study (SAS) on STEM Education in selected secondary schools of five dzongkhags: Samtse, Thimphu, Paro, Zhemgang, and Trashigang to assess the strengths, weaknesses, opportunities, and threats (SWOT) for infusing innovations through the CL4STEM project. On 7th April 2022, the STEM Education Research Centre (STEMERC) organised a webinar to share the study's findings with stakeholders in order to carry out the CL4STEM project more effectively and efficiently in schools. The guests included Chiefs of various divisions of the Ministry of Education, Chief Dzongkhag Education Officers, officials from Thimphu Thromde Education Office, principals, and STEM teachers from across the country.

All the participants were welcomed to the webinar by Dr. Rinchen Dorji, President of Samtse College of Education. He highlighted the importance of STEM education in our country by connecting it to the Royal Kasho and what each of the webinar participants should strive toward as a key player in taking STEM education forward in the country. Dr. Reeta Rai, the country CL4STEM project coordinator, presented a brief overview of the project so that they could better relate to the research findings. She emphasised the importance of STEM education not just in Bhutan but in other countries as well and how works are underway to enhance STEM education in each of the countries collaborating under the CL4STEM project. She captured the timeline of the project, and how the teacher educators in the four countries (viz Bhutan, Tanzania, and Nigeria led by India) are working to achieve the aim of the project and ultimately take STEM education in each of these countries to a higher level.

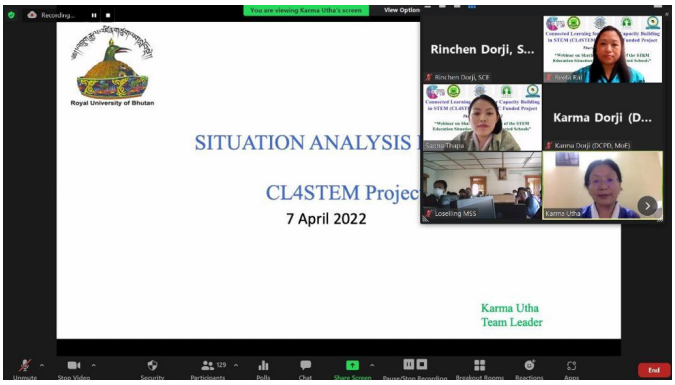
The main event of the webinar started with Dr. Karma Utha, the research team leader sharing their findings. She shared how the research was conducted and the factors that affect the quality of STEM education in the country. The findings facilitated all participants in understanding the current state of STEM education in Bhutan's five districts. Similarly, it allowed them to validate information/concerns about issues reported in the media, such as Bhutanese students performing poorly in STEM subjects. A lack of inclusion and equity for STEM education in schools was reported in the study. Their findings showed that although ICT is made a compulsory subject, some schools have not offered it still. A good percentage of students do not have access to ICT devices to take on ICT education or online classes. It was reported that STEM teachers do not receive an adequate amount of professional development as prescribed by the Ministry of Education (MoE) and some teachers are assigned more hours of classes compared to the standard amount affecting the quality of STEM education in their respective schools and ultimately the quality of STEM education in the whole country.

After the presentation, a question-and-answer

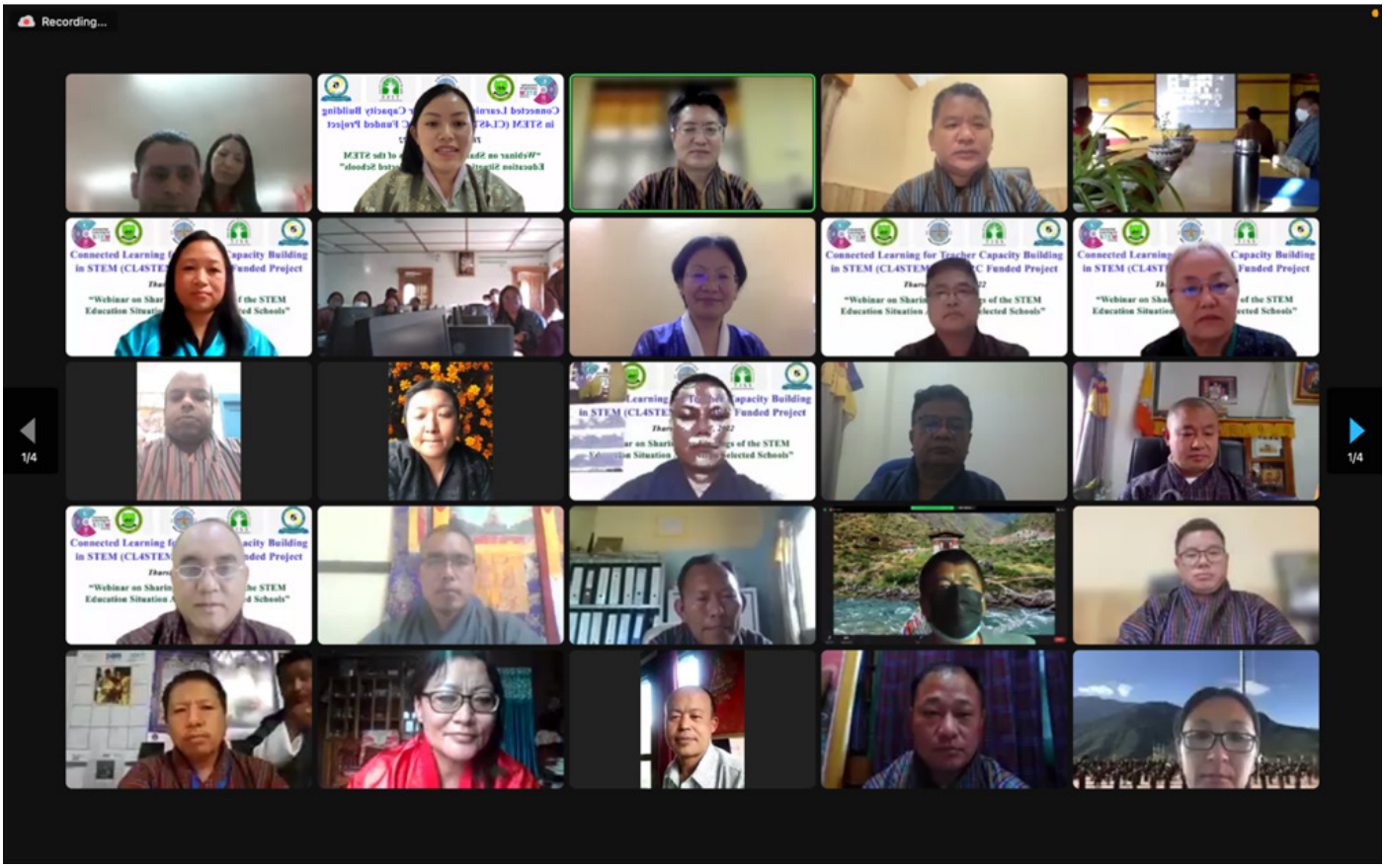
session was held in which officials from the MoE and the STEM teachers actively participated in clarifying their queries and making great suggestions to the research team as well as to each of the participants of the webinar. According to some attendees, CL4STEM's activities would undoubtedly benefit STEM educators and teachers in Bhutan. The main takeaway from the session was that the attendees appreciated the strengths, weaknesses, opportunities, and threats (SWOT) analysis conducted as part of the project and stated that such preliminary research will make it easier for stakeholders or schools to accept new proposed changes or activities.

The webinar ended with a vote of thanks by the moderator and a quick photo session of all the participants.

Dr. Karma Utha (Research Team Leader) sharing the findings

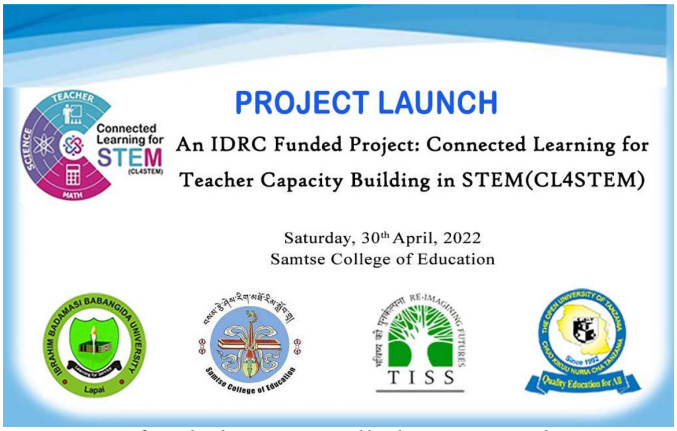


A total of 132 participants from across Bhutan attended the webinar.

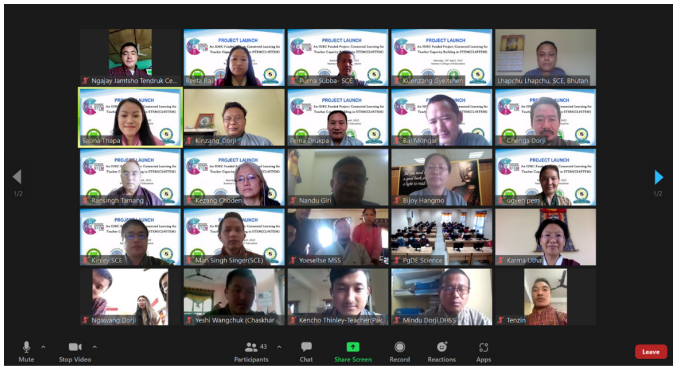


Reported by Ms. Sapna Thapa and Dr. Reeta Rai

Launch of the IDRC-Supported CL4STEM Project in Bhutan



An IDRC-funded project called Connected Learning for Teacher Capacity Building in STEM was successfully launched virtually on April 30, 2022. Officials from the Ministry of Education (MOE), Samtse Dzongkhag's Education Officers, Principals, and STEM teachers from middle and higher secondary schools were among those who attended. Mr. Kuenzang Gyeltshen, the officiating President, launched the project virtually with a welcome note emphasising the importance of STEM education in Bhutan. He also congratulated the STEM faculty members and expressed his best wishes for the project's successful completion.



Dr. Reeta Rai, the CL4STEM country project coordinator, then provided a summary of the project's aims and objectives, emphasising the numerous benefits that the partner schools and teachers will receive to improve the quality of STEM teaching, learning, and assessment through various project activities. She further elaborated on how the participating STEM in-service and pre-service STEM teachers' professional development will be carried out in participatory and localised ecosystems through a virtual learning environment, Moodle, and Telegram chat. She also stated that participants will be awarded certificates upon successfully completing the open education resources (OERs).

Following this, there was an introduction to the foundations of OERs namely: Universal Design for Learning (UDL) and Inclusive pedagogies, Reflective Teaching with ICT (RTICT), and Design Thinking. Mr. Pema Drukpa and Mr. Lhapchu explained the principles of UDL and how it has been used to design the OERs. They also emphasised how UDL takes care of diverse learners in their learning and assessments through hands-on activities. UDL session was followed by the RTICT session where Mr. Ran Singh reiterated how ICT should be used reflectively to support teaching-learning and assessments. Following this Dr. Kinley and Madam Ugyen Pem explained how Design Thinking can be used in classroom teaching-learning to enable students to develop creative and critical thinking skills.

In the afternoon the session started with the introduction of the common module on Pedagogical Content Knowledge (PCK) by Ms. Bijoy Hangmo and Mr. Lhapchu. The participants were briefed on the conceptual frameworks used to design the OERs and the various pedagogical approaches that the science and mathematics teachers should be applying in their classroom teaching. Following that, participants were divided into subject-specific breakout rooms and orientated on the OERs. The sessions were closed within the subject groups.

STEM Leadership Training in Water Resource Management for Community Leaders and Secondary Students of Norbugang Gewog, Samtse

Fieldtrip participants at River Diana, Norbugang Gewog, Samtse

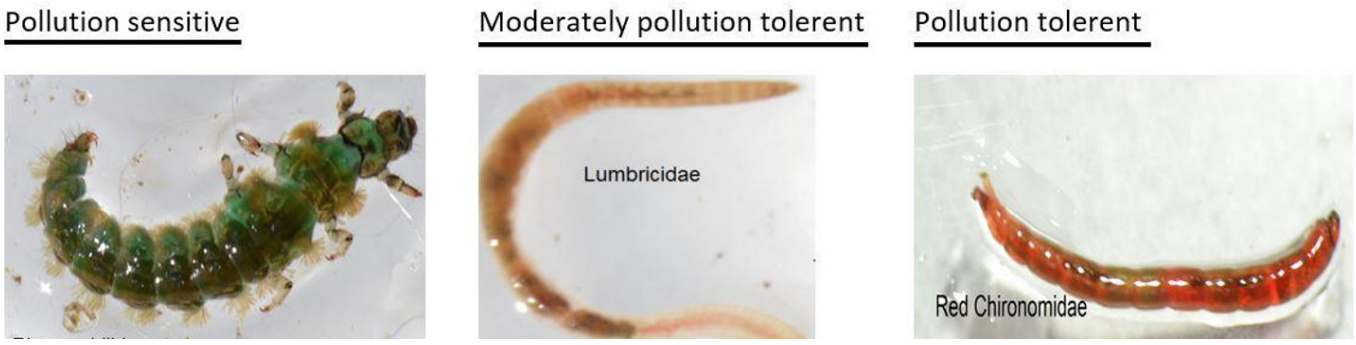
On 7th May 2022, STEM Education Research Centre (STEMERC) organised a community-level STEM activity to train local leaders and Environmental Science students from Norbugang Gewog in Samtse Dzongkhag. The STEM faculty members Dr. Nandu Giri, Dr. Kinzang Dorji, and Dr. Reeta Rai along with M.Ed I Chemistry and Biology students organised a field trip to River Diana in Norbugang Gewog. They were joined by community leaders, 29 students from Norbugang Central School, and their teacher. The primary aim of this activity was to build the capacity of community leaders and secondary-level students to manage their water resources and monitor surface water quality.
Furthermore, STEMERC hoped to accomplish the following objectives:

- explain the importance of managing their water resources;
- train community leaders and students in monitoring and assessing water quality using physical, chemical, and biological methods;
- orient teachers in designing community-based STEM activities or lessons to help students become problem solvers; and
- develop community leadership in STEM.

The STEMERC team briefed the invited participants on the trip's purpose and objectives. The participants were also explained the reason behind managing community water resources and reminded the participants to watch out for the increasing threats to water resources such as pollution, economic activities, and climate change, among other things.

Hands-on training in evaluating water quality

Following that, participants received hands-on training in assessing and monitoring river water quality parameters such as flow rate, dissolved oxygen (DO), pH, and alkalinity using an instrument. They were also introduced to water biomonitoring using macroinvertebrates, which is regarded as the cheapest and most reliable method of monitoring surface water quality. Aquatic macroinvertebrates are mostly insects in their nymph and larval stages, as well as other organisms that spend part of their lives in water, such as snails, worms, and clams. They contribute significantly to freshwater ecosystems by recycling nutrients and providing food to higher trophic levels. They are large enough to see without a microscope, and their distribution or habitat pattern can be used to assess water quality. Some live in freshwater, while others live in moderately polluted or polluted water.



Macroinvertebrates that aid in the detection of water pollution

Finally, students were taught how to mathematically analyse and interpret the collected data in order to inform the community and other stakeholders about their findings. Such hands-on STEM activities can motivate our students to work for the community's cause of preventing water pollution and managing their water resources. Similarly, they can assist community leaders in making decisions based on scientific evidence.

Reported by Dr. Reeta Rai

Workshop to Strengthen Collaboration between the CL4STEM Project Implementing Partner Schools and Samtse College of Education

The Connected Learning for Teacher Capacity Building in STEM (CL4STEM) project is funded by the International Development Research Centre (IDRC), Canada as part of the Global Partnership for Education Knowledge and Innovation Exchange (GPE-KIX). The project's primary objective is to strengthen the capacity of middle and secondary school STEM teachers. One of the project's major activities is to engage STEM teachers in using curated and adapted high-quality, locally relevant, interactive Open Education Resources (OERs) in the form of modules through an online mode. SCE STEM teacher educators developed thirteen OERs (one common and three modules per subject discipline) in collaboration with project partners. Teacher participants were expected to complete four modules as part of the project (one common and three subject-specific modules) and required to complete all assigned tasks, design three lesson plans, implement one lesson, and write a reflection. The modules intended to empower participants in subject content enhancement, emerging pedagogies, and technological knowledge and skills. Currently, forty STEM teachers from seven schools (five high schools and two middle schools) are enrolled in the project.

On July 2, 2022, the College organised a one-day workshop for the partnering CL4STEM schools to strengthen the partnership and provide clarity on the project's OER activity and its implications. The collaboration with the partner schools began in April 2022 with a virtual launching ceremony and webinars, and this was the project's first face-to-face meeting with the principals and STEM teachers of the partner schools. The workshop was attended by the College President, nineteen STEM teacher educators, the Principal Dzongkhag Education Officer (PDEO), 5 school Principals, 2 Vice Principals, and 40 participating teachers from Dorokha Central School, Tendruk Central School, Peljorling Higher Secondary School, Yoeseltse Middle Secondary School, Gomtu Higher Secondary School, Norbugang Central School, and Samtse Higher Secondary School.

The day-long workshop was divided into morning and afternoon sessions. The morning session began with an opening remark from the President, Project Lead, followed by an overview of the consortium by the project coordinator, and an orientation on Reflective Teaching with ICT, Universal Design for Learning (UDL), and Design Thinking, the three basic foundations of OERs. In the afternoon, STEM teachers were given hands-on experience with the virtual learning platform Moodle and its associated features and subject modules. This workshop facilitated STEM teachers' capacity to use Moodle and OERs also.

