STEM EDUCATION NEWSLETTER

Samtse College of Education, 2024

Volume 4

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MESSAGE FROM STEMERC HEAD

Dear Reader,

I am delighted to introduce the fourth volume of STEM newsletter, brought to you by the STEM Education Research Centre (STEMERC). As we continue our journey in advancing STEM education, this edition promises to be a rich tapestry of insights, activities, and reflections that encapsulate the spirit of innovation and exploration within our field.

Within these pages, you will find a diverse array of content, ranging from engaging STEM activities to research works. Our contributors, including esteemed teacher educators and talented school students, offer their unique perspectives on various STEM topics, providing invaluable insights that inspire and inform.

One standout feature of this volume is our emphasis on small-scale research conducted within relevant modules, utilizing an Interdisciplinary Project-Based Learning approach. This time, our focus was specifically on examining wastewater within the SCE campus. These articles offer comprehensive wastewater analysis along with practical strategies for effective wastewater management.

Furthermore, we are excited to showcase the outcomes of two major ongoing projects: Connected Learning for Teacher Capacity Building in STEM (CL4STEM) and Project PANOPTES. These initiatives represent our commitment to pushing the boundaries of STEM education, fostering collaboration, and driving positive change in our communities. Through CL4STEM and Project PANOPTES, we aim to cultivate critical thinking, problem-solving skills, and a passion for discovery among students and educators alike.

As we navigate the ever-evolving landscape of STEM education, let us continue to embrace innovation, collaboration, and inclusivity. Together, we can inspire the next generation of scientists, engineers, and innovators to create a brighter future for all.

I extend my heartfelt gratitude to all our contributors, collaborators, and readers for their unwavering support and dedication. May this volume of the STEM newsletter ignite your curiosity, spark meaningful conversations, and propel us forward on our collective journey towards excellence in STEM education.

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

Karma Utha (PhD)
Head of STEMERC

Online training on Asteroids Search Campaign

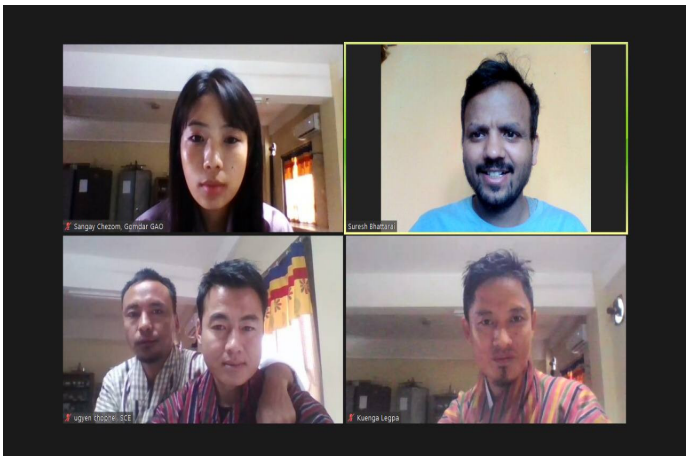
Mr. Kuenga Legpa
MEd II Physics

Three students from MEd in Physics and one student from PgDE were introduced to the Astrometrica software through hands-on practical sessions on September 29 and October 13, 2022, conducted virtually by Suresh Bhattarai, Manager of OAE Node Nepal and Chairperson of the Nepal Astronomical Society (NASO), as shown in the first image below. They learned how to search for asteroids using Astrometrica software.

Image packages were provided to practically analyse them using the software, and the output of the asteroid search using the software is shown in the second image. With the Astrometrica software, it had the ability to easily compare astronomical images for the purpose of moving object detection through the use of software-grade astrometric data reduction of Charge-Coupled Device (CCD) images, focusing on measurements of the minor bodies of the solar system taken through high-power telescopes called the Panoramic Survey Telescope and Rapid Response System (Pan-SRARRS).

It was their first experience using technology to explore astronomy at an advanced level. As a result of training, they represented the SCE Astronomy Club and took part as an international team in two NASO astronomy search campaigns, as shown in the third image.

It sparked interest in them in the field of astronomy, which was evident through their curiosity and time invested in exploring the use of the software to search for asteroids, name them, and motivate others to participate in the asteroids search campaign. Moreover, such training will be useful for school students to develop their aptitude for learning space science and technology.

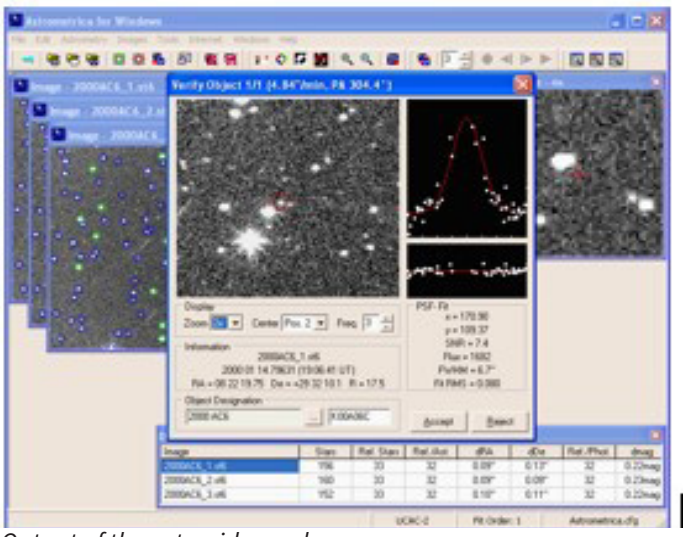


Online training on using Astrometrica software

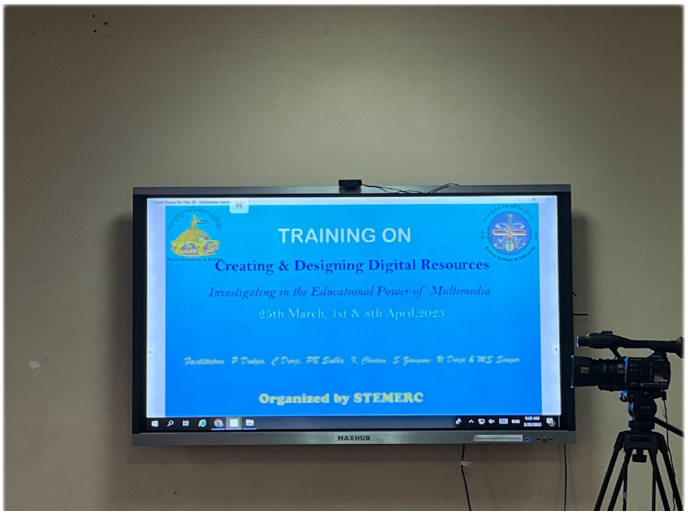
Training on "Creating and Designing Digital Resources

Ms. Sonam Zangmo (Lecturer)
Mr. Man Singh Singer (Lecturer)

Three days of Training on Creating and Designing Digital Resources: Investigating the Educational Power of Multi-media was organized by the STE-MERC on three different Saturdays (25th March, 1st and 8th April Year?). The training participants were the faculty members of the Department of STEM.