CL4STEM workshop participants

In his opening remark, SCE President emphasised the significance of STEM education and the need for STEM teachers to be equipped with the necessary knowledge and skills to prepare our students for the digital world. President further stated that the IDRC-supported CL4STEM project has arrived at a crucial moment in Bhutan's education system, which is undergoing transformation and embracing digital tools and resources.

Likewise, the guests provided the following positive remarks about the ongoing CL4STEM project.

Mr. Chhimi Tshewang
Principal DEO
Samtse Dzongkhag

" We are extremely fortunate to have a College in our Dzongkhag, which benefits the schools in the Dzongkhag. This project's learning will greatly assist our teachers in developing and improving their knowledge and skills. The dzongkhag is very grateful to the college for providing this important opportunity. We will continue to rely on the College for professional assistance in the future. The majority of the lecturers in the College with whom I have worked were found to be open and willing to assist the Dzongkhag Education Office and the schools in the field of professional development of teachers in the schools. The College President is regarded as a gentleman who welcomes any suggestions and looks forward to assisting everyone in their professional development. In the common pursuit of improving the quality of education we are extremely fortunate to be neighbours of Samtse College, which has educated and professional manpower."

Mr. Ajit Sherpa
Vice Principal
Norbugang Central School

" We are very fortunate to be a part of the CL-4STEM project. The national performance of students in STEM is low, and Samtse Dzongkhag's performance this year has fallen short of expectations. Such partnerships and workshops will allow us to improve our STEM teachers' skills and knowledge, which will ultimately benefit our students."

Mr. Tshueltrim Dorji
Principal
Samtse Higher Secondary School

" As a Bhutan Baccalaureate pilot school, we are embracing educational reforms that are starting to emerge in our school. One major reform focuses on maximising the full potential of every child in the STEM domain. As a member of the CL4STEM project, it would greatly benefit our STEM teachers in terms of capacity building to raise their bar and assist students in realising their innate potential in the STEM domain. I sincerely believe that the Bhutan Baccalaureate and CL4STEM projects are a portrayal of major STEM reforms that have been anticipated for decades."

Mr. Ugyen Dorji
Principal
Tendruk Central School

" I'd like to thank the College for considering our school as one of the participants. It is an honour for me and my colleagues to be a part of this event and the CL4STEM project. I anticipate that participants will have numerous opportunities to expand their knowledge and skills in content, pedagogy, and technology, allowing them to improve their professional competence in teaching STEM subjects. Since the professional development of teachers is critical to promoting quality teaching and learning of STEM subjects, our teachers' participation in this project will be a genuine and fruitful endeavour. STEM learning is expected to be more exciting for our children in the future as our teachers' professional skills and competence are further developed through this project. We anticipate and look forward to providing such professional development opportunities for our teachers in the future to help them advance their knowledge, skills, and competence."

Conclusion

The emerging trends in STEM education and technological penetration pose a challenge to educators and teachers; thus, this project is viewed as a timely intervention to help educators and teachers develop knowledge and skills to meet the challenges. The project has been extremely fortunate in receiving ongoing support from the district education office and the schools in Samtse Dzongkhag.

Reported by Dr. Kinley and Dr. Reeta Rai

Webinar Report on Technology and Lifelong Learning

Royal University of Bhutan

Webinar on Technology and Lifelong Learning

Date: Friday, September 16, 2022
Time: 5:00-6:15 pm

Samtse College of Education

BHUTAN SUPER FABLAB

Resource Person: Mr. Ujjwal Deep Dahal

Director of Innovation and Technology Department (InnoTech), DHI

[Join the Webinar by clicking here]

Meeting ID: 650 8215 9110
Passcode: 458968

Moderator: Ms. Neetu Acharya
(PgDE Math Student Teacher)

Organized by: STEMERC (STEM Education Research Centre)

Vision: Center of Excellence for STEM Education Research and Community Development

On September 16th, the STEM Education Research Center hosted a webinar on "Technology and Lifelong Learning," which was resourced by Mr. Ujjwal Deep Dahal, Director of the Department of Innovation and Technology (InnoTech), Druk Holding and Investments. The webinar was attended by the President, all faculty members, students, and some STEM teachers from the school.

Mr. Ujjwal Deep Dahal is also the Director of Bhutan Super Fablab, a leading tech company in the country. He earned a Bachelor of Engineering from PSG College of Technology in India, a Master of Science in Engineering from the University of Brunswick in Canada, a Master of Business Administration from the Quantic School of Business and Technology, and a Fulbright Research Fellowship in Technology Policy Management from the Massachusetts Institute of Technology in the United States. He is also a dedicated volunteer at the Royal University of Bhutan, serving as an external examiner and subject matter expert. His expertise, experience, and interests are in science, technology, and innovation, as well as technology strategy and planning and project management.

To summarize, he says that "passion about that one small idea can bring about a big change." Furthermore, he reminds everyone that individuals are not required to understand the nuts and bolts of technology, but should be aware of how technology is increasingly empowering us. Mr. Dahal started the session by asking the audience to think about what technology can do for them. He then reminded everyone that the mindset toward technology should focus on becoming empowered to solve problems.

The 6Ds of exponential organizations, a technology innovation theory developed by Peter Diamandis, was explained using current examples from Bhutan and the world at large. The 6 D's of Exponential Growth are described as Digitalization, Deception, Disruption, Demonetization, Dematerialization, and Democratization. In his book "Bold," Peter Diamandis guides the reader through the natural progression of innovative technology through a predictable path toward having a pervasive impact on a global scale. Mr. Dahal believes that by understanding the 6D's, we can gain a better understanding of digital innovation and be more aware of the stage at which our innovative idea is.

Singularity UNIVERSITY

THE SIX Ds
OF EXPONENTIAL ORGANIZATIONS

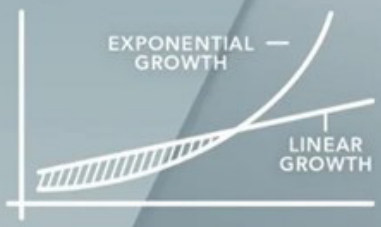
"The Six Ds are a chain reaction of technological progression, a road map of rapid development that always leads to enormous upheaval and opportunity."

—Peter Diamandis and Steven Kotler, *Bold*

DIGITIZED

Anything that becomes digitized enters the same exponential growth we see in computing. Digital information is easy to access, share, and distribute. It can spread at the speed of the internet. Once something can be represented in ones and zeros—from music to biotechnology—it becomes an information-based technology and enters exponential growth.

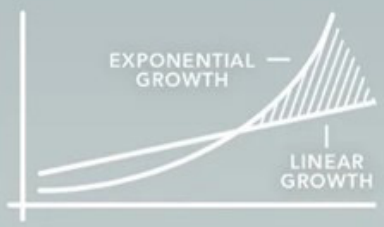
DECEPTIVE



When something starts being digitized, its initial period of growth is deceptive because exponential trends don't seem to grow very fast at first. Doubling .01 only gets you .02, then .04, and so on. Exponential growth really takes off after it breaks the whole-number barrier. 2 quickly becomes 32, which becomes 32,000 before you know it.

DISRUPTIVE

The existing market for a product or service is disrupted by the new market the exponential technology creates because digital technologies outperform in effectiveness and cost. Once you can stream music on your phone, why buy CDs? If you can also snap, store, and share photographs, why buy a camera and film?

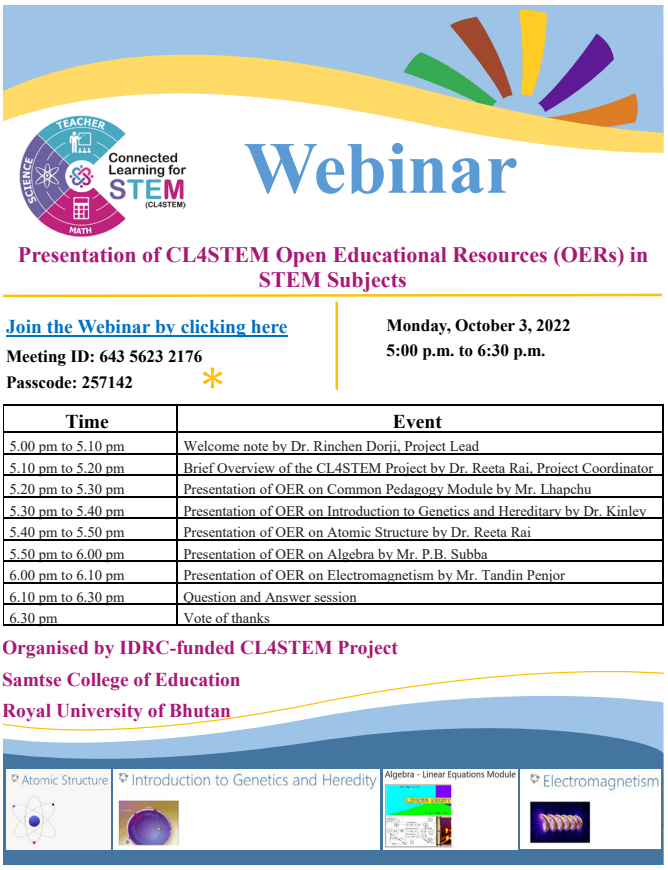


Source: https://www.diamandis.com/blog/the-6ds

During the question and answer session, several pertinent questions about the opportunities and challenges of using technology were raised to the resource person. While there is an abundance of technology available, he advised the audience that when selecting technology for teaching, learning, and assessment, we must ensure that it resolves the issues. Mr. Dahal also encouraged the audience in his closing remarks to become lifelong learners by designing one's own learning path by enrolling in numerous free online courses.

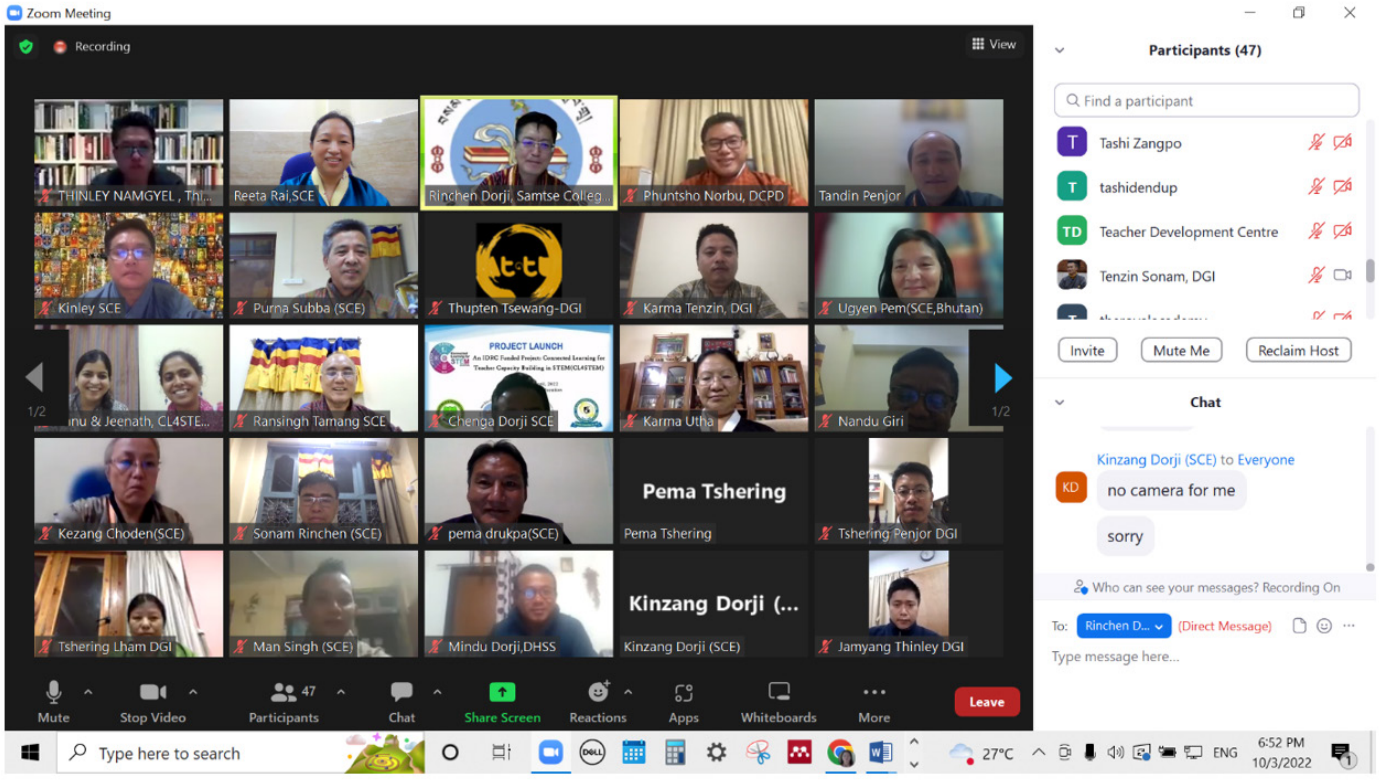
Reported by Dr. Reeta Rai

Presentation of CL4STEM Open Educational Resources (OERs) in STEM subjects



The STEM Education Research Center hosted a webinar on October 3rd to present a sample of OERs to STEM curriculum developers from the Ministry of Education and STEM teachers from Druk Gyalpo's Institute (DGI) in Pangbisa, Paro. Subject leaders from the project's various subject groups presented sample OER from Biology, Chemistry, Physics, and Math. The main objective of organizing this webinar was to share newly learned professional practices with the relevant stakeholders. This kind of resource and experience sharing is expected to benefit STEM education and the professional development of STEM teachers in Bhutan. Such an opportunity is also expected to assist us in contributing collaboratively to the larger national education goals of strengthening technology-enabled teaching, learning, and assessment practices in Bhutan's education system, as enshrined in the iSherig-2 Education ICT Master Plan 2019-2023, as well as realizing His Majesty's vision for STEM education.

The STEM teacher educators of SCE are supporting the professional development of the selected secondary STEM teachers of Samtse Dzongkhag through the use of OERs in STEM subjects curated as part of the CL4STEM project. The OERs in the three sciences (Biology, Chemistry, and Physics) and Math curated by the teacher educators and other consortium



partners have been aligned with Bhutan's national school curriculum frameworks. The foundational designs of OERs are based on Technological Pedagogical Content Knowledge (TPACK), Universal Design for Learning (UDL), and Higher Order Thinking with Inclusion and Equity. The main feature of these OERs is the use of technology/ICT as primary learning, teaching, and assessment tools that are customized to the local contexts and secondary school level requirements from grades VII to XII. The STEM teacher educators at the College spent about a year developing content materials for these OERs, which went through a number of vettings by the project consortium members and Tata Institute of Social Sciences (TISS) Mumbai, an international consultant with experience and expertise in such an educational innovation. Prior to launch, the College piloted these OERs with secondary STEM teachers from various dzongkhags and incorporated their feedback to make the OERs content more relevant and meaningful.

During the question and answer session, webinar participants commended the CL4STEM team's efforts in developing such OERs for the professional development of school STEM teachers. An officer from the ministry stated that the ministry had begun designing such OERs but was unable to proceed for various reasons and that the OERs developed by SCE could serve as a model for all STEM education stakeholders. Similarly, the STEM teachers from DGI raised questions about the incorporation of the life science domain and the cross-pollination approach while developing the OERs. The SCE teacher educators responded that they didn't know much about the Bhutan Baccalaureate (BB) curriculum when developing the OERs, but believe that combining the curriculum framework of BB and the foundational designs of OERs would significantly benefit the country's STEM education framework.

The webinar concluded with the CL4STEM project coordinator requesting continued dialogue and future collaboration in the field of STEM education among the stakeholders.

Presentation of Sample OER at the 48th University Academic Board Meeting

On November 29th, a sample of OER was also presented at the 48th Academic Board meeting of the university to emphasize technology-enabled teaching, learning, and assessment through Moodle. The board members included Dasho Vice Chancellor, Registrar, Pro Vice Chancellor, Department of Planning and Resources, Presidents, and a few academic deans from member Colleges. The board members praised the STEM teacher educators' efforts and proposed expanding it to other member colleges through the development of similar online courses for the professional development of University academics. Dasho Vice Chancellor emphasized the significance of promoting such works because a learner can participate in such open educational courses from anywhere and at any time. Similarly, one of the Presidents suggested that if STEM is taught using OERs, students will find learning more enjoyable and interesting.

Reported by Dr. Reeta Rai

Webinar to the M.Ed Students of Aix-Marseilles University

International Webinar: Teacher Education in Bhutan

'DISCOVERY OF ABROAD EDUCATIONAL SYSTEM

On November 28th, the STEM Education Research Centre hosted a webinar for M.Ed. Primary and Secondary students at Aix-Marseilles University. Three faculty members from the College did the presentation while the international audience was led by Dr. Maria Impedovo, Associate Professor in Psychology and Education at the School of Education, Aix-Marseille University, France. This was organized in response to a request from the University as part of the module "Discovery of Abroad Educational System."

Dr. Kinley gave a brief presentation on Bhutan as a country, the Bhutanese education system, and technological milestones. Dr. Reeta Rai then spoke about STEM Education in Bhutan, STEM Education Programs at Samtse College of Education (SCE), and SCE's international STEM education partnerships. Dr. Yangdon from the Department of Arts and Humanities was also invited to speak about the Green School concept. Mr.T.S. Powdyel, Bhutan's ex-education minister, introduced the Green School concept into the Bhutanese education system in 2010 to support the achievement of Gross National Happiness (GHN). His book, The Green School (2014), has been translated into Spanish, Catalan, German, Japanese, Kannada, and Vietnamese.

The session was very interactive, with many questions from the audience. They were curious to learn about Bhutan as a country, its culture, education systems, the social status of teachers, and educational policies regarding curriculum, medium of instruction, and school uniforms.

Reported by Dr. Reeta Rai

Arduino: Making Teaching Learning Materials Related to Science, Technology, Engineering, and Mathematics (STEM)

Introduction

Arduino is an open-source development platform that connects computers to the physical world to create electronic projects. The Arduino hardware is a microcontroller. A microcontroller is a microprocessor with memory, random access memory (RAM), and some other peripherals attached to it. The Arduino software is programmed through the Arduino Integrated Development Environment (IDE) software using Arduino Code or Sketch. There are different types of Arduino boards like Arduino Uno, Mini, Leonardo, Lilypad, Nano, and Mega. It is used by artists, designers, students, teachers, and engineers. It is used for scientific experiments, hacking and development purposes, such as weather forecast displays, traffic light control, robotic applications, self-driving vehicles, quadcopters/drones, home automation, healthcare, measurement devices, and Internet of Things (IoT).

The Royal Kasho on Educational Reform of February 2, 2021, emphasized the importance of strengthening students' critical thinking, creative thinking, lifelong learning skills, media literacy, and technological skills to prepare them to be interactive, collaborative, and problem solvers. His Majesty the King also stressed the importance of making STEM subjects a part of students' everyday language and has stated that we should facilitate learning that makes learners producers of knowledge rather than mere consumers of it. Therefore, learning to use Arduino when designing teaching-learning materials (TLM) can encourage teachers and students to undertake science projects in schools and colleges.

Some studies have reported that Arduino improves project-based learning through student interaction and group collaboration. It can also help teachers relate TLM to STEM concepts. With the help of Arduino, students can become makers under the supervision of a teacher and create various electronic projects with different levels of difficulty that can interact with the real world. Which, in turn, promotes STEM education.

On May 18, 2022, a presentation introducing Arduino was given by Sobit Pradhan during the club hour from 3:30 p.m. to 4:30 p.m. in the physics laboratory to the members of the astronomy club. The main purpose of this presentation was to give members an orientation on using Arduino in real-world applications. The presentation included the definition of Arduino, its hardware and software, code, types of Arduino boards, applications, Arduino's anatomy, steps to connect Arduino software and hardware, and a demonstration of using Arduino IDE software and hardware.

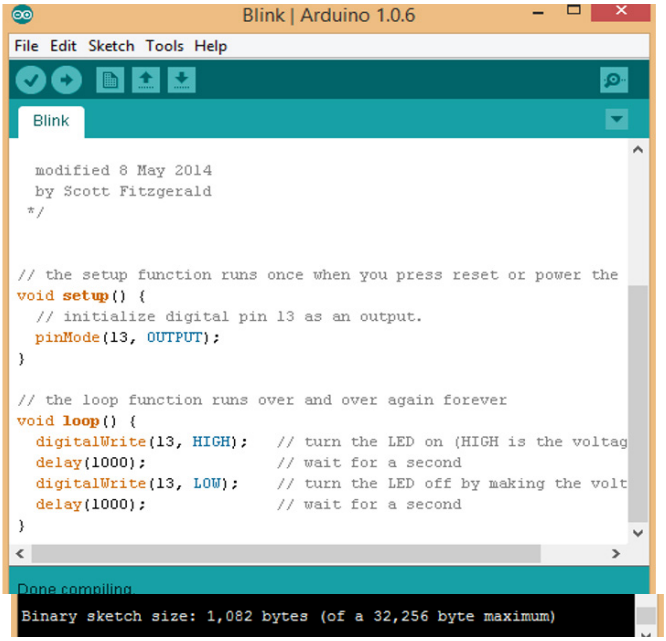
Demonstrations of Arduino-based experiments were performed, such as blinking LEDs and temperature sensors. Apart from that, the presenter showed the audience the video about making robots and shared his positive experience of using Arduino as TLM to teach about Light Dependent Resistor (LDR) with class X students in his school. The audience was quite amazed to see that robots could be made with Arduino and were very interested in using Arduino as a TLM. However, they shared that they have no knowledge of coding. In addition, the moderator pointed out that Arduino codes for various electronic projects are available on the Internet and the audience can also learn how to code using YouTube tutorial videos.

Figure 1

Explaining about Arduino's Anatomy

Figure 2

Coding in Arduino IDE



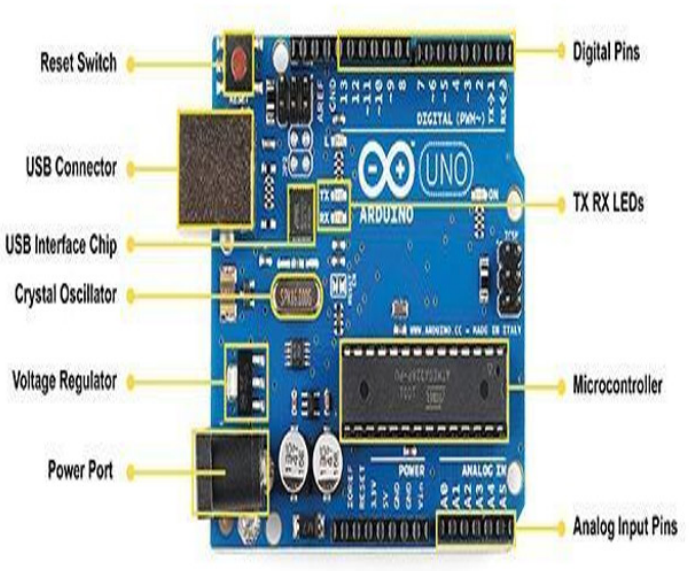
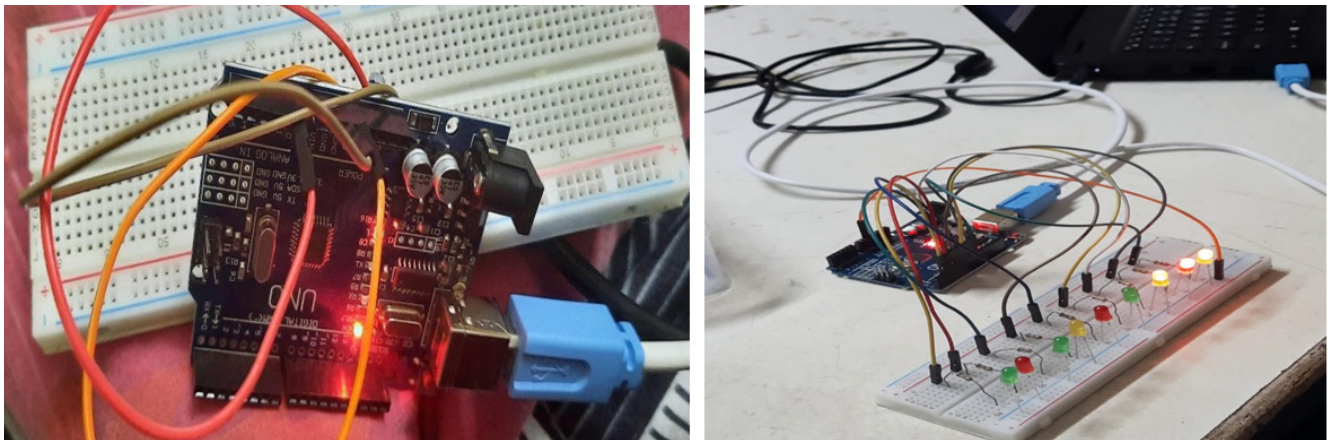


Figure 3

Explaining and showing the connection between Arduino IDE software, Arduino Uno & Bread board

Figure 4

Circuit connection and Blinking of LEDs using Arduino



Sobit Pradhan (M.Ed. I Physics) & Namgyel Wangchuk (M.Ed. II Physics)

Using Multi-representational Instruction to Overcome Preservice Chemistry Teachers' Misconceptions On Redox Reactions

The redox concept is an introductory chemistry concept that students need to conceptualize before learning more complex concepts, such as redox titrations (Masykuri et al., 2018). Moreover, this is an important concept that permeates several topics and includes many everyday life-related phenomena. Nevertheless, the redox concept is considered one of the most challenging chemistry concepts to teach and learn. Students have difficulties understanding redox concepts due to various abstract concepts that need a deep understanding at the sub microscopic level, leading to misconceptions (Wiji et al., 2021).

A misconception is an idea or conception that is mistaken and not grounded in scientific understanding (Luxford, 2014). It significantly affects how students build new scientific knowledge and inhibit their learning (Sendur, 2013). According to Brandriet et al. (2014), one of the potential sources of misconception is a student's inability to transition between the wide variety of chemical representations found in textbooks, lectures, laboratories, and scientific journals as a concept is represented through three domains such as symbolic, the macroscopic and the particulate. Many studies have identified misconceptions students hold regarding redox reactions (De Jong et al., 1995; Garnett & Treagust, 1992a; Österlund et al.,2010). For example, a study conducted by Masykuri et al. (2019) revealed that students experience misconceptions in all areas of the basic concept of a redox reaction, such as the redox concept based on losing and gaining oxygen, increasing and decreasing in oxidation number, and reducing and oxidizing agent concept. Furthermore, Üce and Ceyan (2019) stated that it is too hard to eliminate such misconceptions via traditional teaching methods. However, with the changing perspective, several new teaching techniques have emerged in education, and traditional teaching methods have been replaced by various constructivist learning methods (Üce & Ceyhan, 2019).

Therefore, this case study aimed to diagnose final-year preservice chemistry teachers' misconceptions about the basic concept of redox reaction at Samtse College of Education. In addition, the study also attempted to investigate the effectiveness of Multi-Representational Instruction in reducing the misconceptions based on the redox concept. The study employed the Redox Concept Inventory (ROXCI- a set of ten three-tier multiple-choice questions) adapted from Brandriet (2014) as a diagnostic test instrument. The first, second, and third tiers explain the concept of a redox reaction, the students' reasoning, and the student confidence level, respectively. The diagnosis of misconceptions about the basic redox concept is categorized into four themes, as shown in Table 1.

Table 1

Classification of the basic redox concept into four themes

Sl.no	Theme	Number of questions
1	Oxidising and reducing agent	4
2	Losing and gaining of oxygen	1, 3, 9
3	Losing and gaining of electron	5, 7 & 8
4	Increasing and decreasing oxidation number	2, 6 &10

An overview of the methodology (Figure 1) and a glimpse of the intervention period (Figure 2) are illustrated below.

Figure 1

Overview of Methodology

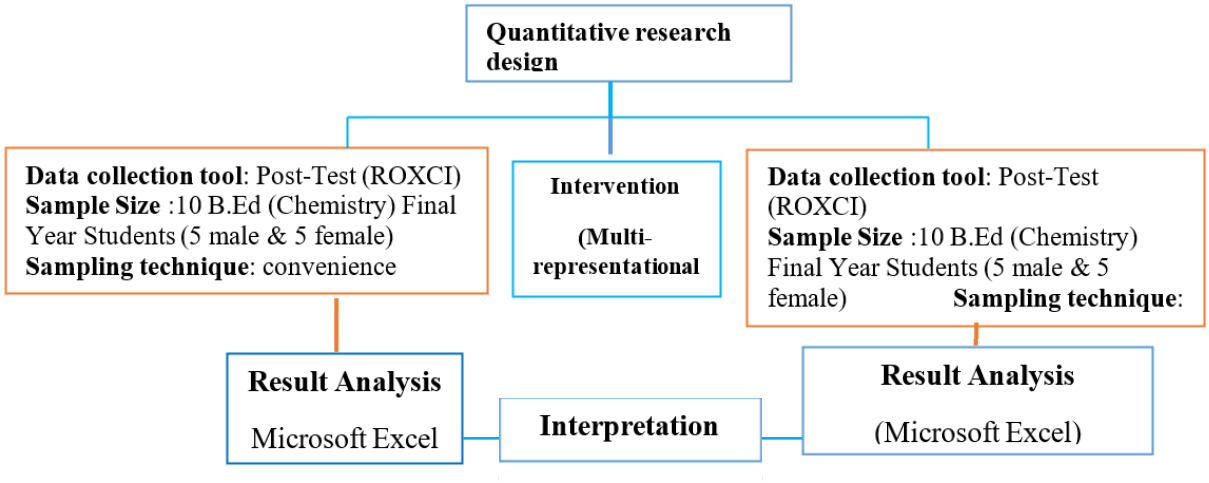


Figure 2

Glimpse of the intervention period

The data obtained from the study were analysed using Microsoft Excel and made a comparison between the pre-test and post-test. The percentage of students' responses to each concept category was used to detect the participants' misconception level. The comparative finding of misconceptions

in the basic redox concept of pre-test and post-test after intervening with Multi-representational instruction is given below in Table 2 and Figure 3

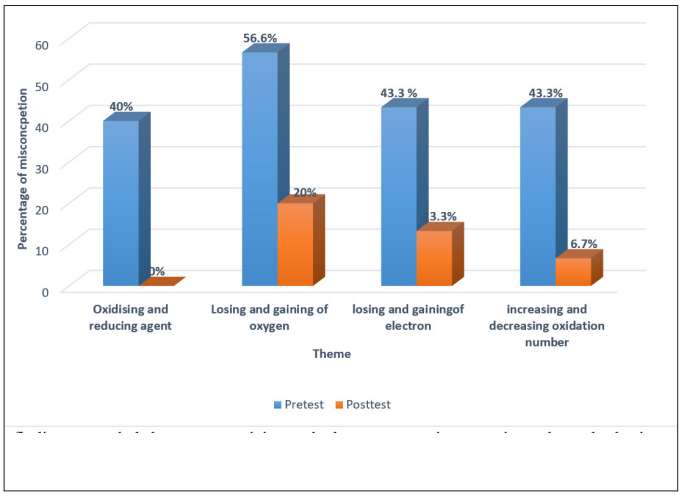
Table 2

Comparison of Pre &Post-test Analysis

Misconception	Pre-test	Post-test
Category of concept	Percentage	Percentage
Oxidising and reducing agent	40 %	0
Losing and gaining of oxygen	56.6%	20
losing and gaining of electron	43.3%	13.3
Increasing and decreasing oxidation number	43.3%	6.7
Overall %	45.8 %	10%

Figure 3

Comparison of percentage of misconceptions in pre-test and post-test



The findings revealed that most participants had numerous misconceptions about the basic redox concept before intervention. Many participants could occasionally choose the correct answers. However, they could not support their answers with reasons from the second tier with less confidence in choosing an answer from the first and second tier, indicating that they have some knowledge of the concepts of the redox reaction, but it is incomplete and not scientifically correct. Table 2 and Figure 3 shows that intervention such as Multi-representational Instruction (visual, textual, audio, and hands-on activity) have helped address students' misconceptions. The percentage of misconceptions has drastically decreased in every theme, indicating that the intervention positively addresses the misconceptions. The overall percentage of misconceptions among students during the pre-test was 45.8% and decreased to 10% in the post-test, as shown in Table 2 and Figure 3. The use of ROXCI diagnosed the following set of misconceptions;

- The substance that is oxidized is the oxidizing agent, and similarly, the substance that is reduced is the reducing agent
- Elements in a redox reaction cannot be both oxidized and reduced
- Oxidation numbers represent an ionic charge in a polyatomic ion or a covalent molecule
- Oxygen is necessary for every redox reaction
- A combination reaction is not redox because there is only one product, so oxidation and reduction cannot occur
- In a redox reaction, a metal must be a reactant

Multi-representational Instruction (visual, textual, audio, hands-on activity) about the macroscopic phenomenon and the possible actions occurring at the sub microscopic level with a simple explanation of the concepts was used as an intervention. Teaching with multiple representations not only supports student learning but has the potential to capture students' interest in a specific domain (Ainsworth, 1999). In addition, multiple representations provide students with a range of opportunities to construct the targeted knowledge; if a student fails to un-

derstand a concept concerning one particular representation, another representation may be more effective and engaging (Ainsworth, 1999). Post-instruction findings revealed that the Multi-Representational instruction was more efficient in promoting a scientific understanding of the redox concept and reducing alternative conceptions. The study's three-tier multiple-choice tests (ROXCI) aided in diagnosing students' misconceptions about the fundamental redox concept. Incorporating such investigative tests into our instruction allows us to identify students' misconceptions and intervene as needed to bridge the gap. A teacher should be well-versed in the content they will deliver in class, be aware of a child's prior knowledge of the topic, identify misconceptions, and use appropriate teaching strategies to help students retain the concept for extended periods. On the other hand, misconceptions cannot be eliminated if a teacher fails to diagnose students' misconceptions and provide necessary intervention. Thus, the following suggestions may help the teacher to address any misconceptions;

- Identifying students' misconceptions is the first step in preventing misconceptions in chemistry.
- Chemistry teachers can use Multi-Representational instructions to clear students' misconceptions. Students can see the same concept presented in multiple ways when it is presented in multiple representations. This strategy aids students in understanding the fundamental redox concept and can be used effectively when conceptualizing redox titration.
- Chemistry educators may use a variety of representational tasks, discussions and collaborative work to provide preservice chemistry teachers with opportunities to learn the specific content. Such opportunities may assist preservice teachers in developing more scientific conceptions and providing ideas for how to use similar strategies in their future teaching careers. Furthermore, this study may help preservice teachers think deeply about fundamental chemistry concepts and recognize their inadequate or non-scientific understandings.