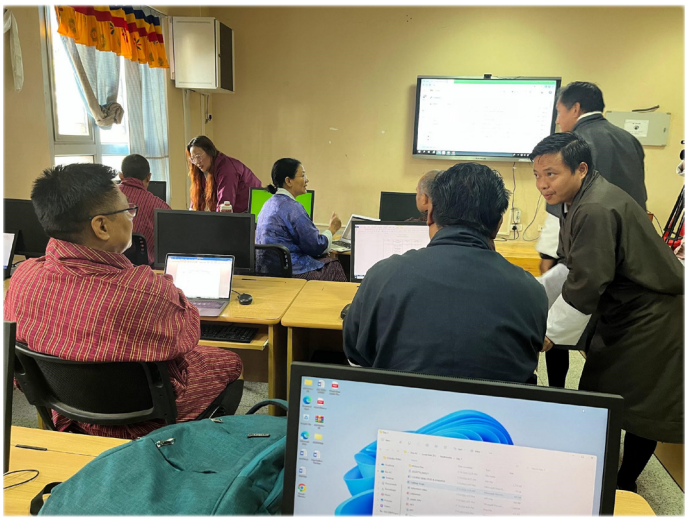
Output of the asteroid search



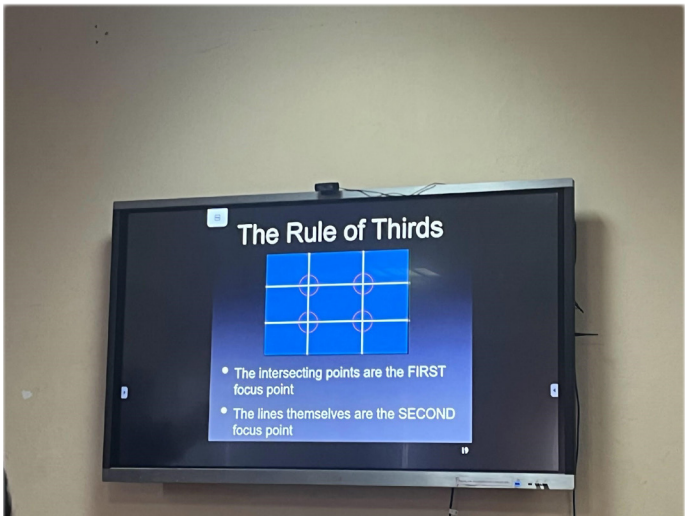
Participation in Asteroids Search Campaign

It was facilitated by six faculty from SCE who underwent Training of Trainers on Creating and Designing Digital Resources in Teaching and Learning from 20th - 29th June, 2022. Day one focused on the format of Scripting, Photography, and Photoshop.

In the first session the participants developed scripts in their respective subjects for a duration of five minutes.



The second session of the first day oriented the participants with the basics of photography including lighting, composition, and framing. As a follow-up to the photography orientation and to provide hands-on practice to develop photography skills, participants were made to capture ten photographs and share with others for comments and discussion.



Day one ended with the use of Photoshop to edit images, adjust brightness and contrast, cropping, and remove unwanted backgrounds from the image. Participants edited their own images to familiarize themselves with Adobe Photoshop software.

In the interest of time, participants were divided into four different subject groups namely Biology, Chemistry, Physics, and Mathematics. Each group

was attached to a facilitator to further refine their draft scripts during weekdays between 26th to 31st March, 2023, participants refined their scripts, and collected images, pictures, footage, and foley required for their video lesson. The final scripts and images, pictures, footage, and foley were uploaded to the Google Folder.

On day two, participants were familiarized with the preparation of the A roll. According to their scripts, participants recorded A roll. Participants had to memorize the lines and face the camera while preparing A roll.


The participants were inducted with Audition software to edit sound, remove background noise, adjust the sound level, and use sound effects to enhance the overall impact of the project.

On the final day, the participants were introduced to the interface of Adobe Premier software and its various features like importing media, editing, adding effects, and exporting the final project. The participants learned to edit video footage, add sound effects and music to their video, and export the final project in various formats. Participants had an opportunity to apply acquired skills during the previous two days of the training on the last day of the training.

In conclusion, the three days training provided the participants with essential skills and knowledge in multi-media production. The training covered various aspects of multi-media production like scripting, photography, video, and sound recording using Adobe Audition, Adobe Photoshop, and Adobe Premier.

Participants were equipped with the necessary skills and knowledge to create high-quality digital resources in teaching and learning. The participants also committed to producing at least one digital resource in their respective subject groups.

The findings of the concluding activity popularly known as the 3-2-1 activity indicated that the majority of the participants mentioned the concept of Foley (A roll and B roll), scripting, and photography (portrait, landscape, and Photoshop) as three things learned from three days training.

The desire to improve their skills in video editing and Photoshop and to use these skills to create educational content for their students were two things that they wanted to implement in the future. The one question from each participant revolved around the duration of the training, workload management, other principles of multi-media, video production tools, resource management, and the possibility of extending the training to other groups.

The CL4STEM Governance Meeting in Bhutan

Dr. Reeta Rai
CL4STEM Country Coordinator

From June 21-24, 2023, a four-day CL4STEM project governance meeting was convened at Samtse College of Education, Royal University of Bhutan. Attended by project partners from India, Tanzania, Bhutan, and Nigeria, alongside stakeholders from the Ministry of Education and Skills Development (MoESD), District Education Officers, School Principals of Samtse District in Bhutan, and the SCE STEM teacher educators, the meeting aimed to assess the progress of the project.

The CL4STEM project focuses on bolstering the professional development of secondary school STEM teachers. Its objectives include enhancing content knowledge, fostering the use of technology, and promoting inclusive pedagogies to elevate the quality STEM education while ensuring equity and inclusion in classroom practices. The meeting provided an invaluable opportunity to review the achievements of the CL4STEM project and disseminate findings to partners and stakeholders. During the meeting, participants engaged in discussions about the project's successes, challenges, and future plans, fostering a collaborative environment to address pertinent issues and refine strat egies for the project's continued success. One of the CL4STEM project's major achievements has been the creation of a set of subject-specific Open Education Resources (OERs) for teachers. The use of OER is the first of its kind in Bhutan and it's a proven approach to promoting equitable, inclusive, and quality professional development.

The OERs are aligned with the national curricula framework and tailored to local contexts and needs of secondary levels (Grade VII to XII) and were vetted by project consortium members and consultants several times. The OERs curated through the project are valuable resources for teachers, and the project's findings could be used to guide future STEM education initiatives in Bhutan. The CL4STEM project has achieved a significant milestone by developing a set of subject-specific Open Education Resources (OERs) tailored for teachers.

This marks a groundbreaking initiative in Bhutan, promoting equitable, inclusive, and high-quality professional development. The OERs, meticulously aligned with the national curricula framework, are specifically designed for secondary levels from grade VII to XII and have undergone multiple evaluations by project consortium members and consultants. These resources, proven valuable for teachers, not only adhere to local contexts and needs but also lay a foundation for guiding future STEM education initiatives in Bhutan.

Despite it accomplishments, the CL4STEM project has encountered a few challenges too. School Principals reported obstacles faced by teachers, including tight schedules, misalignment of OERs with the academic calendar, insufficient ICT resources in classrooms, and high data charges.

The project partners have committed to address these challenges during the scaling phase. Despite these hurdles, the CL4STEM project has made substantial strides in enhancing teacher capacity in STEM education as stated by the Country Coordinator of Bhutan,

"the project has had a transformative impact on the professional development of secondary STEM teachers across the partner countries, with participating teachers reporting significant improvements in their teaching practices as well as renewed knowledge, skills, and enthusiasm for STEM education."

The meeting yielded key outcomes, highlighting the project partners' concerted efforts

1. Agreement on Priorities. The project partners successfully reached an agreement on the priorities shaping the next phase of scaling in their respective partner countries.

2. Strategy for Challenges. A comprehensive strategy was discussed and formulated to address the challenges faced by schools during the project implementation.

3. Dissemination of Findings. A decision to initiate the dissemination of the project's findings to the field of STEM education was also made in the meeting.

4. Year 3 Planning. Project partners resolved to plan the Year 3 activities with a focus on maximizing participation from all relevant stakeholders.