Rinzin Wangmo
M.Ed. II Chemistry

Blended Learning Approach in Teaching Chemistry

Blended learning is an innovative approach to the teaching and learning process that embraces the advantages of traditional teaching and ICT-supported learning for both offline and online learning (Hinampas et al., 2018). I strongly feel that blended learning is the revolutionized approach to innovating and rethinking the way teaching and learning processes must take place, in the current context, where modernization means digitization and children are considered to be digital natives. Hence, if there is one best approach for effective teaching and learning, it is blended learning. In recent times, the Ministry of Education (MoE) of Bhutan has been emphasizing blended learning, especially during the pandemic. However, I have been less serious about using it in the teaching and learning processes. I misunderstood blended learning as a sheer waste of time, energy, and resources, trying to teach the same concept or topic, online as well as face-to-face teaching in class. I now realized that it has a major role in the teaching and learning of chemistry concepts as well as practical skills, effectively.

The study done by Hinampas et al. (2018), found an increased academic achievement of the students when the blended learning approach was used. Similarly, I also came across a similar trend in the academic year 2020. I taught the periodic table in class 9 chemistry, with the use of zoom to the students who have access to the gadgets and can afford the internet charges during the nationwide lockdown. For the students who were deprived of internet facilities, I taught them face to face, during the mobile teaching session. 'Mobile teaching' was initiated by the school administration under the directives of the MoE, where teachers move from village to village twice a week to teach and evaluate the students' learning, specifically those who do not have access to the online class. During the mobile teaching, I focused more on the students who were disconnected in online teaching and learning sessions. On the other hand, the students who had access to online classes were also taught altogether. By doing this, I came to conclude that the students who attended online classes, as well as mobile classes (blended mode), had higher grades in the annual examination than the rest of the students.

Hinampas et al. (2018) also found significant differences amongst the students in terms of practical skills; questioning skills, communication skills, designing skills, and analyzing skills when a blended approach to learning was used. Although I do not have any experience in teaching chemistry practical using a blended learning approach, I firmly believe that the laboratory skills of the students will be enhanced. This is because the blended learning approach provides enough time, resources, and opportunities to familiarize with the contents and skills before the onset of the practical class in the laboratory. Further, it provides an opportunity for the students to discuss and learn amongst themselves and interact with the teacher. Moreover, such practices allow the students to prepare well for practical classes.

In Bhutan, the blended learning approach will have a promising future in educational institutions, across Colleges and Universities. With the *Royal Kasho* on the Education Reformation, the Royal Government and the MoE are working closely on the pedagogical and curriculum transformation. One of the reformations is focused on the integration of information and communication technology (ICT) in daily teaching and learning practices. Further, I feel that the chemistry concepts are abstract. Due to its abstractness, children find it difficult and take more time to learn, compared to other science subjects. In these contexts, perhaps blended learning could be only the learning approach that promises sufficient time to teach and learn chemistry effec-

tively. In addition, children of this age are known to be digital natives, and the use of electronic gadgets for teaching and learning processes is an advantage for them. It is the prime obligation of any teacher to integrate ICT into teaching and learning processes. Otherwise, it is an injustice to the digital natives, not to use ICT during the teaching and learning processes. Therefore, I strongly feel that blended learning will turn out to be the backbone of instructional, pedagogical, and learning approaches in the years to come, in Bhutan.

However, blended learning will encounter numerous challenges in Bhutan owing to these reasons: Firstly, due to the poor internet connections, remote pockets of the country either do not have internet access or have poor connectivity. Secondly, due to the hefty internet charges, the internet charges in Bhutan are so high that the majority of the people in the country cannot afford its use for everyone in the family. Likewise, lack of expertise among the teachers in the country in using a blending learning approach. The schools also lack the required ICT facilities for the teachers' and students' use and also some parents are not able to buy electronic gadgets for their children. Finally, there are issues in monitoring children's usage of gadgets as they utilize them for online gaming and may become victims of cyberbullying and cyber-related crimes, which may impair their health and attitude.

In summary, blended learning is the aspiring innovative approach to learning that embraces the advantage of both online and offline teaching and learning processes and has been shown to increase students' learning interest and academic achievement.

Kinley Wangchuk
M.Ed II Chemistry

Teaching and Learning Resources Development for Chemistry Using eXe

This article reflects on the use of the eXe tool for the development of learning resources for students in chemistry. It consists of the conceptual definition of the eXe tool, seven strengths of the eXe tool in the teaching and learning of chemistry, and four challenges of using eXe tool based on my experiences of using it in the development of teaching and learning resources on Halogens.

eXe is an open-source application that allows the creation of a learning resources package without the need to use HTML/XML. The icon of eXe looks as presented in Figure 1. Its features enable the users to create the webpage, by using various multimedia platforms, as well as links to other online resources without the need of expensive web-publishing software. eXe provides an avenue for the teachers and students to optimize resources as it is also operational in the offline mode. Further, the use of eXe applications enhances the students' learning of chemistry. The use of eXe applications in the teaching and learning process is attributed to the following strengths.

Figure 1

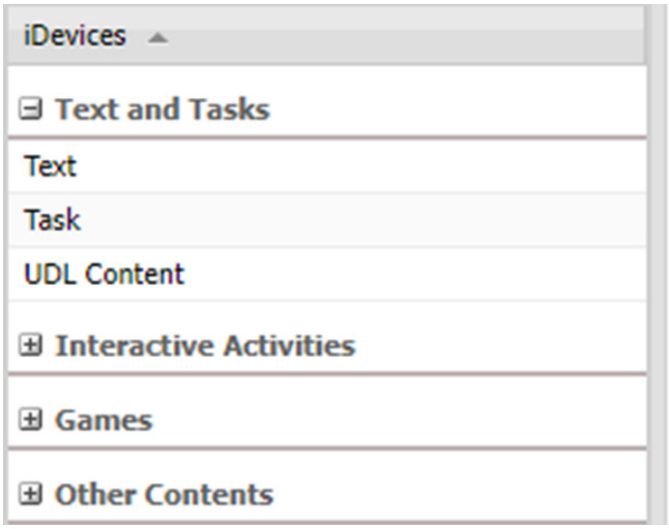
eXe Software Icon

The students can use eXe in a flexible manner. Participants who are unable to attend the class, are too shy to speak and interact, and unable to afford the time can study the same topics on their own by upgrading their knowledge using

the eXe applications. eXe provides numerous features of interactive activities, adding variety to the teaching and learning materials and resources such as quizzes, dropdown activities, true or false, fill-in-the-blanks, games, and interactive videos as shown in the Figure 2. Such interactive activities will engage the students meaningfully in the teaching and learning processes. In addition, the use of such interactive activities will cater to the diversity of learners.

Figure 2

Features of Interactive Activities Provided by eXe



The eXe also provides the features of embedding various online resources like online videos such as YouTube videos, online platforms such as Padlet, slides, and various online links, which enriches the teaching and learning materials used in the classes. Further, the use of YouTube videos enables the students to learn from various experts and professionals other than the teacher teaching chemistry. The eXe program can be operated in offline mode without the need for internet access. Therefore, its uses can serve the purpose of teaching and learning resources in remote pockets of places and educational settings where there is no internet accessibility.

The eXe application is designed in a way that its features can be customized through the use of HTML codes. For example, the padlet and slide can be embedded in the eXe interface into the eXe files directly, using the HTML codes ensuring the teachers' and students' access to the online resources without the requirement to insert links as indicated in Figure 3. The use of eXe suits the learning needs of twenty-first-century students as it provides features of integration of technology into teaching and learning processes. My experience of teaching chemistry in schools made me realize that the use of technological tools and internet resources with the use of gadgets such as mobile phones and computers motivate students to learn more and perform better in tests and examinations.

Figure 3

eXe Feature Customization Through Use of HTML codes

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<marquee><font color="red"><font size="8"><font="bold">
Welcome to lesson on Halogens </font></marquee>
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Finally, the use of eXe in the teaching of chemistry enhances the students' learning of chemistry. For example, a study done in the senior high school at Al Hidayah Medan in Indonesia found a significant correlation between motivation and learning outcomes of students that learned through direct learning model instruction with eXe learning media for teaching redox reactions (Sari et al., 2017). This finding is consistent with the study done in Universitas Negeri Medan, Indonesia by Juniar et al. (2018) on the learning of analytical chemistry with guided learning by using eXe. Further, the eXe provides the platform for the use of multimedia. Multimedia technology is a highly effective approach to developing and enhancing knowledge and memory in children. My experience as a chemistry teacher for the last nine years found out

that the basic foundation of learning concepts in chemistry is the memory and the ability of the students to build up on the knowledge from the classroom.

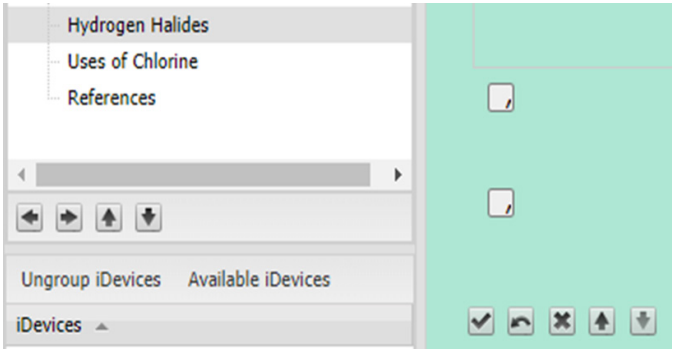
In addition, interactive videos, which can be made within the features of the eXe or embedded using external links or HTML code, engage the students meaningfully in the teaching and learning process.

However, my experience of using eXe for the development of a webpage on Halogens by using eXe made me realize four limitations, as given below:

- The features of writing chemical equations were not available. Writing superscripts and subscripts, which are the fundamentals of chemistry, is not an evident feature of eXe.
- Adding a new page before the added page is not possible in eXe. This means that once the page is created, there is no option to create a new page above the already created page, which adds inconvenience for the teachers working to develop resources for the students.
- The eXe does not have the features of customizing the web pages at different positions in a variety of ways. The page setting is restricted to only the left side of the home page.
- The eXe application is not very user-friendly. The language used in the eXe is confined to its own language. It does not resonate well with other computer languages and online platforms. For example, the save button in the eXe is in the form of a tick mark, delete with a cross mark, and edit with a pencil mark, as shown in Figure 4. The use of such language in the eXe restricts other users, who are a beginner, from trying to use it.

Figure 4

Non-User-Friendly Language of eXe



In conclusion, eXe is an open-source application that allows the creation of a learning resources package without the requirement to use HTML/XML. The use of eXe in teaching and learning chemistry has many strengths, such as its utility value within the comfort of the students, provision of a variety of features such as interactive activities, embedding various online resources, and page customization with the use of HTML codes. In addition, the feature of eXe that enables it to function offline is another advantage. Further, the use of eXe applications enhances the students' learning of chemistry. However, the eXe is subjected to four limitations as stated above.

Kinley Wangchuk
M.Ed II Chemistry

Rivers Study

Rationale: One of the robust and widely used approaches for assessing the ecological conditions of perennial streams and rivers, rely on indicators of stream dwelling biotic communities such as fish, benthic macroinvertebrates, periphyton, and the physical attributes of the stream channel and surrounding riparian area. These parameters can provide useful information about whether a stream or river is healthy or degraded.

Introduction: To comprehend the current status of 'stream water quality' influenced by the ongoing industrial developmental activities at the Damdum stream, a rapid field bio-assessment protocol was employed using stream dwelling

macroinvertebrates as bio-indicator of environmental stress. Bio-indicators are biological organisms that readily reflect both biotic and abiotic state of an environment, representing the impact of environmental change on a habitat, community, or ecosystem in general spatially and temporally at the given areas. Among them, the most preferable bio-indicator is the stream dwelling benthic macroinvertebrates. The purpose of this article is to create the sense of awareness on bio-assessment protocol among students, teacher educators and other environment enthusiasts. Outreaching the science based information to larger public domains is critical and instrumental for water resource conservation. Its aims include assessing the current ecological status of local stream systems influenced by the ongoing developmental activities, and assessing the stream water quality using benthic macroinvertebrates as most preferable bio-indicator of environmental stress on water resources.

Methods: Field Samplers included a total of 39 M.Ed. students from four different subject disciplines (viz. Biology, Chemistry, Physics and Mathematics) along with 4 respective module tutors and a biology lab assistant. This arrangement was done to bring in the concept of the Bhutan Baccalaureate Curriculum - so called the 'Cross Pollination' into our programmes.

Macroinvertebrate samples were collected from the perennial stream of Dhamdum, located approximately at 260 66'04.4"N and 890 04'26.3'E (Upstream site) and 260 54.4'18.4" N and 890 05'09.0'E (Downstream site) at an elevation of 417m above the sea level.

Field samplings were performed using a triangular shaped dip net, followed by field sorting, preservation, and lab identification. The collected samples were sorted into separate taxonom-

ic groups and identified down to family level using HKH (Hindu-Kush Himalaya) identification key to the family level. The stream status and water quality were determined using the HKH Eco-data management Tool (ECODAT) assessment software. Therefore, the findings described in this article are based on the available taxa scores and weightings assigned within the HKH-ECODAT processing software.

Results and Discussion: A total of 501 macroinvertebrates belonging to 14 families and 5 taxonomic orders were captured from 6 dip standard net samplings. At the upstream site, the most dominant macroinvertebrates include Trichoptera, Ephemeroptera, Plecoptera, Odonata and Coleoptera. Their presence in the stream ecosystem indicates stable water quality because most members of these orders remain sensitive to environmental stress. Therefore,

presence of such sensitive macroinvertebrates in the stream system collectively infers an undisturbed stream system at the upstream site corresponding to 8.57 HKH scores and river class I (Table 1). However, the abundance of these organisms' decreases as the stream water quality deteriorates downstream. This trend may be attributed by the effluent discharge from the construction activities as part of industrial development and the quarry activities due to stream bank sedimentation. Thus, declining trends of taxa richness, evenness and abundance have been observed at the downstream site (Figure 1).

Figure 1: Comparative HKHScores between Upstream & Downstream

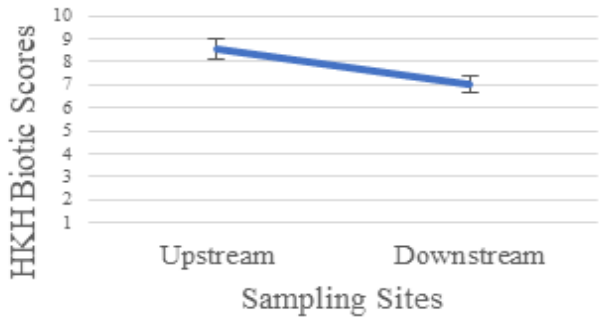


Table 1

The HKH biotic scores and its corresponding river quality class.

Sampling sites	HKH-biotic scores	River Class	Water Quality
Upstream	8.57	I	Reference
Downstream	7	II	Good

Conclusion: Biological communities are sensitive to environmental stresses influenced by both natural and anthropogenic activities.

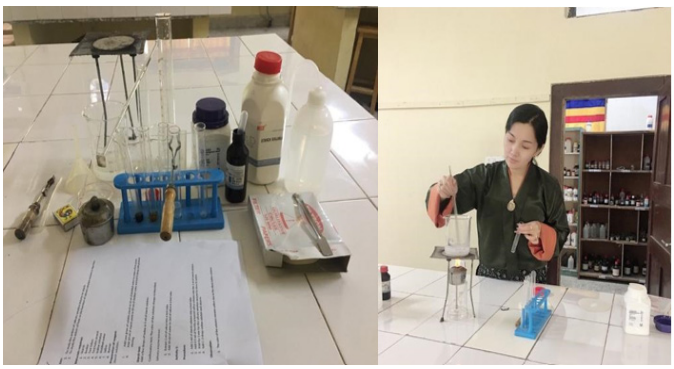
Present study indicates the HKH based biotic scores (Table 1) classifies the upstream site as Reference and downstream site as Good stream water quality. Although River Class corresponds to Reference and Good water quality status, its overall declining trend in terms of HKHScore, River Class and Water Quality indicates the alteration of biotic communities of stream ecosystem.

Kinzang Dorji (Lecturer), Lekraj Ghalley & Tandin Zam, M.Ed II Biology

Investigating the Action of Salivary Amylase on Starch to Eliminate Students' Misconception on Human Digestive System

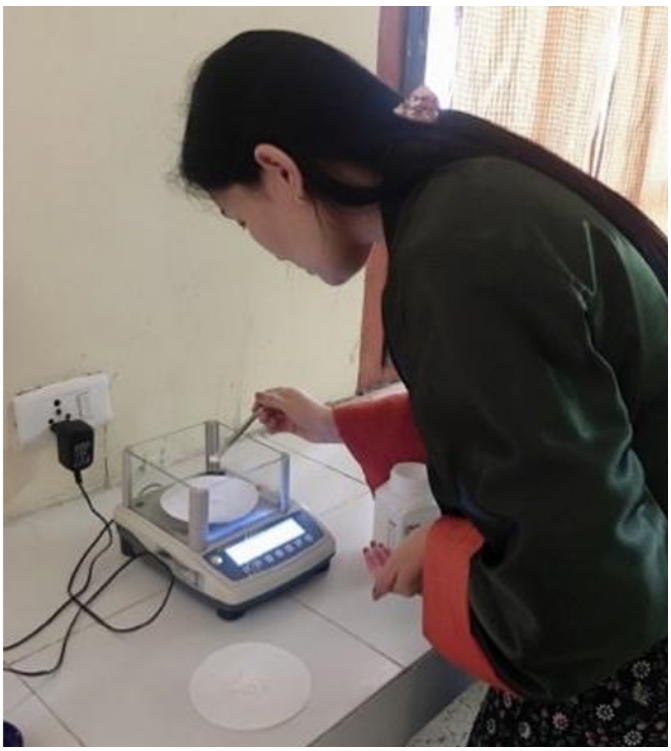
Introduction: One of the most important factors that impedes effective biology education is attributed to the prevalence of various misconceptions in students. Unless an appropriate intervention is remediated at the right time, the misconceptions may continuously pose hindrances for students in constructing an adequate mental representation of the science based phenomena due to various abstract natures of biological concepts. For example, the concept of digestion is taught from grade VI to X level in the Bhutanese schools. It is imperative that biology teachers comprehend the prevalence of students' common misconception on the human digestive system. One of the most common students' misconceptions that prevails on digestion is students generally believe that food digestion begins initially from the stomach. So, this lab-based designed experiment is intended to demonstrate how biology teachers can demystify the prevalence of students' misconception on "chemical digestion of food begins initially from the stomach."

Methods: A lab-based experiment was conducted in Control and Experiment settings to show that chemical digestion of food actually starts in the mouth where salivary amylase (digestive enzyme) acts on the starch in food and converts to simple sugar known as maltose. Lab procedures included:



A. Preparation of the reagent starch solution where one gram of soluble starch was added in 10 ml of distilled water to make a thick starch paste. Subsequently, added 90 ml of distilled water to the prepared starch paste and boiled with gradual stirring for 3 minutes.

B. Salivary enzyme extraction- where 2 ml of saliva was added to 10 ml of distilled water in a test tube.



C. Confirmatory Test- 1 ml of freshly prepared saliva solution was added to 2 ml of starch solution in a test tube. The set up was allowed 3 minutes for the salivary amylase enzyme to show its action. Then added 2 -3 drops of iodine solution for a confirmatory result.

Results: Experiment revealed that starch solution with salivary amylase showed no indication of starch (i.e. lack of blue-black colouration) when a few drops of iodine were added to the solution. This outcome indicated the absence of starch in the solution since salivary amylase has already digested starch into maltose in the event. While in control, a set up that consisted

of only starch solution without salivary amylase turned blue-black when a few drops of iodine were added, indicating the presence of starch. The experiment was conducted to provide evidence on the digestion of starch that actually begins initially in the mouth.

Conclusion

After the conduct of this particular experiment on Digestion, students' misconception on digestion beginning in the stomach would be clarified. Students would understand that initial digestion of starch begins in the mouth with the help of enzyme salivary amylase. The starch gets digested into maltose and as a result it produces a sweet taste in the mouth. The breakdown of large insoluble food substances into smaller soluble food molecules for easier absorption through the villi of the small intestine into the bloodstream is known as digestion. Digestion is classified into two types i.e. mechanical digestion and chemical digestion. When food is broken down into smaller parts by physical force such as chewing, it is known as mechanical digestion whereas in chemical digestion breaking down of food into basic units involves acids and digestive enzymes.

Tandin Zam. M.Ed II Biology

Food Waste and its Safety for Animal Consumption

Introduction

Food waste is an issue that is inextricably linked to food safety. Globally, an estimated 1.3 billion tonnes of food are lost and wasted each year (Gustavsson et al., 2011), enough to feed more than a billion people. Food waste is also a resource and sustainability issue. With the wastage of food, resources are sacrificed in vain and environmental pollution increases. To sustainably meet the growing food demand in the face of climate change and dwindling resources, improved use of the food produced and the reduction of waste is a necessity.

In developed countries, the largest waste stream is generated at the end of the food chain, including consumer-facing businesses (supermarkets, grocery stores, distribution centres; restaurants; institutional food services), schools, colleges, and households (Xue et al., 2017). When the food is no longer fit for human consumption, food waste is diverted to animal feed or energy generation systems. Therefore, a study was carried out as a part of the Project Based Learning in Teaching, Learning, and Assessment module under the supervision of Dr. Karma Utha and Madam Bijoy Hangmo Subba. This study aimed to create a database that could be used to determine how safe the food waste derived from Samtse College of Education (SCoE) garbage was for animal consumption.

Objectives

- Analyse the physical parameters and organic components of food waste.

▶ Suggest appropriate approaches for safe food waste consumption.

Question

How safe is the food waste generated in the SCE mess safe for animal consumption?

Methodology

Three samples of food waste were collected from the college mess. The collected materials were stored in appropriate conditions for the analysis. It is stored in a secure weatherproof container and stored below 10oC in the refrigerator. The analysis was conducted to determine the physical parameters and identify the organic compounds present in the food waste. The pH was analysed by Multi-parameters and the moisture and ash content were measured by thermo-gravimetric analysis (TGA) as per the guideline developed by the American Society of Testing and Materials ([ASTM], D3173 standards). The detailed procedures are discussed below:

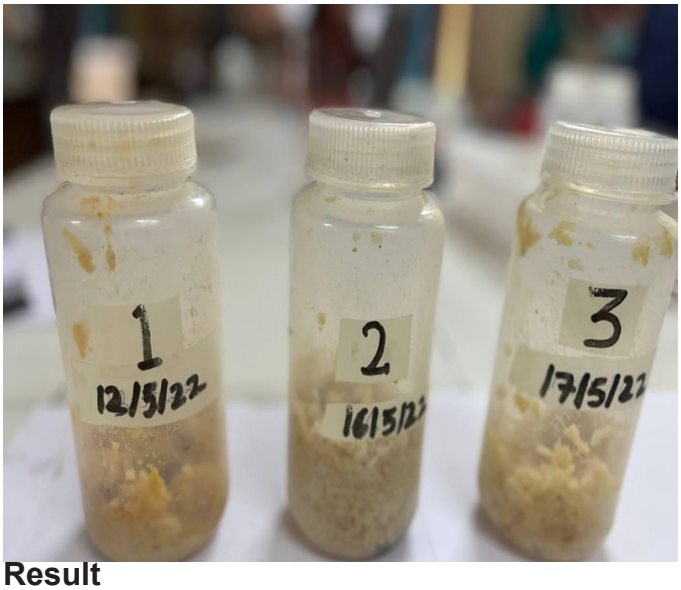
Table 1

Physical Parameters and analytical procedures

Sl. No	Physical parameters	Procedures
1	**pH**	The pH was measured by mixing the sample with distilled water and determining the pH of the resulting aqueous solution using the Multi-parameter, equipped with a probe for detecting pH
3	**Moisture content**	The moisture content of the food wastes samples was determined by weighing 20 g for each sample. The sample was then dried at the temperature of 100 °C for one hour (ASTM, D3173 standards). The dried samples were weighed again and recorded the observation. The percentage moisture content was calculated using the formula: $\%\text{Moisture content} = \frac{(Wet\ weight - Dry\ weight)}{Wet\ weight} \times 100\%$
4	**Ash Content**	Ash content of the wastes is the non-combustible residue left after the waste is burnt. The samples were weighed and placed in a furnace for about 6 min at a temperature of 950 °C according to ASTM D3175. After combustion, the samples were weighed to determine the ash dry weight. $\%\ \text{Ash} = \frac{(Weight\ of\ dry\ sample - Ash\ weight)}{Dry\ sample\ weight} \times 100\%$

Figure 1

Food Waste Samples Collected for the Analysis of the Physical Parameters



Result

Through the analysis of the physical parameters, it was found that Sample 1 (S1) was acidic and PH increases from Sample 2 (S2) to Sample 3 (S3). The moisture and ash content also revealed that the S3 got the highest content compared to the other two samples as shown in Table 2. The physical analysis was also employed to analyse the organic components. The samples were mostly found consisting of rice, potato, cabbage, chilli, onion with some salts, and oil as shown in Figure 2. The following results were compared with the existing literature in the discussion section to determine whether the SCoE food waste was safe for consumption by animals such as pigs and cows.

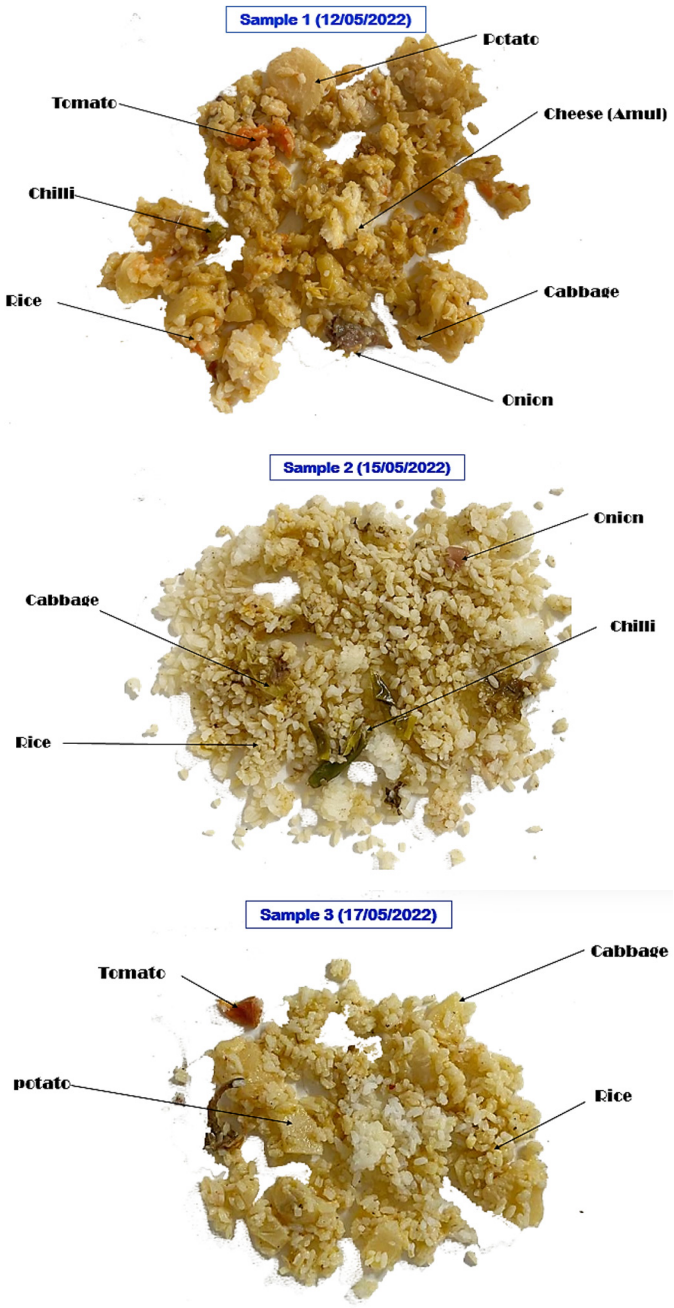
Table 2

Results recorded from food waste samples

Sample	pH	Moisture Content %	Ash Content %
S1(12/5/22)	3.72	24.37	93
S2(15/5/22)	3.95	26.53	93.1
S3(17/5/22)	6.05	29.18	95.2

Figure 2

Organic Components in the Food Waste Samples



Discussion and Conclusion

The primary objectives of our study was to conduct physical and organic components analysis of food waste and to recommend the applicable approaches to safe food waste. The pH of our food sample was found 3 - 6.5. Our findings were found consistent with several other studies. For instance, Missotten et al. (2015), found that the required pH for feeding pig and cow is to be lower than 4.5. This is because enteric pathogens, such as E. coli and Salmonella spp., do

not tolerate pH values below 4.5. Similarly, the moisture content of the samples was found between 24 % to 29.5%. As per the United States department of agriculture ([USDA], 2015), and the Food and Agriculture Organization of the United Nations ([FAOUN], 2013), food waste as feeding should be stored at or below 12% moisture content at this temperature, to avoid the risk of the development of mites. As per USDA, (2015), ash content should be above 59% in the food waste to feed animals. Ash contents help to determine the amount and types of minerals in food. We found 93-95% of ash content in our samples.

The analysis of the organic components showed that the food waste contained more carbohydrates (rice and potatoes) and a certain amount of onions, chillies, tomatoes, salt, oil, and cabbage. According to USDA (2015), overfeeding carbohydrates has compromised meat quality, milk production and risk animal life due to bloat complications.

Our findings indicate that the food waste generated by mess was satisfactorily safe for consumption by the animals. However, it did not meet the safest range as indicated by international standards. Therefore, additional food waste preservative measures still need to be implemented to ensure the safest food consumption for animals.

Limitations

Data was collected using only the scientific quantitative approach of three food waste samples from the SCE mess. Therefore, the finding cannot be generalized to all the food waste in Bhutan. However, future studies could analyse more samples and employ mixed method studies to include interviews and open-ended techniques to gain a better understanding and insights from related stakeholders.

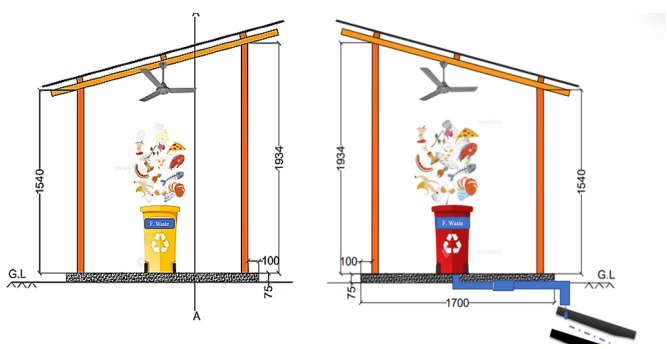
Recommendations

The food waste we generate greatly affects the health of our animals' lives and our planet. Therefore, it is important to educate others jointly to reduce the risk imposed and to make the food waste as useful resources. The following recommendations were put forward from our findings.The existing waste bin needs to be improvised for proper management of the food waste for safety consumption (Figure 3a & b). Install organic compost bins to reduce and manage food waste in the kitchen garden. The only way to efficiently recycle food waste without harming the environment is to compost it. Composting doesn't require any significant power, does not release any nasty by-product and, more importantly, only generates low levels of carbon dioxide. Therefore, composting is the only natural way of recycling, and can then be used to plant fruits and crops. As recommended by USDA, if the food waste was more than 6 days old , it shouldn't be used as feedings as it contains more pathogens and the methane gas, which risks the life of animals. Heat the food waste before feeding it to the animals to remove pathogens

Figure 3

(a) Waste Bin With Shelf and Cooling fan

(b) Waste Bin With Shelf, Cooling Fan and the Outlet



Project by
M.Ed II Chemistry

Students' Academic Performance and their Perception of Science and Mathematics

With the introduction of modern education in the 1960s in the Bhutanese education system, there existed a practice of written examination referred to as Summative assessment (SA). However, each school had its own way of conducting SA (Utha, 2015). Over time, uniform assessment practice in the school assessment of students for promotion to next higher grade evolved, though the practice was completely summative and factual in the form of midterm and end of the year examination. During the late 1980s, ongoing evaluation was included, which from 1996 onwards was synonymously referred to as Continuous Assessment (CA) (Rinchen, 2000). The Curriculum and Professional Support Division (CAPSD) which is called as Department of Curriculum and Professional Division (DCPD) starting in 2022, defined CA as that which "involves the process of gathering information about student knowledge, understanding, skills, attitudes, and values before, during and after each chapter or unit (CAPSD, 2008, p. 47). This information is used to make judgments about the level of student achievement; identify future learning needs of the students; report student progress. The CA is carried out by respective subject teachers and is based on students' performance in classwork, homework, and project work.

A uniform assessment practice was introduced phase wise and Bhutan Council for School Examination and Assessment (BCSEA) inducted a board examination for class X called Bhutan Certificate for Secondary Education (BCSE). The assessment practice in science which included Biology, Physics, and Chemistry, and Mathematics for class X till 2020 is reflected in Table 1.

Table 1

Assessment in Science and Mathematics till 2020

Class	Continuous Assessment (CA)		Summative Assessment (SA)		Over all pass %
	Weighting (%)	**Responsibility**	**Weighting (%)**	**Responsibility**	
X	20	Subject teacher	80	BCSEA	35

Students achieving an aggregate of 35% in CA and SA were promoted to the next higher class. According to the Special Committee for Education (Rapten et al., 2016) and Yangdon et al. (2020), the students' score in CA was comparatively high irrespective of their academic performance making it easy to score an aggregate of 35% in BCSE. In some schools, students scored as high as 18 out of 20. It was felt that students may undertake selective study of the subject topics encouraging complacency and thus compromising students' holistic development. Thus, starting 2021 academic year, the Ministry of Education (MoE), Bhutan, mandated all class X students to pass both in CA and SA. The pass mark is also increased to 40% for each (BHSEC, 2022). Table 2 shows the new assessment practice for class X.

Table 2

Assessment practice starting 2021

Subject	CA full marks	CA pass mark	SA full marks	SA pass mark
Mathematics	30	12	70	28
Science	40	16	60	24

The new assessment practice has seen a significant drop in the overall pass percentage of BCSE. Of the 12,546 candidates (6,740 females and 5,806 males) who appeared for BCSE, the overall pass percentage was 70.12 %. There has been a drop in the pass percentage by 26.45 as compared to the pass percentage of 96.57% in 2020. Though there is no formal study carried out to find the impact of increasing the pass percentage on the quality of education, it is opined by many (informal verbal communication) that it will in the long run lead to quality education.