The CL4STEM project stands as a valuable initiative, bringing positive changes to the professional practices of teachers and students learning experiences across partner countries. The critical meeting in Bhutan provided a timely opportunity to evaluate progress, accomplishments, and scaling plans. The project partners are unwavering in their commitment to advancing the CL4STEM initiative, ensuring the provision of quality and equitable STEM education in partner countries.

Visit of the Project PANOPTES team from USA

Ms. Ugyen Pem
Assistant Professor

Samtse College of Education (SCE) welcomed a team of professional and amateur astronomers, Dr. Oliver Guyon, Dr. Preethi Krishnamoorthy, Dr. Nour Skaf, Mr. Joe Wise, and Ms. Summer Dawn Chamberlain, from Project PANOPTES, the USA, on May 10, 2023. The main aim of their visit is to train the members of Project PANOPTES of Samtse to build a robotic telescope.

Assembling the Camera Box

The Project PANOPTES Samtse team consists of students and faculty from the College and a few students from Samtse Higher Secondary School and Samtse Lower Secondary School. Prior to their visit, the Project PANOPTES team at Samtse attended several online training sessions during weekends facilitated by Project PANOPTES USA.

During their one-week stay from May 10 to May 16, 2023, at SCE, the following activities were carried out:

1. Building units of PANOPTES

The unboxing of the PANOPTES units was an exciting experience for the students with many hands-on learning activities. All the students were fully engaged in assembling the components of the Control Box, Camera Box, and fixing the Mount and Pier. To kick off the installation process, the students began by setting up the Ubuntu server on the Raspberry Pi situated in both the Control and Camera boxes of the PANOPTES.

After getting the Raspberry Pi up and running with the necessary operating systems, we installed a software system called PANOPTES Observatory Control System (POCS). The Power Board provides power distribution to various components of the system, including the camera, mount, and control box.

Assembling the Control Box

Learning how to fix pier and mount

Learning the processes of installing and running the software

Testing the PANOPTES robotic telescope

2. Star watching

On May 11, 2023, a total of 100 college students, faculty, and staff, as well as their family members, took turns watching stars in the night sky. The telescope used for the night sky watch was the 10-inch hybrid truss tube Dobsonian Telescope. The astronomers interacted with the incoming audience and engaged them by helping them recognize certain stars and notice moving satellites in the night sky. They were also delighted to entertain questions from a wide range of audiences related to astronomy. The star-watching event was enjoyed by the public using the telescope.

3. Astronomical talk show

Around 500 students and faculty of Samtse Higher Secondary School gathered in the College Auditorium on May 12, 2023, to attend an inspiring talk on “Introduction to Astronomy and the Search for Life in the Universe” by Dr. Nour Skaf, followed by a question-and-answer session. The talk show went on for about an hour, during which the students got the opportunity to clarify their misconceptions related to space science and technology.

And Dr. Oliver Guyon, Dr. Preethi Krishnamoorthy, and Mr. Joe Wise proactively answered some of the questions raised by the students. Overall, this event was an enriching experience for the school students and teachers and the College faculty and students. It also played a vital role in promoting enthusiasm amongst the audience for learning STEM subjects and their career prospects.

Dr. Nour Skaf

Dr. Oliver Guyon

Dr. Preethi Krishnamoorthy

4. Empowering women for STEM

On May 10, 2023, there was an interactive session by three women, Dr. Preethi Krishnamoorthy, Dr. Nour Skaf, and Ms. Summer Dawn Chamberlain from Project PANOPTES with the members of the Women in STEM group at Samtse College of Education. The interactive discussion was centered around the issues faced by women around the world, focusing on imposter syndrome and the difficulties faced by women in education and their workplaces. Moreover, the discussion led to the concept of women supporting women to achieve their dreams.

5. Paper presentation on the Project PANOPTES

On May 15, 2023, Dr. Preethi Krishnamoorthy presented a paper titled "Exploring the Universe and Finding Exoplanets with Small Cameras: Project PANOPTES" as part of the 2nd National Conference in Higher Education. Her presentation was an eye-opener for many in the audience to hear about Project PANOPTES and how it sets up a global network of small telescopes, built by citizen scientists and schools, to monitor much of the sky.

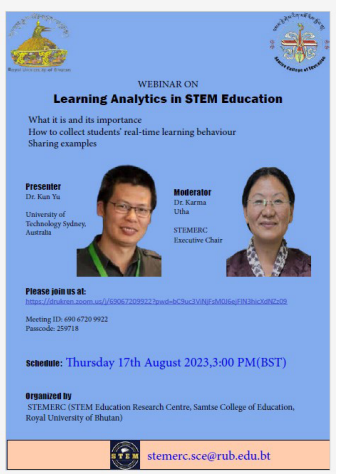
Learning Analytics in STEM Education

Mr. Man Singh Singer
Lecturer

Introduction

The webinar on Learning Analytics in STEM education, organized by the STEM Education Research Centre (STEMERC) of Samtse College of Education (SCE) on 17th August, 2023 featured Dr. Kun Yu from the University of Technology Sydney, Australia. The webinar was moderated by Dr. Karma Utha, Head of STEM Education and Research Centre.

The presentation delved into the opportunities



and challenges associated with learning analytics in STEM education, exploring its potential applications. The webinar participants included STEM faculty, a few non-STEM faculty members of SCE, MEd Science andMathematics students, and interested school teachers from different parts of the country.

Dr. Yu initiated the presentation with an overview of education in Australia emphasizing the high standards and widespread cultural commitment to lifelong learning in the country. He then explored various aspects of learning analytics, including techniques, applications, deployment, and user interfaces. Highlighting the transformative potential of these technologies, he discussed their role in personalizing learning outcomes and providing real-time feedback to students.

The presentation also touched on the origin of Computer-Aided Learning (CAL) and its significance, citing a 1973 research report that recognized CAL as a crucial educational tool for the future. However, Dr. Yu acknowledged uncertainties surrounding student adaptation and the learning efficiency of CAL.

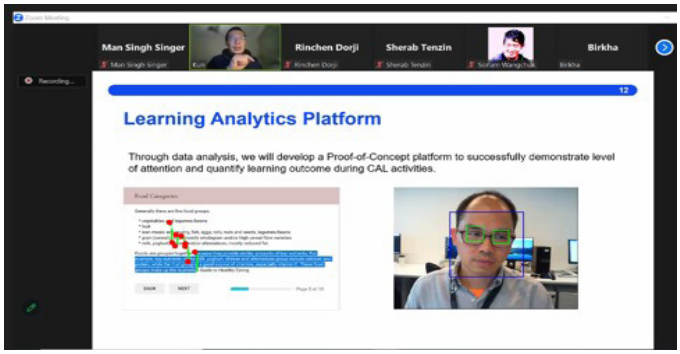
Challenges of Computer- Aided Learning

Dr. Yu discussed the challenges associated with computer-aided learning, underscoring its potential cost implications in development and implementation. He emphasized the difficulty of ensuring the effectiveness of CAL and noted its impersonal nature, which can lead to disengagement and neglect of student well-being in the school environment.

Behavior Data Collection

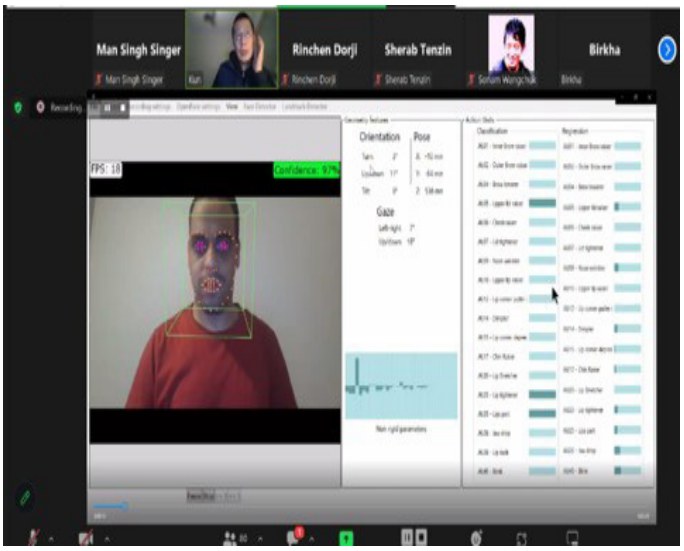
The presentation shifted to the importance of behavior data in learning analytics. Dr. Yu emphasized that behavior data can effectively track student engagement, attention, and learning progress. Various sources for collecting behavior data were explored, including clickstream data, eye tracking data, and facial recognition data.