The subject-wise and gender-wise performance of STEM students in BCSE, 2021 (BHSEC, 2022) is as reflected in Table 3.

Table 3

Subject wise and gender wise academic performance in 2021

Gender-wise	Gender wise pass %		Total pass %	Gender-wise Mean marks		Total Mean marks
	F	M		F	M	
Physics	61.94	68.12	64.80	62.43	63.55	62.95
Chemistry	55.74	57.48	56.54	61.56	61.66	61.60
Biology	58.16	61.09	59.52	61.72	61.93	61.82
Mathematics	45.95	50.76	48.17	52.21	53.38	52.75

Table 3 indicates that in terms of gender-wise performance, across all STEM subjects, male students are performing better than female though the percentage difference is minimal. The subject wise performance indicates that student's performance in STEM is just above average with the highest being in Physics with mean 62.95 and lowest in Mathematics with mean 52.75. This is worrisome for all the stakeholders: MoE, school teachers and teacher educators, as STEM education plays a vital role in realization of Bhutan's developmental philosophy of promoting Gross National Happiness (GNH) as the quality of Mathematics and science education is central in building human capital.

Some insights may be drawn from a study carried out by Utha et al (2021) in schools across five Dzongkhags namely Thimphu, Paro, Samtse, Pemagatshel and Trashigang. A total of 524 class IX and X students completed the survey and 82 students participated in the focus group interviews. The insights could be useful to all stakeholders and especially to teachers and educators as their study reports new data on secondary school students' perceptions and experiences of learning Science and Mathematics. Their study collected new quantitative data about Biology, Physics, Chemistry and Mathematics separately, including items specifically linked to anxiety and assessment. Some of their findings are as follows:

- Among the Science and Mathematics subjects, Chemistry was reported as the most difficult subject with lowest performance. Besides, 20% of respondents had a special dislike for Chemistry, and 21% rated it as one of their worst subjects. Chemistry tests were found to be most frightening with pressure, nerves, mind going blank, and test-related stress. Among the four subjects, Chemistry is the one that requires most urgent attention, requiring scope, difficulty, and perceived irrelevance to be addressed.
- The picture with Mathematics was more complex. Frequencies generally placed Mathematics just behind Biology in terms of positive attitudes with 51.6% respondent indicating it as among their favourite subjects. However,

20% indicated it as one of their worst subjects. Mathematics tests reported the second highest frightening experience. Use of rote learning of formulae and confusion as to which formulae to use was reported. In Mathematics, possibilities include reducing reliance on remembering formulae in assessments, and pedagogies focused on helping students differentiate between topics so they can determine which equation to use more confidently. Given the evidence that some students feel mathematics is "not for them", it seems that efforts to promote a "growth mindset" would be particularly valuable in this subject, where students are more likely to associate poor performance with innate ability, and anxiety rises with learned helplessness and expectations of poor grades.

- Physics was third in terms of positive attitude.

It was found less frightening than Chemistry and Mathematics. Physics could be taken as a reference point, as despite the inclusion of abstract content and equations, many more students found it manageable, interesting and enjoyable.

- Biology was found to be the least frightening.

It emerged as the most liked subject with 52% of the respondents agreeing it was their favourite subject, and 70% said they enjoyed it. However, streamlining curricular scope could help to reduce anxiety around assessment in Biology, especially given generally more favourable perceptions of content, and that difficulty was associated with needing to memorize so much content.

- Practices of memorization were reported by nearly 60% of students in three sciences. In mathematics, rote learning was attached to formulae mostly.

The above findings, if studied carefully and addressed, may lead to students' improved learning and increased academic performance.

Dr. Karma Utha, Asst. Professor

Tackling Class X Students' Misconception on Cell Division Using Audio-visual Aids

Introduction

One of the most important factors which impedes effective learning for students is misconception. The term "misconception" has been defined by many authors in different ways. According to Martin et al. (2002), misconception is described as an idea that provides incorrect understanding of concepts that are constructed based on a person's experiences including such things as preconceived notions, non-scientific beliefs, naive theories, mixed conceptions, or conceptual misunderstandings (Dikmenli, 2010).

There are number of techniques that determines conceptual understanding and misconceptions of students on cell division such as open-ended questions, two-tier diagnostic tests, interviews, drawings (Dikmenli, 2010). These misconceptions are often eliminated through models (Clark & Mathis, 2000), Animation-Based Instruction (Kalimuthu, 2017), conceptual maps, conceptual networks, semantic features analysis, conceptual change texts (Novak & Canas, 2004; Tekkaya, 2003) and computer-based technologies (Yesilyurt & Kara, 2007). Therefore, this case study projects to determine the misconceptions on cell division among Bhutanese students. Subsequently, misconceptions are also going to eliminate using audio-visual aids. This study also made an attempt to eliminate misconceptions about the cell division processes using audio-visual aids as intervention. The methodology (fig 1) and the pictorial anecdote (fig 2) is discussed below.

Figure 1

Methodology

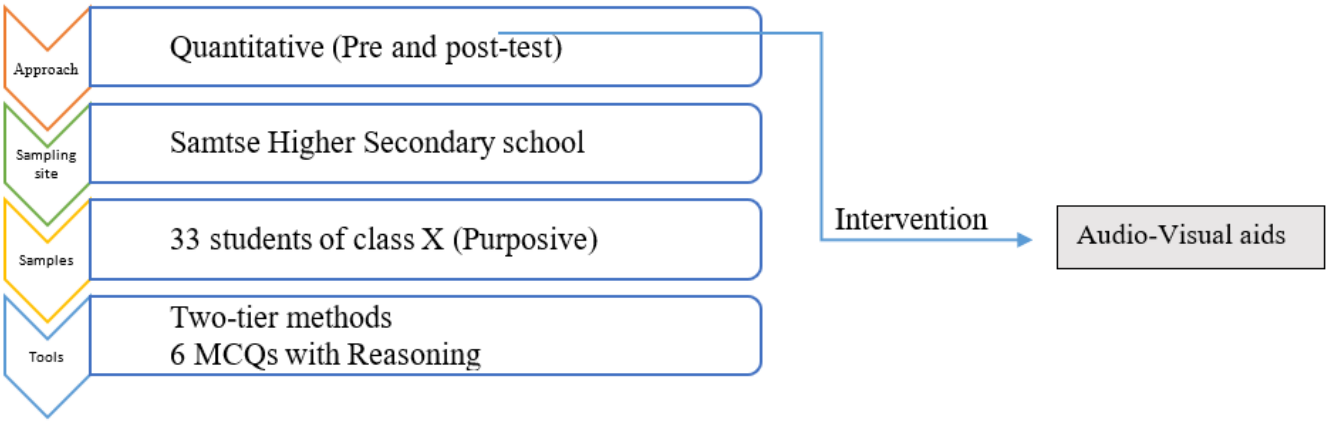


Figure 2

Conducting pre and post-test and intervention of misconceptions using audio-visual aids

The data collected was analysed using SPSS version 25. Mean score differences of the pre-test and post-test of the group were calculated, and a dependent samples t-test was performed to compare the differences between pre-test and post-test mean scores.

The baseline data was gathered from the pre-test. The test was administered and the percentage of students' responses on each question was used to detect the level of misconception on gender basis.

Figure 3

General mean scores of Pre-tests and Post-test and gender wise performance

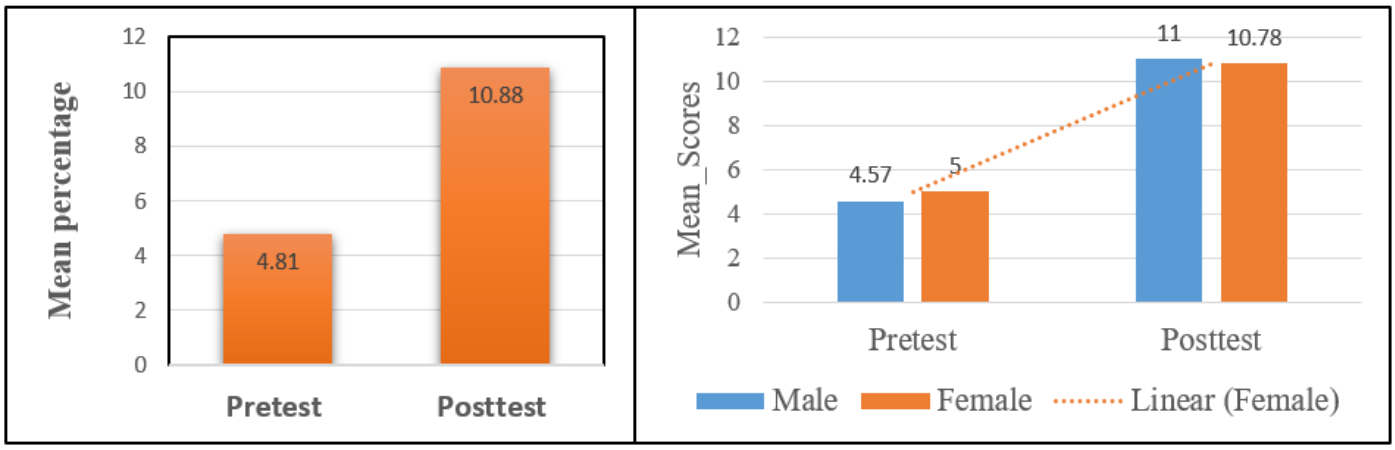


Table1

Corrected responses of students in pre-test and post-test

Sl.no	Questions	N	Pre-test (%)	Post-test (%)	Differences (%)
1	The Interphase is the "resting phase" of mitosis.	32	40.63	96.90	56.27
2	Chromosome number is doubled in the prophase of mitosis.	32	18.75	85.70	66.95
3	Mitosis produces two new identical daughter cells	32	34.38	90.60	56.22
4	Meiosis occurs in all cells	32	65.63	100.00	34.37
5	Diploid cells (2n) are produced during Meiosis.	32	96.88	100.00	3.12
6	Chromosomes and chromatids are one and the same thing.	32	0.00	71.80	71.80
	Significant difference (Post-Test-Pre-Test)		42.71	90.83	48.12

Conclusion

The findings revealed that the majority of students held misconceptions about the cell division process and the events occurring during these stages with each other. Students lack conceptual understanding of cell division and more than 50% of students were confused between the terms chromosomes and chromatids.

Ugyen Tenzin, M.Ed II Biology

Use of ICT Tools in Learning Ratio and Proportions

Proportional reasoning is one of the crucial mathematical ideas children develop over the school years. It is a good indicator of learners' understanding of the relationship between two quantities through one-to-one correspondence at the primary level. For example, students can calculate that the price of 2 pens will be Nu 10 if the price of one pen is Nu 5. Proportional reasoning forms the basis for understanding measurement and conversion among units of measurement and therefore a foundation concept for comparing quantities. Proportional reasoning provides a foundation to learn higher concepts in mathematics such as the equivalent fractions/equivalent ratios, rates, algebraic representation of ratios, direct and inverse variations, scaling, similarity, trigonometry and probability.

Table 1

If a pen cost Nu 5 and two pens cost Nu 10, by drawing such diagram, a learner will be able to easily compute the cost of 5 pens without having to use the algebraic method employing the unit rate (cross multiply procedure).

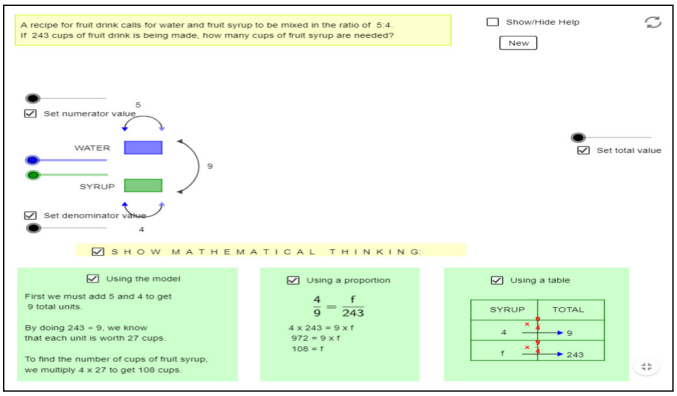
Number of pens	1	2	.	.	5
Cost (Nu)	5	10	.	.	25

The use of diagrams and geometrical shapes in teaching concepts of ratio and proportion helps children acquire proportional reasoning abilities. The use of ICT tools goes a step further. Children get hands-on experience in solving a problem by being able to draw, move and count shapes.

For example, this problem in proportion "a recipe for fruit drink calls for water and fruit syrup to be mixed in the ratio of 5:4. If 243 cups of fruit drink are being made, how many cups of fruit syrup are needed?" can be easily solved virtually using GeoGebra tool. Children will be able to see all three methods of solving as given in figure 2. When children apply these methods to solve a ratio problem, not only will they be following prescribed algebraic rules, but they would also be able to learn why, when and how they have to use these rules. By drawing and using diagrams (geometrical shapes) to solve ratio problems, they would also develop their spatial intelligence.

Figure 1

GeoGebra Activity: Ratio and Proportions



Direct and indirect variations in proportion are concepts that study the relationship between the two quantities. For example, the relationship between distance and time, speed and time, x and y and more. To solve a problem of direct variation, for example, "if 2 pencils cost Nu. 6, then how much would 5 pencils cost?", a child would simply use an algebraic approach (unit rate and unitary method) and tell us 5 pencils would cost us Nu. 15.

Let x donote the number of pencil

2x=6

implies x=6/2=3

therefore 5x=5*3=15

Now to solve a problem of indirect variation, for example, "If 12 men take 6 hours to paint a house, how many hours would 8 men take to complete the same task?", a child would still continue to use the same approach given above and tell us it would take 4 hrs. for 8 men to paint the house which is incorrect. The correct answer would have been 9 hrs.

The algebraic method/approach only focuses on following the rules irrespective of the context of the problem and hence doesn't help children develop their proportional reasoning abilities. We should use digital ICT tools to help our children reason proportionally and deepen their understanding of direct and indirect variations. One such tool is called the "ice cube in lemonade", a virtual activity which aims to find out what happens when ice cubes of two different sizes are put into a glass of lemonade.

Figure 2

Ice cube in lemonade digital activity to learn direct and indirect variations.

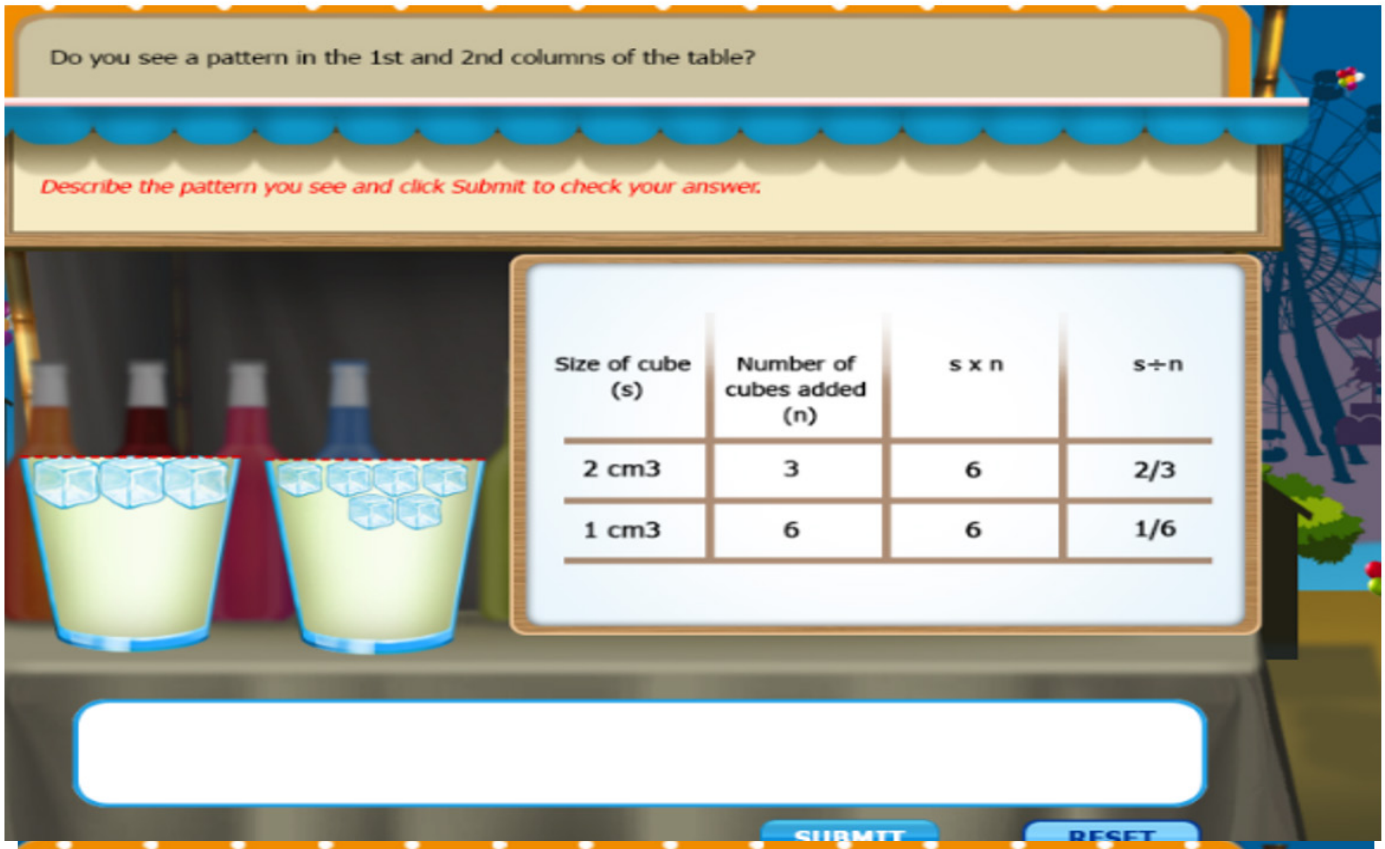
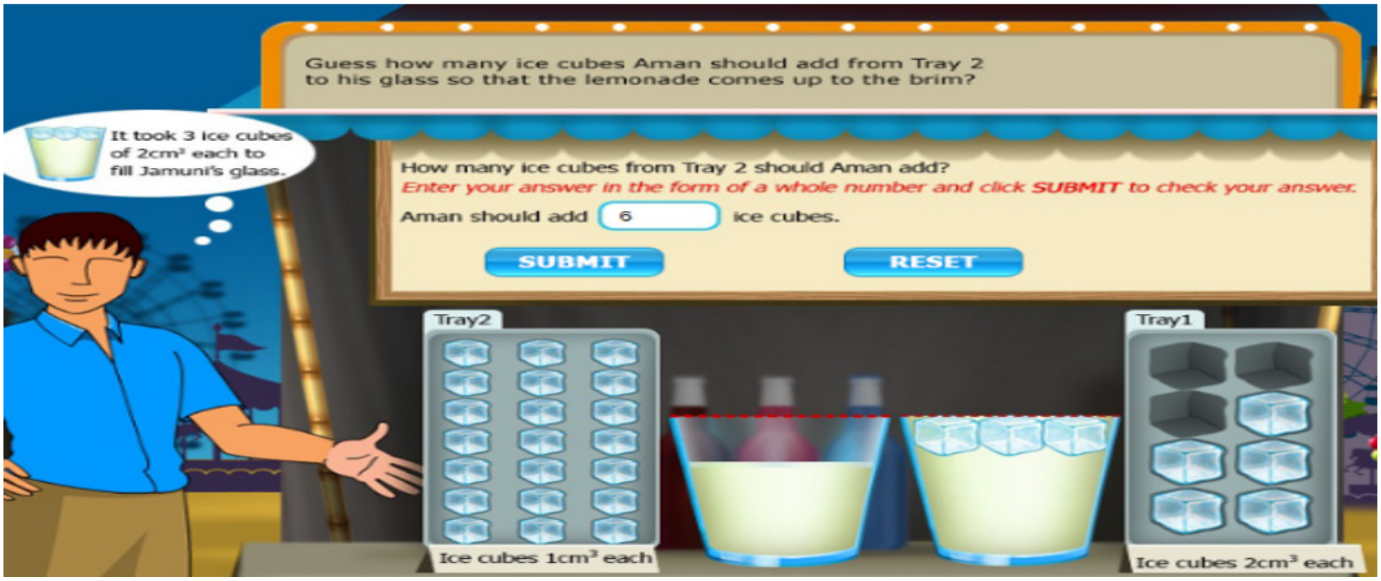


Figure 2 (a): *A girl drags and drops ice cubes from tray 1 to the glass to find out how many ice cubes of size 2cm³ would be required to fill up the glass.*

Figure 2 (b): *A boy tries to guess how many ice cubes of size 1cm³ should he add from tray 2 to his glass so that the lemonade comes up to the brim.(c): A boy is asked to describe the pattern that he sees in the 1st and 2nd columns of the table to arrive at an understanding of indirect variations.*

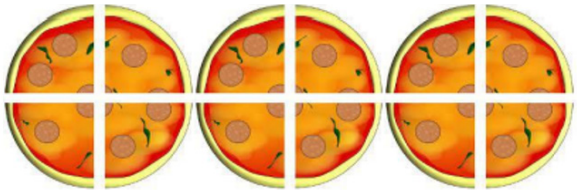


As the volume of the glass is fixed, it will always remain the same which means the number of ice cubes needed and the size of the cubes are inversely related (indirect variations) to each other. The hands-on experiences acquired through such activities will help learners to easily contextualize the concepts in their lives and in this case, the ice cube in lemonade, and thus enable a child to easily grasp and retain the concept.

To solve this problem of equipartitioning and chunking, "divide 3 pizzas into smaller pieces so that all the 4 girls will get an equal share?", a virtual cutting tool can be used. In this activity, we can literally divide the pizzas into many pieces of uniform size a number of times until we reach a number that can be shared equally by the 4 girls. As a result of this process, children are able to state reasons for their actions and steps taken unlike in the algebraic approach where they only follow the rules. This helps them develop their spatial sense (spatial intelligence) and acquire proportional reasoning abilities.

Figure 3:

Cutting tool Activity



In this case, one possible way is to cut 3 pizzas into 12 pieces so that each girl will get 3 pieces. The share of each girl is found as 3/12.

Clearly, many people who have not developed their proportional reasoning ability have been able to compensate by using rules in algebra, geometry, and trigonometry courses, but, in the end, the rules are a poor substitute for sense-making. They are unprepared for real applications in statistics, biology, geography, or physics. Foundational principles rely on proportionality. Proportional reasoning refers to detecting, expressing, analysing, explaining, and providing evidence in support of assertions about proportional relationships. The word reasoning further suggests that we use common sense, good judgment, and a thoughtful approach to problem-solving, rather than plucking numbers from word problems and blindly applying rules and operations. We typically do not associate reasoning with rule-driven or mechanized procedures, but rather, with mental, free-flowing processes that require conscious analysis of the relationships among quantities.

Ugyen Dorji
Associate Lecturer

Determination of Ascorbic acid (Vitamin C) Content in Vitamin C Tablets and in Fruits and Vegetables

Introduction

Vitamin C also known as ascorbic acid is an essential nutrient required by the human body. Vitamin C plays a vital role in the proper growth and development of teeth, bones, gums, cartilage, skin, and blood vessels. It is an important antioxidant (reducing agent) that helps protect against cancers, heart disease, and stress. Vitamin C is also critical in enabling the body to absorb iron and folic acid. The Recommended Daily Allowance (RDA) of vitamin C for an adult is 75–90 mg, however, levels as high as 200 mg are proven to be beneficial.

Our bodies cannot produce vitamins hence they come from the food we consume. Vitamin C can be obtained from a variety of fresh fruits (most notably, citrus fruits) and vegetables.

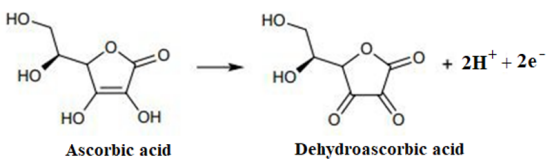
Vitamin C can be destroyed by heat and light. High-heat cooking temperatures or prolonged cook times can break down the vitamin. Since it is water-soluble, vitamin C can also seep into cooking liquid and be lost if the liquids are not consumed. Foods at peak ripeness eaten raw contain the most vitamin C.

Vitamin C is a colourless, water-soluble acid. It is a powerful biochemical reducing agent, meaning it readily undergoes oxidation, even by the oxygen of the air. Its reducing properties are used in this experiment to analyse its concentration in various samples. There are many other acids present in food, like citric acid, which may interfere with our analysis of ascorbic acid content.

The oxidation reaction of ascorbic acid.

Figure 1

Oxidation of ascorbic acid



$$C_6H_8O_6(aq) + H_2O(l) \rightarrow C_6H_8O_7\,(aq) + 2H^+(aq) + 2e^-$$

Aim

The aim of this project was to determine the amount of ascorbic acid found in commonly consumed fruits and vegetables and some over-the-counter vitamin C tablets sold in Samtse. The vegetables and fruits chosen were green chillies, tomatoes, and tangerine. Chillies and tomatoes form a major part of the Bhutanese dish, the hot tangy flavour of these two in Bhutanese curry and salad is what every Bhutanese relishes. The exact content of vitamin C in fruits and vegetables is not known but the range of vitamin C content in many fruits and vegetables is well documented. Our analysis of ascorbic acid in Vitamin C tablets can be used to further validate if our method is correct since the exact content of ascorbic acid in Vitamins is given on the tablets.

Table 1

The concentration of Vitamin C(ascorbic acid) in various food items

The concentration of Vitamin C	Food items
<10mg/100 g	Beets, carrots, eggs, and milk
10-25 mg/100 g	Asparagus, cucumbers, green peas, lettuce, and pineapple
25-100 mg/100 g	Citrus fruits, tomatoes, and spinach
100-350 mg/100 g	Chili, turnip, and kiwi.

Sample preparation

A fraction of the tablet containing 100 mg ascorbic acid was taken for analysis.

For fruits, freshly squeezed fruit juice was used for analysis while for vegetables, a 100 g of fresh vegetable was ground carefully in mortar and pestle, and its juice was extracted for analysis.

Method

Iodine is readily reduced by Vitamin C and when this happens, the brown colour of iodine fades to colour less solution. This colour-changing property was explored in determining the vitamin C in our samples.

In this analysis, the method used is called iodometry. In this method, a known amount of iodine is generated by using the required reagents, and a brown-coloured solution of iodine is formed. The iodine was then titrated against our samples. The endpoint of this reaction is the change in colour from brown to a colourless solution. The starch solution is added towards the end of the titration. Starch forms a blue complex with iodine solution but does not interfere the reaction. The disappearance of blue colour to colourless solution gives a better endpoint perception. By doing some common stoichiometric calculations, it is possible to determine the iodine titrated and therefore the amount of Vitamin C present in the sample.

Figure 2

Colour changes happening during the process:
(a) solution of iodine before titration
(b) Half way through titration
(c) after the addition of startch indicator, solution immediately before the endpoint
(d)- solution at the end of titration

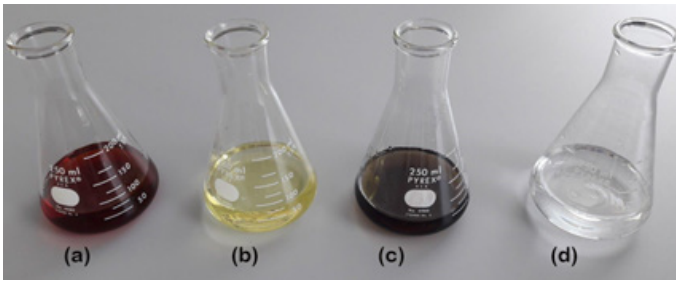


Figure 3

Some apparatus and reagents used for analysis of Vit. C

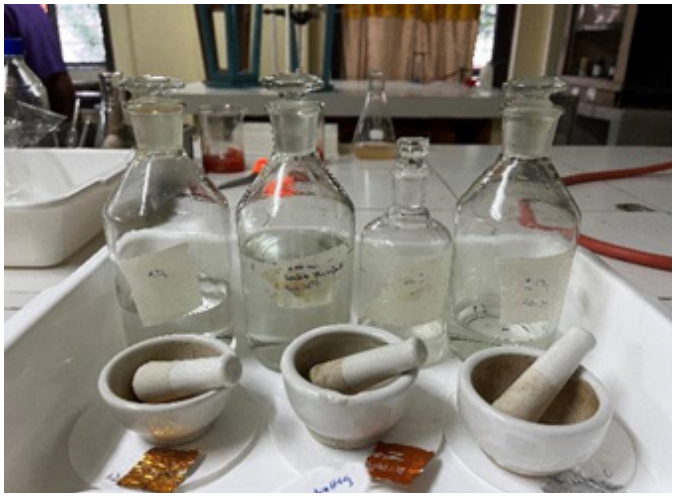
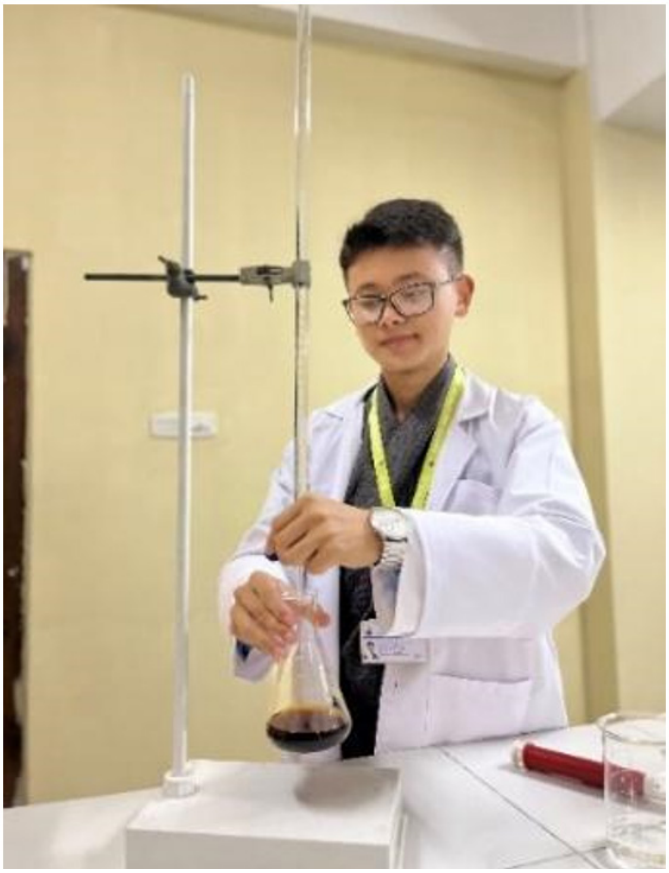


Figure 4

Samples used for analysis for Vit. C

Figure 5

Student working on analysis of ascorbic acid



Results and Discussion

Three samples of over-the-counter vitamin C tablets with the commercial name ADIVIT-CZ, VeeCee-Z, and Vitamin C were analysed. Three samples of vegetables and fruits were analysed. The results of the ascorbic acid content in the above-mentioned samples are tabulated below in Table 2.

Table 2

The concentration of Vitamin C(ascorbic acid) in the analysed samples

samples	Vit C/100mg Sample
ADIVIT-CZ	80 mg
Vee Cee-Z	81 mg
Vitamin C	82 mg
Tomatoes	30 mg
Chili	94 mg
Tangerine	40 mg

The labels on the vitamin C tablets showed that 83.3 % of the mass of the tablet is ascorbic acid. Our results were very close to the amount of ascorbic acid labeled on the tablets. This confirms that the method we have used was within + 5% error. The vegetables and fruits analysis shows the ascorbic acid content is within the range given in table 1 except for chili.

Hence it can be concluded that Bhutanese do consume vegetables rich in vitamin C but the impact on the content of ascorbic acid after cooking has to be studied further.

Team members Sonam Changa, Dechen Pedey, Neten Dema, Pema Lhamo, Tashi Choden 'B', Sangay Chophel, Tenzin Choden, Lhakpa Tshering, Kalawati Gaylal, Nima Wangchuk. B.Ed. 4th Year Science B 2022

Data Encryption

Why Should We Know About Data Encryption?

The use of instant messaging applications like WhatsApp, Telegram, and WeChat has made our communications easier and at our fingertips. We share our bank details, business, and medical information, educational materials, and videos through these apps. We use these apps because our friends and families use them and not because of their security features. We hear about cyber crimes such as email and internet fraud, identity fraud, theft of financial or card payment data, and theft and sale of corporate data around the world through television. We will become vulnerable to such risks if we are not careful about how we conduct ourselves in the virtual community and how we decide to choose these apps. Here I have presented the data encryption of WhatsApp, which is a commonly used messaging app in our college.

WhatsApp Encryption Overview

With over 1.6 billion active users, today WhatsApp is the most used messaging app worldwide and is currently owned by Facebook and now Meta. It allows people to exchange messages (including chats, group chats, images, videos, voice messages, and files), share status posts, and make WhatsApp calls around the world. Our messages/data in WhatsApp are encrypted using an asymmetric encryption algorithm, which means this algorithm uses a pair of keys called a private and a public key for its data security.

Pema uses the public key that belongs to Dorji to encrypt the message. The ciphertext is then relayed to the receiver (Dorji) by its server, and Dorji decrypts the ciphertext using his private key and reads the message as plain text. As a result of the asymmetric encryption, WhatsApp messages/data are end-to-end encrypted, which means only the sender and the recipient can read the messages. E2E is designed to prevent third parties and WhatsApp from having plaintext access to our messages/data, even if encryption keys from a user's device are ever physically compromised, they cannot be used to go back in time to decrypt previously transmitted messages

Figure 1

WhatsApp simplified E2E encryption

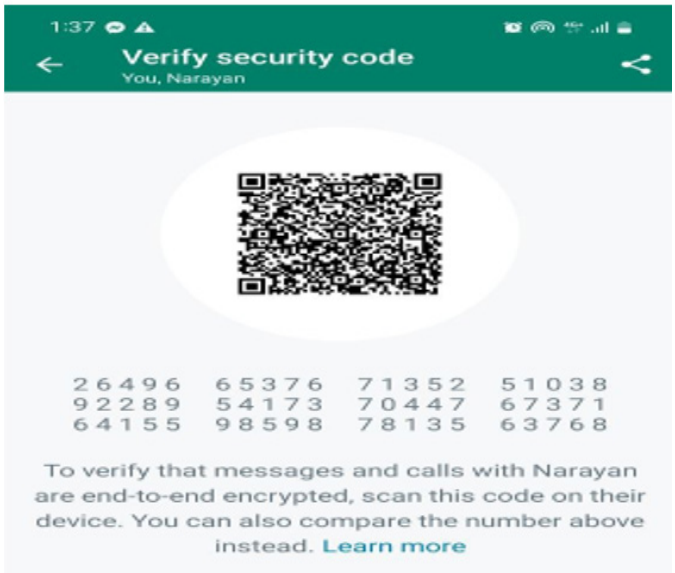
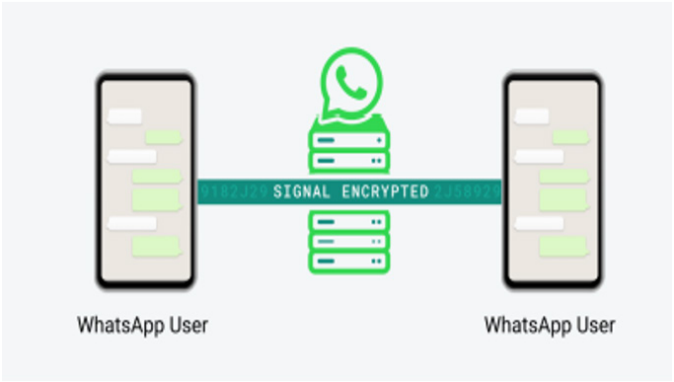


Figure 2

E2E verification in WhatsApp



How Does End-to-End (E2E) Encryption work in WhatsApp?