A Typical Study Process



Dr. Yu proceeded to outline a typical study process for STEM learning stressing various activities such as reading, watching videos, taking notes, and practicing problems. Emphasizing that the study process varies among students, based on their learning styles and preferences, Dr. Yu recognized the diversity in approaches.

Learning Analytic Platform



The presentation then delved into different learning analytic platforms available. Dr. Yu underscored the variety for collecting and analyzing behavior data, emphasizing that the choice depends on the specific needs of the educator or institution.

Real-time Engagement Examination

Dr. Yu discussed the use of real-time engagement examination in learning analytics. This method, he explained, can track student engagement, identify struggling students, and facilitate personalized interventions.

Emotion as another way to examine learning

Dr. Yu then discussed the use of emotion as another way to examine learning. He highlighted emotion as a potent indicator of learning, citing ways to measure it, including facial recognition, physiological data, and self-report measures. These metrics can gauge student motivation and engagement. Potential Applications

The presentation concluded with Dr. Yu discussing potential applications of learning analytics in STEM education. These applications include improving student learning outcomes, personalizing learning experiences, identifying struggling students, and enhancing the overall quality and efficiency of education.

Conclusion

Dr. Yu's comprehensive presentation offered valuable insights into learning analytics in STEM education, covering opportunities, challenges, and potential applications. The audience responded positively, indicating a likely impact on the adoption of learning analytics in STEM education in Australia. The webinar concluded with a question-and-answer session, fostering further engagement and understanding.

Linnaeus Palme International Fauty-Student Exchange Programme

Mr. Purna Bahadur Subbha
Project Coordinator

The Linnaeus Palme Project started in 2018 successfully completed in Spring 2023. As part of the last phase of the project, several activities were carried out. The following are some highlights of the activities that took place in Samtse College of Education.

Formal Reception Programme

A formal reception programme was organised to welcome the two exchange faculty members of Malmo University on 21st March 2023 at the office of the officiating President. Officiating President, HoD DSTEM, Deans, ADM, Research Officer, and LP Project Coordinator were present at this programme. A formal introduction to each other was followed by some interaction/exchange of information, ideas and ideologies amongst the members of this reception programme. After this programme, a short campus tour was carried out.

Meeting with STEM Faculty and Dean of Academic Affairs

The SCE exchange faculty members and the LP Project coordinator met in the math faculty conference hall for a short departmental meeting to discuss the exchange programme activities for the rest of the exchange days. On the following day, Dr. Nandu Giri and Dr. Reeta Rai, Chemistry faculty of SCE met with Prof. Annette, and discussed chemistry education and research, writing a professional development program. A separate day was fixed for meeting with the STEM Research Coordinator and the HoD of the Department of STEM Education to discuss the STEM Research programmes and developments.

Seminar on Flipped Supplementary Instruction and Peer-Assisted Study Session (SI- PASS)

The main objective of this seminar was to educate the faculty and students of SCE on Flipped Supplementary Instruction on a blend of the teaching subject matter and environment, facilitated on 27/03/2023 jointly by Professor Annette, SCE exchange faculty members Mr. Tandin Penjor , Mr. Ran Singh Tamang and Mr. Man Singh Singer. This seminar was organized for all interested staff. Professor Per Schubert also attended this seminar.

SI-PASS, an educational model developed in the 1970s by Deanna Martin at the University of Missouri-Kansas City (UMKC), is based on collaborative learning. The students meet regularly in small study groups with 5 to 15 participants under the leadership of an older student who has previously taken the course and who acts as a role model and guide, but not as a teacher.

The SI Leader's task is to help the students to sort out and shed light on the components of the course that are experienced as difficult, to act as the leader of exercises and moderator in discussions to address and solve these difficult components. The SI Leader is to help the students to find answers to their questions together and to work effectively and purposefully in the group. In order to carry out these tasks, SI Leaders take a special two-day

course in SI strategies and leadership.
The following link provides the site of SI-PASS through which the reader may learn more about this approach to teaching, learning and assessing students: About SI-PASS European Centre for SI-PASS (lu.se)

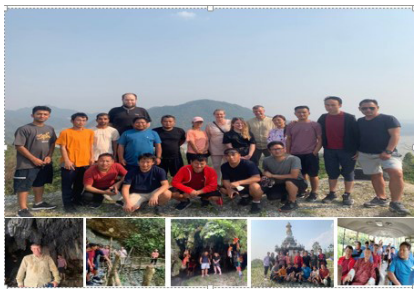
Seminar on Geographic Information Systems (GIS) as Tools for Teaching Geography as a spatial science. Teaching geography has an interdisciplinary nature, and by using geographic information systems(GIS), we could coordinate subjects for teaching about complex problem areas that are related to, for example, sustainable development and the environment. This seminar was facilitated on 27th March, /2023 by Professor Per Schubert for all the geography faculty members and geography students, with opportunity to participate for other interested faculty members as well. The goal of this programme was to provide an increased understanding of how GIS as a teaching tool can strengthen interdisciplinary teaching and learning of complex issues of sustainability and environment, in order to contribute to lifelong learning and action skills to meet the societal challenges we face.

Visit to Bukay Dham

“Dham” in the local language means a holy place where the local deities are worshipped and the place is taken care of by the local people, whereas “Bukay” is the name of the rural village where this Dham is situated. So, “Bukey Dham” is the name of this holy place located in the village of Bukay, in Samtse, Bhutan.

Bukey Dham is a limestone cave situated inside a cliff. The cave is known to be a meditation site of Lord Shiva and is considered a sacred place by many locals. According to the local people, the cave is said to have been discovered by a saint who was meditating in the area and was drawn to the cave by a divine force.

On March 28, 2023, 14 M.Ed Geography students (10 M.Ed II Yr. and 4 M.Ed I Yr.) along with the tutor Mr. Tashi (Geography Course Leader) and the four international guests from Sweden visited Bukay Dham.



This trip provided students with hands-on learning experiences where they could observe the natural beauty of the cave, its unique geological formations (stalactites and stalagmites) and the cultural significance of the site. Additionally, the trip aimed to foster cultural exchange between the international guests and the students. They also learned about the importance of preserving natural sites and cultural heritage of the area. Additionally, the trip provided an opportunity for cultural exchange between the international guests and the students. The field trip to Bukay Dham was also a part of an exchange program between the M.Ed students and the international guests.

In conclusion, the journey was an exciting and adventurous experience for the students and the guests. The students and guests were captivated by the natural beauty of Bhutan's landscape throughout the journey. It was a memorable experience for the M.Ed students, their tutor, and the international guests. The cave, with its rich history and spiritual significance left a lasting impression on the group.

The meeting with visitors from India also provided a unique opportunity for cultural exchange and learning. This trip was a success story and served as a reminder of the importance of exploring and appreciating the natural and spiritual wonders of the world.

School visit

In continuation of the student-faculty exchange programme, two school visits were organis ed. A visit to the Bukay Primary School was organized on 28 March 2023. The principal Mr. Karma Thinley supported this visit wholeheartedly and was a successful programme. Bukay Primary School is situated 13 km from Samtse town. It is a journey of a little

over 30 minutes' drive by car. Currently, it has 84 students with equal gender representation, 7 teachers and 4 support staff. It was established in 2012.

The visit to the Dorokha Central School (DCS) organised on 31st March 2023 was also successful mainly through the wholehearted support of the School Principal Mr. Udai Narayan Bhattarai. DCS has situated 53 km from Samtse town. It is a journey of a little over 2 hours' drive by car. Currently, it has 444 students, 30 teachers and 18 support staff. It was established in 2019.

The objective of the school visits was to do educational and cultural exchanges in Bhutanese and Swedish perspectives. The following activities were performed in this programme:

1. Observation and interaction in 1- 2 classroom teachings in Bhutanese perspectives

2. Brief presentations about the people and culture of Sweden, for both students and teachers

3. A brief presentation on the teaching approaches: flipped classroom, Google Earth Pro and SI-PASS (1 hour)- for teachers.

4. Lunch/Refreshment programme.

Cultural exchange

Towards the end of the exchange programme, an exchange of Bhutanese cuisine and Swedish cuisine happened in which both parties prepared their own most common and popular traditional food items. Different traditional food items of Bhutan were prepared such as Ema Datshi, Kewa Datshi, Red Rice, Khulee, and Sel Roti. From the Swedish partners, Semla, the Swedish special traditional food and other few Swedish traditional foods were prepared and served. It was truly an exciting cultural exchange event that transcended beyond educational practices .

Comment: Maintain uniformity in writing captions on figures. Why is it done here on the picture unlike the earlier ones? Also look at the colour contrast of the caption fonts and the background. We are teacher educators that teach students about this in Teaching Skills but we promote such poor practices of poor colour combination. Double oversights by the writer and editor. We cannot make such mistakes. The same comment for the figures on the next paragraph.

See off

After a successful and memorable semester-long student exchange programme at SCE, the two exchange students from the University of Malmo in Sweden, Ms. Anna Ellinor Falt left for Sweden in 12th June 2023 and Mr. Toborjorn Martin Hansson left on 26th June 2023.

Book Release on the Status of STEM Education in Bhutan's Secondary Schools

Dr. Reeta Rai
CL4STEM Country Coordinator

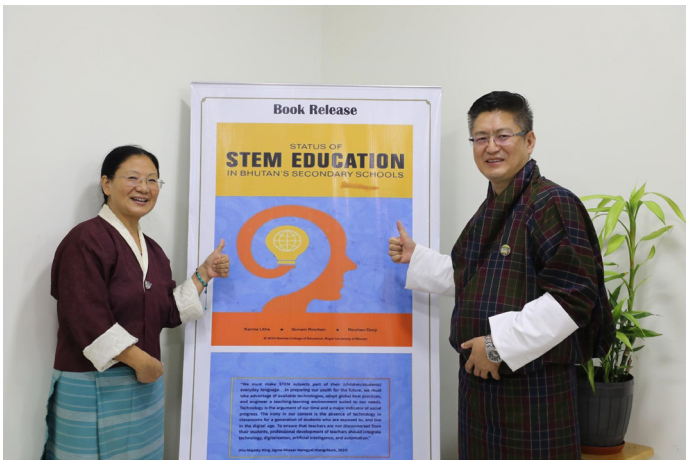
The Bhutan CL4STEM project unveiled a significant publication on June 22, 2023, during the governance meeting held at Samtse College of Education (SCE). Authored by Dr. Karma Utha, Dr. Sonam Rinchen, and Dr. Rinchen Dorji, the book, titled "The Status of STEM Education in Bhutan's Secondary Schools," offers a comprehensive overview of STEM education across five dzongkhags: Thimphu, Paro, Samtse, Trashigang, and Zhemgang.

The book meticulously examines the challenges and opportunities within Bhutan's STEM education sector, offering insightful recommendations for improvement.

The book release ceremony was graced by esteemed guest Prof. Padma Mudumbi Sarangapani, Principal Technical Consultant at Tata Institute of Social Sciences, Mumbai, India, and Dr. Rinchen Dorji, President of SCE. Attendees at the ceremony, including CL4STEM project partners, Samtse Dzongkhag Education Officers, and school Principals, received copies of the book.

Additionally, plans are underway to distribute it to key stakeholders such as the Ministry of Education and Skills Development (MOESD) and secondary schools nationwide, ensuring widespread access to its valuable insights and recommendations.

The event not only celebrated the achievements of the Bhutan CL4STEM project but also raised awareness about the importance of STEM education in the country. With its release, this comprehensive resource is set to empower educators and stakeholders, ultimately contributing to the enhancement of STEM education quality in Bhutan.



Exploring Grey water Stagnation: A Case Study

Kuenga Legpa
Geley Wangchuk
Dorji Wangchuk
Dawa Tshering
Ugyen Chophel
Kamal Prasad Powrel
Sobit Pradhan
(M. Ed II Physics)

Introduction

Samtse College of Education (SCE), a prominent teacher training institute, serves as an academic hub for over 600 students, a considerable number of whom call the on-campus hostels their home. Despite providing a nurturing academic environment, the institution grapples with a significant challenge – the issue of clogged drainage accompanied by unpleasant odours. The increasing student population and the confined living quarters in hostels have exacerbated this problem. To address these existing concerns, the first step was to gain a clear understanding of the issue and instilling environmental consciousness among the student community.

Recognizing the need for an effective and immersive approach, the integration of Project-Based Learning (PBL) becomes a focal point. Embedded within the Teaching, Learning, and Assessment module of M. Ed. II Science and Mathematics, PBL offered student's dynamic, real-world problem-solving experiences. This study explored an application of PBL and harnessing knowledge of physics in the context of wastewater management, specifically targeting the unique drainage challenges faced by SCE.

Through hands-on, collaborative learning experiences, the objective of the study was to empower students with the skills and knowledge necessary to apply physics concepts to practical problems. The distinctive context of SCE serves as a backdrop for comprehending the intricacies of the drainage system challenge and proposing context-specific solutions applicable within SCE and potentially replicable in similar settings. The project's primary focus centred on investigating the stagnation of grey water, particularly in terms of flow rate. This endeavour transcended academic exercises, aiming to bridge theoretical knowledge with practical application, fostering a holistic understanding of fluid mechanics and drainage engineering.

Aims

This study not only intended to understand the immediate environmental concerns but also lays the groundwork for the future where educational institutions actively contribute to sustainable solutions, integrating theory and practice seamlessly. Hence, the study aimed to determine the state of stagnation of grey water at SCE investigate and determine the flow rate of grey water

Objectives

The objectives of this study were to:

calculate the flow rate of both pure and grey water.

determine the inclination of the current drainage system in the self-catering hostel.

calculate the appropriate inclination required for the efficient flow of stagnant water.

Literature Review

Water, covering two-thirds of the Earth's surface, is predominantly saltwater, leaving only 3% as freshwater, much of which is confined in ice caps and glaciers (Tahir et al., 2020). The growing scarcity of water, exacerbated by global demand surpassing supply, underscores the urgent need for effective wastewater management strategies (El-Rawy et al., 2020; Barnes, 2014). In the realm of proper drainage, several studies have delved into its significance. Jones and Smith (2019) advocate for a minimum slope of 1/8 inch per foot in drainage pipes to ensure swift water flow, while Gracia and Hernandez (2016) stress the importance of a 2% slope for unimpeded water movement within drainage systems. Furthermore, Mohamed et al. (2018) contributes valuable insights by highlight-

ing the potential degradation of soil structure due to non-degradable salts from laundry detergents, laying a foundation for the objectives of this study. Guidelines provided by the International Plumbing Code (IPC) in 2018 offer specific recommendations for designing an efficient drainage system.