WhatsApp Encryption Overview, also called a (Technical White Paper) can be readily found on its website and provides a detailed technical ex-

planation of its end-to-end encryption system. A user first downloads a WhatsApp app from a google play store, and during the app installation time, which also involves user registration, a uniquely private and a public key pair will be generated for each user. A user then transmits its public key to the server to be stored.

To communicate with another WhatsApp user, a user first needs to establish an encrypted session. If Pema wants to send a message to Dorji, Pema has to first request Dorji's public key, for which the server will return the requested public key values. Pema then uses the public key belonging to Dorji to encrypt his messages/data. The server will relay the message as cipher text to Dorji. Dorji uses his private key to decrypt the encrypted/scrambled message and read the plaintext.

A WhatsApp server only stores the user's public key and not the private keys and hence our messages/data remain encrypted in its server. Even if a WhatsApp employee wants to read the message, he/she will not be able to do so.

Ugyen Dorji
Associate Lecturer

Determination of Iodine in Table Salt

"*Se dang encha choni la kangulung bu zhim pay na,"* is a famous saying of the people in East Bhutan when it comes to taste. The direct translation of the phrase is, "In the presence of oil and salt even a stone would taste nice". Bhutanese dishes are mostly salty. The preference for salty taste over others is basically because most Bhutanese dishes are very spicy, mainly consisting of chilies. The average Bhutanese consumes almost twice (8.3 grams) the recommended value (5 grams) of salt by the World Health Organisation (WHO) (Tshedup, 2021).

Table salt is also the source of Iodine needed by our body. Iodine is an essential micronutrient required by the human body. Iodine helps in the production of thyroxine a hormone required for cell metabolism. Inadequate iodine in the body can cause goitre, swelling of thyroid glands, and in severe cases mental retardation.

The average requirement of iodine by the human body is 150 µg per day. Since our bodies cannot produce iodine, the iodine should come from the diet we take. Iodine is rich in coastal areas as most iodine from inland ends up in oceans due to leaching. Bhutan being inland, the soils typically contain less iodine, thereby even the plants grown for consumption contain less iodine. The easiest way to supplement iodine into our diet is through the consumption of iodized salt.

In this project, we aim to find the iodine content in different salt samples iodized in the form of potassium iodate (KIO3) that are sold in Samtse Dzongkhag and analyse if they supplement daily requirements for iodine.

Figure 1

Salts sold in Samtse Town

Four salt samples (as shown in Figure 1) were collected and were tested for the amount of iodine in these samples. The salt samples chosen were, TATA salt, Saffola salt, Everyday salt, and Black salt.

The analytical method used was iodometric titration. In this method, the iodate (IO3-) present in the salt is converted to tri-iodide (I-3) in the presence of excess iodide (I) and sulphuric acid. The solution formed is yellow in colour. The yellow tri-iodine solution is then titrated with standard thiosulphate (Na2S2O3) to colourless solution. Starch solution was close to the end of titration to make the endpoint more perceptible. The following equation summarizes the chemistry involved.

$$IO_3^- + 5I^- + 6H^+ \rightarrow 3I_2 + 3H_2O$$

$$I_2 + I^- \rightarrow I_3^-$$

$$I_3^- + 2S_2O_3^{2-} \rightarrow 3I^- + S_4O_6^{2-}$$

Table 1

Iodine content in the salt samples from our project

Salt Samples	Iodine Content (ppm)
TATA salt	20
Saffola salt	32
Black salt	0
Everyday salt	18.2

World Health Organisation (WHO) recommends a concentration of 15 to 40 ppm of iodine in salt at the household level (UNICEF, 2021). On average the recommended table salt consumption is 5g a day which contain 150µg iodine if iodine content is 30ppm. On comparing this with our results, we found out that except for black salt, all the other three have the recommended amount. If the right amount of salt is consumed, the salt would be helpful in keeping away the iodine deficiency disorders.

Team members (from left: Jamyang, Dorji Wangmo, Ugyen Dema, Kusum Bhandari and Karma Yangdon, B.Ed. 4th Year Science B 2022)

SCE Faulty as Panellist for Online Book Launch - STEM Education from Asia: Trends and Perspectives

The HEAD Foundation, Singapore hosted a two-part webinar series with contributors of the book ***STEM Education from Asia: Trends and Perspectives*** for an insightful sharing on innovative STEM education policies in the region, particularly on teacher education, curriculum and research. Moderator and co-editor **Associate Professor Teo Tang Wee** from the National Institute of Education, Singapore highlighted the growing interest in STEM education in the last two decades. This is in part driven by the Fourth Industrial Revolution that catalyses rethinking about how education should evolve to meet the demands for a future workforce equipped with 21st Century Competencies. Co-editor **Professor Paul Teng,** Managing Director of the National Institute of Education International, shared that policies on their own are only articulations of intent by governments; they have to be backed by guidelines, statutes, directives and supporting measures. This sentiment was echoed by **Assistant Professor Choy Ban Heng**, co-head of meriSTEM@NIE in Singapore, who affirmed that the improvement of STEM education has to be seen as confluences of different educational aspects beyond a single change. Educational policies, initiatives and practices need to be in sync with the purpose. Using STEM teacher education in the Philippines as an example of responding to a confluence of country-specific factors, **Professor Gladys Nivera** from the Philippine Normal University elaborated how there needs to be consistency of programmes across the country, a focus on capacity building of educators and administrators, and harmonisation across the system to move towards the same goal to achieve results.

Assistant Professor Kinley, Royal University of Bhutan, shared that the Bhutanese government's priority to enhance STEM education has led to creating urgency in the pathways towards doing so. **Professor Rohaida Mohd Saat** from the University of Malaysia shared heartening news of an upward trend in the number of research articles on STEM education in Malaysia. However, current research focus on individual disciplines or two disciplines and she recommended that future research should move towards mul-

tidisciplinary or interdisciplinary STEM, in line with the nature of STEM. **Assistant Professor Yann Shiou Ong** from the National Institute of Education, Singapore proposed an integrated STEM education as a paradigm of future-orientated education; many would agree that the final form of knowledge of various disciplines is not as critical as 21st Century Competencies and life skills to help students thrive in the Fourth Industrial Revolution. the speakers touched on the importance of cohesive policies and supporting measures to balance ground-up initiatives and top-down planning. Many panellists also linked back to the importance of STEM education in nurturing critical thinkers to thrive in the Fourth Industrial Revolution.

Associate Professor Ida Ah Chee Mok from the University of Hong Kong highlighted that teachers can only work within the various constraints of the system that includes policy, resources and concerns for the school vision and stakeholders. Similarly, co-editor **Associate Professor Tan Aik Ling** from meriSTEM@NIE, posited that the way forward involves asking pertinent questions such as: "What is the nature of STEM leadership that will develop and support teachers of STEM to design and implement meaningful STEM curriculum?", and "What are the factors that affect partnership between schools, industry and the community, and what partnership model would result in mutual benefits for all stakeholders?"

The book "STEM Education from Asia: Trends and Perspectives" published on 9th December, 2021 by Routledge's Critical Studies in Asian Education series. Written by Asian academics, this book will provide valuable insights to policy makers, educators, and researchers interested in the topic of STEM education, especially in the Asian context. The three hundred plus academics participated in the webinar that consisted of both international and Bhutanese. The President and STEM faculty of SCE also participated in the webinar. Dr. Kinley because of his contribution of two chapters namely "A journey towards STEM education in Bhutan: An Educational Review"; "Effect of 5E Learning Cycle to Enhance Grade Twelve Students' Conceptual Understanding of Gene Expression: An Integrated STEM Education Approach" has been invited by the organizer as a panelist for the first part of the webinar studies on 7th March, 2022. He made a 15 minute presentation broadly capturing STEM education in the education system in Bhutan. Besides the presentation he was also involved in the question and answer session towards the end of the presentation.

According to Dr. Kinley the opportunity to share a platform with renowned academics in the field of STEM education has been coupled with anxiousness and intrigue. It was also truly intriguing and inspiring. Further, he added that STEM subjects have been taught in Bhutan since the introduction of the country's modern education system. Since then, various attempts have been made for a progressive reform in the teaching and learning process of STEM subjects. Though at a later stage there has been an attempt to teach science in an integrated approach, unfortunately, it has not seen much success. The STEM acronym has been used in academic conversations in Bhutan for quite some time now. Realizing its significance and implications in recent times both in the Royal University of Bhutan and the Ministry of Education, Bhutan STEM is taking a centre stage in the curriculum. He mentioned that, therefore, the platform provided an apt and timely opportunity to present Bhutan's relationship with STEM, the status of STEM education in Bhutan, and a way forward for STEM education in Bhutan. Additionally, the forum provided a maiden occasion to learn from advanced STEM education systems in Asia.

Woman Faculty of Electronics and Communication Engineering

A representative from STEM Education Research Centre had an opportunity to converse with Ms. Srijana Gazmer, an Associate Lecturer at Jigme Namgyel Engineering College (JNEC), Royal University of Bhutan. She teaches Electronics and Communication Engineering at JNEC. She recently completed a Master of Technology in Electrical Engineering from the Indian Institute of Technology Kanpur (IIT Kanpur) through the first India-Bhutan Friendship Scholarship. She is also the coordinator of Radio Club JNEC.

STEMERC: Kuzuzangpo, could you introduce yourself to our readers?

Srijana: Kuzuzangpo. My name is Srijana Gajmer, and I am an Associate Lecturer at Jigme Namgyel Engineering College, popularly known as JNEC, Royal University of Bhutan. I am a faculty of Electronics and Communication Engineering.

STEMERC: Could you briefly highlight your educational and professional journey?

Srijana: I have lived all my life on Samtse College's campus, and completed my high school at Samtse and Ugyen Academy in Punakha. I completed my Bachelors of Electronics and Communication Engineering from the College of Science and Technology. I got recruited as an Associated Lecturer in JNEC and have been serving the nation in my small yet dynamic capacity as a STEM teacher. Additionally, I have also completed PgCHE (Post Graduate Certificate in Higher Education) which has equipped me with the skills necessary to pursue a career in teaching. I recently completed a Master of Technology in Electrical Engineering, from the Indian Institute of Technology Kanpur (IIT Kanpur), receiving the first-ever India-Bhutan Friendship Scholarship.

STEMERC: What motivates you as a STEM educator and advocate?

Srijana: STEM, Science, Technology, Engineering, and Mathematics encompasses our daily life. The moment we wake up, we are breathing in the same space as science is evolving and advancing. Innovation in science is one basic metric to measure the development and progress of a society and country in the Global Innovation Index. Unequivocally, STEM is a major tool to design the landscape of technology, education, sustainable practice, food security, economic growth, health and well-being, and every other aspect of our daily life. We can also never ignore the fact that STEM plays an important role in achieving Sustainable Development Goals (SDGs), empowering human resources, and moving coherently with development in the world. Today's students are future leaders, and to establish continuity of interconnected viewpoints, decision-makers, thinkers, and problem solvers, STEM education plays a pivotal role.

STEMERC: What is your philosophy of STEM education and approach?

Srijana: STEM is an evolving culture, and keeping students and learners, at its centre is challenging yet involving. Creativity and dynamism are the most important approaches to learning and applying STEM knowledge. Integrating theoretical concepts into hands-on practices, inculcating design philosophy, and implementing them into real-life and real-time problems would be an encouraging method. With adequate personal and educational principles, one must be locally responsive and globally competitive without a blur on personality and moral values.

With regard to approaches to handling STEM education basically, STEM education and curriculum are built around four Cs; Creativity, Critical thinking, Collaboration, and Communication. At any given time, one must be prepared to adapt, accept, and inculcate STEM and the concepts around it.

In the preparatory aspects, a teacher can use Inquiry-Based Learning, which serves to fuel curiosity and spark enthusiasm and initiative around a designated problem. Students should be encouraged to ask questions and investigate a subject which helps develop skillsets on 'How to think and reason.'

To a beginner group, Project- Based learning methods may be applicable. A student may be introduced as a part of a project which demands input in research and solution-building process where the goal and problem set is described. The student bridges problems to a goal, and the tutor can be a facilitator. To an intermediate group, Problem-Based Learning can be applied. In addition to the beginner-level skill set, the students are required to analyse and evaluate a problem statement. This involves elements of creativity and critical thinking, in approaching a problem with probable solutions, the development of teamwork, leadership, and communication skills in the periphery.

STEMERC: What are some of the challenges in STEM teaching-learning landscape as you have observed as an educator in a Higher Education Institution?

Srijana: One challenge that has invariably occurred in all these years, is the disparity in the gender ratio of STEM students in a classroom. It is always discouraging to see, lower enrolment of female students in STEM higher education. STEM education, as perceived is not a gender-based specialization and role. Creativity and innovation are genderless and strictly interpersonal capabilities. Through my personal and professional experience as an engineer and lecturer in an engineering college, I am confident enough to say that Bhutanese students are way more capable than they perceive themselves. Given the challenges of any magnitude, they are equipped with adaptive, and self-motivating skills, and capable of applying concepts and logic in relevant space. However, the only limitation lies in their imaginary glass ceiling, that STEM is tough, and one lags behind in global standards. Whatever may be the global status and standing in innovation and science, if we do not even try and indulge in the universe of STEM, our progress may not move an inch. The only limitation persists in inhibition brought by self, and that should be shed by the learners.

School curriculum is relevant and sufficiently accommodating relevant subjects and standards, however, there needs to be an accelerated adaptation and strong integration of theoretical and practical synchronization and depth of programming culture. Programming and coding should be introduced from an earlier stage of education, in relevant and understandable format, through progressive build up from introduction to advanced level. Programming should be treated as the third language taught at school, and every student should have fundamental content and confidence on it.

STEMERC: What are some of the ways, Bhutanese students can engage in STEM activities?

Srijana: As an initiative to achieve His Majesty's vision of tech- driven society and culture, one should understand that this integration should be brought to mainstream education system.

Practical aspect to theoretical concepts should be emphasized with hands-on practice as the basis. Students should retrospect more, experiment more, identify real time and local problems which could be given a touch of technology, design and formulate solutions to local problems and share knowledge.

A major drawback also is the non-uniformity of information and distribution of exposure. Every student should take the personal initiative of participating in or attending STEM challenges and hackathons and similar events. Observation and questioning can build the way for a personally motivating innovation, which often is nipped in the bud, because a lot of us tend to be a follower instead of a trendsetter. STEM should ignite a researcher, wanderer, theorist, problem solver, designer, and thinker in one. There needs to be a bridge between schools and universities in terms of STEM facilitation which can be implemented through mentorship programmes, community projects, workshops, and dissemination events. Schools can introduce exposure programmes through an industrial visit to STEM avenues like Fablabs, innovation labs, and workshops, industries etc. in the country.

As a part of the University to School mentoring programme, JNEC is catering to early STEM culture development in students through hands-on workshops, winter boot camps and seminars. The students can learn the basics of hardware-software integration, build projects using sensors, build robots and programme on them, learn the basics of IoT and build relevant projects, solve real-life problems through concept design and prototyping the same, and many other tech-driven projects.

To adapt and inculcate STEM as a way of life, one must be intrinsically motivated and that comes from taking initiative and exploring. A STEM beginner can learn the basic concepts on the internet or in books, attend relevant workshops and seminars and build fundamentals. Using relevant programming platforms, even the rigor of intense programming can be eased and replaced with manual design. To an intermediate learner, conceptualizing, brainstorming, and designing projects using STEM from scratch and building a framework should be the target level. As an expert STEM practitioner, the practical elements of the design and prototyping should be the target level. Further being informed of global innovation trends and technologies, may provide a check on ones standing, and keep one around relevant news and concepts which may inspire a learner to immeasurable depth. STEM should be a way of daily life and approach, instead of perceiving as a tough subject.

STEMERC: What is your final piece of advice to our young Bhutanese students?

Srijana: We are equipped with the best technologies, curriculum, facilities, and platforms, at the right time and we should take advantage of what we have with us. Bhutanese students have immense cognitive capabilities and mental resilience with added values of culture and rapid adaptation, which is a unique boon. Our problems are unique and only we understand them best and should be relying entirely on our capabilities to solve them with head, hand, and heart. We are capable of the best, and the only limitation is what we set with our minds.

STEMERC: Thank you very much for taking the time to share your thoughts on STEM education with us. STEMERC wishes you all the best in your career as a female STEM educator.

STEM EDUCATION NEWSLETTER

Samtse College of Education

Royal University of Bhutan