These encompass maintaining a 1/8 inch per foot slope, ensuring drain sizes can accommodate maximum wastewater flow, incorporating grease traps for kitchens, and preventing the disposal of hazardous materials into the drainage system to mitigate pipe damage and environmental harm.
Neglecting the upkeep of drainage systems poses substantial risks in both community and healthcare contexts, fostering infections and the development of multi-resistant bacteria (Blom, 2015).

Additionally, inadequately managed grey water may produce unpleasant odours and attract pests (Ramanathan et al., 2017).
In residential settings, structural damage often results from water backflow, seeping into foundations and compromising the house's integrity. Inadequate drainage systems stand out as the primary cause of persistent flooding, environmental degradation, and the resultant loss of lives and property (Alejo, 2018). Recognizing this, effective drainage systems play a pivotal role in redirecting excess flow and mitigating peak flow stages during floods (Alejo, 2018). Therefore, proper grey water management is imperative for maximizing benefits while minimizing negative effects on the property and public health. This nuanced understanding underscores the pressing need for comprehensive wastewater management strategies in the face of global water challenges.

Methodology

This study employed a multifaceted approach to investigate the drainage system at SCE. The methodology included experimental analysis based on Bernoulli's principle, observational methods, and expert consultations. According to the Bernoulli's principle of fluid dynamics, a fluid's speed increases at the same time as its static pressure or potential energy decreases. Bernoulli’s principle provides a mathematical means to understanding the mechanics of fluids. It is used in designing water supply and sewer networks.

Through experimentation, the flow rates of both grey water and tap water were meticulously measured, and the inclination of the existing drainage system was calculated. The application of Bernoulli's principle provided insights into fluid dynamics, facilitating a comprehensive understanding of water velocity and pressure. Additionally, expert consultations added a practical dimension to the study, ensuring that real-world insights complemented theoretical analyses.

Result and discussion

The physical observations of the drains around the campus were carried out. It revealed multiple points of clogging in the drains, with the base showing damage in the form of holes, impeding smooth flow. It was observed that drainage blockages occurred at various points, contributing to the compromised flow dynamics. Moreover, the irregularities in the elevation of the drains were identified as a significant factor, as they were not inclined adequately, further impeding the water flow. The water in the drains also exhibited a lack of a uniform direction, contributing to the overall inefficiency of the drainage system.

After the physical observation, the scientific calculations detailed below was carried out to get a thorough understanding of the drainage issues at SCE, shedding light on the quantitative aspects of the observed blockages and compromised flow. These findings shed light on the multifaceted nature of the challenges within the drainage system, emphasizing the necessity for a comprehensive examination and targeted interventions to address issues related to blockages, improper inclinations, and the non-uniform flow of water in drains.

Volume flow rate of grey water at SCE

To examine the grey water's volume flow rate, data were collected from the drains at different time for different volume.

Sl. No	Reading (cm^3)	Time (s)	Flow Rate (cm^3/s)
1	0	0	0
2	5	80	0.063
3	10	152	0.066
4	15	220	0.068
5	20	299	0.067
		Average	0.066

The data analysis showed that the
Volume flow rate of tap water = 0.0759 cm^3/s
Velocity of tap water = 1.98 cm/s
Velocity of grey water = 1.74 cm/s
Using Bernoulli's Principle, the water runoff was then calculated as follows.

Bernoulli's Principle

$$P_e + \frac{1}{2}\rho V_e^2 = P_0$$

Static pressure + dynamic pressure = Stagnation pressure

Runoff value of the sample drain, Qr

Qr = CIA, where, C is a runoff coefficient,
I = grey water's volume flow rate and
A= Area of the drain
Area of the drain = 2971.92 m2
Runoff value, Qr = CIA
= 0.65 x 0.066 cm^3/s x 2971.92 m^2
= 0.35 m^3/s

The examination of grey water's volume flow rate, which measures at 0.066 cm^3/s, presents a notable contrast with tap water, registering a higher flow rate of 0.0759 cm^3/s. This discrepancy suggests a potential inefficiency in the drainage system, where grey water is experiencing a slower discharge compared to tap water. Such differences in flow rates highlight the existence of hindrances within the drainage infrastructure that impact the overall fluid dynamics.

Furthermore, the velocity assessments provide crucial insights into the speed at which water moves through the system. Tap water demonstrates a faster velocity at 1.98 cm/s, while grey water exhibits a slightly slower velocity of 1.74 cm/s. This variance underscores the unevenness in fluid movement within the drainage system. The reduced velocity of grey water could be indicative of obstructions, pipe damage, or insufficient slope, contributing to the observed stagnation issues.

The application of Bernoulli's Principle in determining the runoff value adds a layer of scientific rigor to the findings. The principle reveals that the runoff value for the sample drain is 0.35 m^3/s, surpassing the standard range recommended for residential areas (0.1 - 0.2 m^3/s). This excess runoff value points towards a potential risk of water stagnation, emphasizing the urgent need for a comprehensive examination of the drainage system.
In summary, the combination of lower flow rates, differing velocities, and the runoff value exceeding standards collectively signals a complex issue within the drainage system. These findings stress the importance of a thorough investigation to identify and rectify specific points of obstruction, damage, or inefficiency, ultimately addressing the concerns of water stagnation and ensuring optimal functionality of the wastewater management system at SCE.

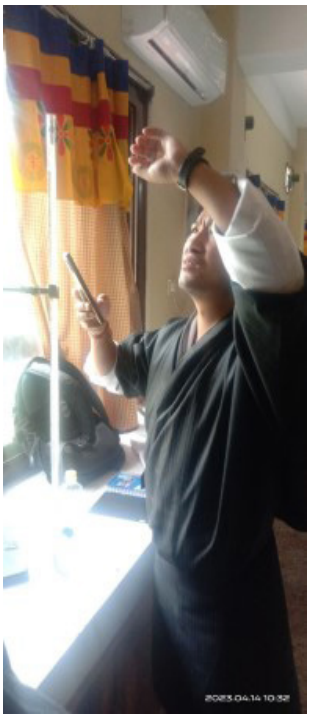
Conclusion

In conclusion, the study unveils critical dynamics in grey water drainage at SCE, identifying drainage blockages and irregularities in drain elevations as primary contributors to compromised flow. The application of fluid mechanics principles, complemented by empirical observations, highlights the intricate challenges within the existing system. The discerned runoff value exceeding standard thresholds emphasizes the urgency for proactive measures to avert water stagnation and ensure optimal wastewater management.

The findings concerning the Volume flow rate of grey water at SCE present significant insights into grey water drainage characteristics. Grey water's flow rate at 0.066 cm^3/s contrasts with tap water's higher rate of 0.0759 cm^3/s. Velocity disparities reveal tap water flowing faster (1.98 cm/s) than grey

water (1.74 cm/s). Calculations using Bernoulli's Principle determine a runoff value of 0.35 m^3/s, surpassing residential standards (0.1 - 0.2 m^3/s). This poses a risk of water stagnation, necessitating a thorough drainage system examination to avert hygiene issues and pest breeding grounds.

The study also underscores the critical need to optimize the drainage system at SCE. The observed flow rate variations and elevated runoff value emphasize the importance of implementing efficient drainage solutions. Future measures should focus on capacity enhancement, potential installation of gutters for rainwater collection, and the establishment of regular maintenance protocols to fortify the sustainability and effectiveness of the wastewater management system on the campus.



Recommendations

These recommendations aim not only to address the current challenges identified but also to fortify the sustainability and effectiveness of the wastewater management system at SCE. Based on the study's findings, several recommendations are proposed as outline below.

1. There is a need to assess drainage sys tems and enhance its capacity. Increasing the system's capacity may mitigate the risk of water stagnation.

2. The college may install gutters strategically to collect rainwater to develop the overall efficiency of the drainage system.

3. Establish regular maintenance protocols for the drainage system to prevent blockages, sediment build-up, or other issues that could impede water flow. Additionally, implementing routine inspections and cleaning schedules may help to improve effectiveness of the drainage infrastructure.

Waste Water Analysis

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INTRODUCTION

Wastewater is a kind of water that has been contaminated through various human activities such as domestic sewage, industrial effluents, and agricultural runoff. Domestic wastewater is generated from residential areas, commercial establishments, and institutions that contain a mixture of organic matter, nutrients, pathogens, and chemicals used in toilets, sinks, and showers (Mara, 2013). Likewise, industrial wastewater is generated in industries that contain pollutants such as heavy metals, organic compounds, and toxic chemicals (Patwardhan, 2017). Similarly, agricultural runoff contributes to wastewater through the discharge of pesticides, fertilizers, and animal waste from farms into water bodies, which can lead to harmful algal blooms and oxygen depletion in aquatic ecosystems (Wang et al., 2018).

According to the World Health Organization [WHO] (2017), approximately 80% of the world's wastewater is discharged into the environment without treatment. The release of untreated wastewater into the environment can contaminate water sources, degrade water quality, and make it unfit for human consumption. Wastewater discharges can also disrupt aquatic ecosystems, leading to the decline of aquatic species. Additionally, the presence of pathogens in wastewater poses a risk to public health, facilitating the spread of waterborne diseases.

WHO (2017) reported that approximately 1.8 million people die yearly from diarrheal diseases caused by contaminated water and poor sanitation. These statistics highlight the urgent need for improved wastewater management worldwide to protect public health, safeguard the environment, and promote sustainable development. To safeguard the environment and human health, the implementation of proper treatment processes to remove contaminants before discharge, as well as the promotion of water conservation and pollution prevention practices, is crucial at the earliest. By addressing the challenges associated with wastewater, we can strive toward a sustainable and healthier future for both ecosystems and communities. Therefore, the data obtained from this wastewater analysis may help identify potential contamination sources and design appropriate treatment systems to protect public health and the environment.

RESEARCH QUESTION

Does wastewater generated at Samtse College of Education require treatment?

Sub-questions

1. What are the different kinds of wastewater generated at the College?
2. What are the parameters to test the wastewater?
3. What are the different methods to minimize wastewater?
4. How can we conclude that wastewater requires treatment?

PARAMETERS FOR WASTEWATER ANALYSIS

To evaluate the wastewater originating from the boys' self-catering hostel, kitchen drain, and canteen for environmental release, various indicators including pH, turbidity, conductivity, dissolved oxygen (DO), total dissolved solids (TDS), and temperature were identified. These parameters were utilized to determine the necessity for treatment before discharge into the environment.

pH

pH is a measurement used to assess the acidity or alkalinity of a water solution. Pure water is considered neutral and has a pH value of 7. When the pH of water falls below 7.0, it is classified as acidic, while a pH value above 7.0 indicates basic or alkaline properties. The WHO sets guidelines for the acceptable pH range of wastewater that can be discharged into the environment without treatment.

According to the WHO, the recommended pH range for untreated wastewater to be released into the environment is 6.5-9.5.

Turbidity

Turbidity refers to the degree of cloudiness or haziness in a water sample due to suspended particles or solids. This characteristic serves as a crucial parameter in assessing water quality. According to the WHO, the recommended threshold for turbidity in water is 5 NTU (Nephelometric Turbidity Units).

Electrical conductivity (EC)

EC testing of water is a method used to quantify the concentration of dissolved ions within a water sample (Girard, 2013). The WHO has established a standard range of 200-800 µS/cm for electrical conductivity in water, while the National Environment Commission's ambient water quality standard suggests a range of 800-1000 µS/cm.

Dissolved oxygen (DO)

DO serves as a crucial indicator of the oxygen concentration in water, reflecting the level of oxygen availability for aquatic organisms (Girard, 2013). The WHO recommends an acceptable range of 6.5-8 mg/L for dissolved oxygen to support the well-being and survival of aquatic organisms.

Total Dissolved Solids (TDS)

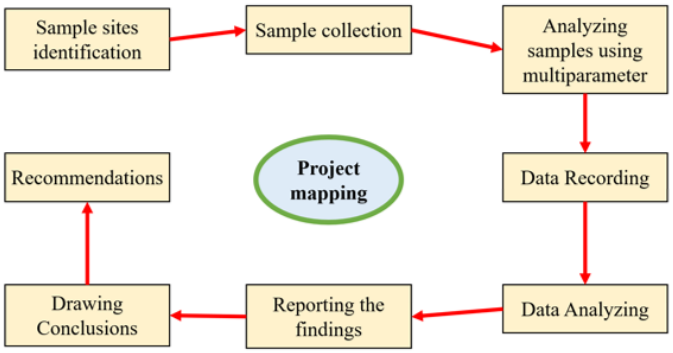
The TDS of water signifies the level of dissolved minerals, notably calcium and magnesium ions, within the water, which collectively determines its hardness of the water. According to the WHO, the advised limit for turbidity in water is typically stated as 300 parts per million (ppm).

Temperature

Water temperature holds a pivotal role in water analysis, impacting numerous physical, chemical, and biological processes. As per the WHO's guidelines from 2017, an acceptable threshold for untreated wastewater discharge is set at 40 degrees Celsius.

METHODOLOGY

1. Project Mapping



2. Sampling sites and techniques

The selected sampling locations included the self-catering hostel for boys, the college kitchen, and the college canteen. The sampling locations were selected through a random draw from a list wastewater generation sites.

3. Sample collection analytical procedures.

Samples were collected from the self-catering hostel for boys, the college kitchen, and the college canteen. Physio-chemical parameters such as TDS, Turbidity, DO, pH, and EC were measured using a multiparameter meter Hanna 98194. The finalized data obtained from the sampling sites were compared using the water quality standard developed by the WHO (2017). Finally, data was interpreted and recommendation was made based on the study's findings.

OBSERVATIONS AND FINDINGS

Table 1: The observation table showing the parameters reading from different sampling sites

Sl. No.	Parameters	Acceptable Values (WHO)	Self-Catering hostel	Kitchen site	Canteen
1	pH	6.5-9.5	8.65	7.9	8.33
2	Turbidity	5 NTU	23.9 NTU	23.3 NTU	23.5 NTU
3	Conductivity	200-800 µS/cm	128 µS/cm	123 µS/cm	126 µS/cm
4	DO	6.5-8 mg/L	7.9 mg/L	6.4 mg/L	7.1 mg/L
5	TDS	300 ppm	360 ppm	380 ppm	372 ppm
6	Temperature	40 0C	27.76 0C	23.78 ^{0}C	26.71 ^{0}C

1. pH

Regarding this parameter, the acceptable value mandated by WHO (2017) is 6.5-9.5, however, the pH of the wastewater from the boys' self-catering hostel, kitchen drain, and canteen were 8.65, 7.9, and 8.33 respectively which is relatively high. The reasons could be attributed to the excessive use of different soaps that are alkaline.

2. Turbidity

The WHO (2017) recommends a turbidity level of 5 NTU as acceptable. However, the
wastewater samples obtained from the drainage of a boys' self-catering hostel, kitchen drains, and canteen exhibited remarkably high turbidity levels of 23.9 and 23.3, respectively. These elevated readings were attributed to the murkiness of the collected wastewater, caused by the inclusion of sewage and kitchen waste like discarded rice and vegetable peels. Additionally, the presence of contaminants such as leaves, debris, and sand further contributed to the observed high turbidity.

3. Conductivity

The conductivity measurements of wastewater from the boys' self-catering hostel, kitchen, and canteen were recorded at 128 µS/cm, 123 µS/cm, and 126 µS/cm, respectively. These values fall below the acceptable threshold outlined by the WHO. The reduced conductivity observed in these samples is likely due to a deficiency of minerals.

Dissolved Oxygen

The DO of wastewater from the boys' self-catering hostel, kitchen, and canteen was recorded at 7.9 mg/L, 6.4 mg/L, and 7.1 mg/L respectively. Therefore, the DO content from the sample sites indicates that the oxygen content is within the acceptable range of WHO recommendations.

4. Total Dissolved Solid (TDS)

The TDS amount of 360 ppm, 380 ppm, and 372 ppm in sample wastewater from the boys' self-catering hostel, kitchen, and canteen indicate that there is a high amount of suspended substances which is the amount beyond the recommended amount of WHO. These high readings were attributed to the presence of soap waste contaminants from the sample sites.

5. Temperature

The temperature was measured at 27.76 0C, 23.78 0C, and 26.71 0C respectively for boys' self-catering hostel, kitchen, and canteen. The temperature measured at the sample

sites revealed a low temperature compared to the WHO acceptable value of 40 0C. This was because the sample was collected from a site that was less exposed to the direct sun.

CONCLUSIONS

Table 2 shows the conclusion of the study. The conclusions are stated with respect to each sub questions that are catered to answering the overall driving question.

Table 2: The table showing the conclusions from the study

Sl. No.	Sub Questions	Boys' Self-catering hostel, Kitchen, and Canteen
1	What are the different kinds of wastewater generated at the College?	• Waste water from the kitchen, hostel and canteen. • Soap water from the bathroom.
2	What are the parameters to test the wastewater?	pH, Turbidity, Conductivity, DO, TDS, Temperature
3	What are the methods to minimize wastewater?	• Reuse the cloth washed wastewater for flushing the toilet. • Throw the soap water in the toilet . • Clean the drain and basin frequently.
4	Does wastewater from different sites require treatment?	While comparing the parameter values of different sites with WHO standard values, it was found that no treatment was required. The wastewater produced is safe to be released directly into the environment.
5	General findings	Water stagnation was observed in all the outlet drains of the boys' self-catering hostel, college kitchen, and canteen.

RECOMMENDATIONS

Based on the study findings, it is recommended that the College drainage system be improved so that the wastewater can be drained out freely in the environment without clogging.

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Implications of Waste Water on Ecosystem at Samtse College of Education

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Introduction

Freshwater is vital for practically every aspect of lives of humans, animals, plants, environments and ecosystems. Approximately 900 million people worldwide lack access to improved sanitation facilities, while approximately 2.6 billion do not have access to safe drinking water (WHO/UNICEF, 2008; United Nations, 2010). According to Siva, millions of people die every year from water-related illnesses like malaria, typhoid, and cholera; in fact, water-borne illnesses are the third leading cause of death from all infectious diseases, primarily due to these and other related factors (2011).

Domestic wastewater is produced during routine daily activities like showering, flushing the toilet, doing laundry, and dishwashing. It originates from home and residential sources. According to Rakesh et al., (2020) waste water generated from kitchen, bathroom, showers, washing machines excluding toilet wastes and that has low pathogenic and organic contaminants are known as Grey Water. The characteristics of grey water depend on the number of occupants, their age distribution, their lifestyle and water use habits, their living standards, their use of social media and other cultural practices, the amount of household chemicals they use, and the amount of time the grey water is stored before being used (Ghaitidak et al., 2013). This calls for a need to treat waste water.

The main goal of wastewater treatment facilities is to protect humans and the ecosystem from harmful and toxic elements found in wastewater. Globally, over 80 percent of the waste water and 44% of household wastewater is discharged without treated properly (UNO,2021). In poorer urban areas, a large proportion of wastewater is discharged untreated directly into the closest drainage channel or water body. (UNO,2021)

The study conducted by Dorji et., (2019) shows that only eight (22.8%), of the total 35 classified towns covered in this survey, have a public sewerage system which includes the four Major towns of Thimphu, Phuentsholing, Gelephu and Samdrup Jongkhar and the four district towns of Bajo, Damphu, Mongar, and Trashigang. Only the four district towns of Bajo, Damphu, Mongar, and Trashigang have a public sewer network. The above literature clearly shows that no proper treatment of waste water is done in Samtse Dzongkhag and in Samtse college of education. However, out of two major waste waters produced by residents of college, blackwater is directly drained into septic tank to reduce its impact to human and ecosystem whereas greywater is drain out of the campus through the proper drainage system.

Therefore, this study was aimed to investigate the waste water produced from the hostels of Samtse College of Education and its impact on the ecosystem. The study was also intended to create awareness on solving the water problem through waste water management strategies. The driving question for this study was “How does the waste water produced from the hostels of Samtse College of Education affect the ecosystem?”

The method used for the study is through interview and survey. The interviewee was asked some questions regarding the problem of waste water in the college and some strategies to minimize water wastage in the campus. The survey questionnaires were prepared and data were collected from some of the residents of the hostels.

Result and Discussion

Identifying the types of waste water produced from the hostel

Grey water from residential apartments makes up 50% to 70%. Depending on where it comes from, grey water has a very different makeup, which is also determined by the local water quality. Grey water is likely to contain a range of impurities, such as acidic and alkaline substances, suspended and dissolved particles, fats, oil, and grease, heavy metals, synthetic compounds, and pathogenic organisms. Grey water has an organic fraction of about 30% and a nutritional fraction of between 9% and 20%. Grey water was found to contain heavy metals, xenobiotic substances, nitrates, phosphates, and quaternary ammonium compounds (QUATS). The majority of these come from cosmetics, hair dyes, and body lotions (Rakesh et al., 2020).

Bathroom grey water contains soaps, shampoos, toothpaste, body care products, shaving waste, skin, hair, body fats, lint, and traces of urines and faeces. Grey water originating from kitchen sink contains food residues, high amount of oil and fats, dish washing detergents (Ghaitidak et al., 2013). The total grey wastewater fraction has been estimated to account for about 75% of the combined residential sewage (Friedler et al., 2013).

The biological characteristics of waste water produced from the kitchen

The Characteristics of grey wastewater is determined by the source and installation from which the water is obtained, such as the kitchen, bathroom, or laundry. Wastewater produced from the hostel usually can be considered as domestic wastewater which includes two common types known as the grey wastewater and black wastewater. Boutin & Eme (2016) affirms that Black water and grey water are the two main categories of domestic wastewater. Grey water includes wastewater from kitchen and laundry activities, as well as bathroom effluents, while black water includes flush water, urine, feces, and toilet paper (as cited in Rai, 2021).

Wastewater also contains insoluble materials, debris and other pollutants which affects the living organism in the aquatic environment. It depends mainly on the food habits of the residents and the usage of soaps and detergents in the bathroom and kitchens by them. According to Ajit (2016) the characteristics of grey waste water vary highly among households depending upon the food habits and standard of living. Kitchen waste water will be rich in TSS, oil and biological oxygen demand (BOD) but the bathing water and laundry water will show more of xenobiotic compounds.

On the contrary the nutrient content in grey water will be comparatively lesser as the urine and toilet flushing water are discharged to the black water stream. Moreover, untreated domestic wastewater contains high concentrations of excreted pathogens which can degrade water quality by depleting oxygen levels due to microbial decomposition of organic matter, making it unsafe to drink and causing diseases such as dysentery, cholera, and typhoid (Rai, 2021).

As for the Suspended solids, it will be contributed highly by food particles, dish washing soap and oil from kitchen waste while the hair and dust matters the most in bathroom and laundry water. In accordance with World Health Organisation, a limit of less than 5.0 mg/l is ideal for water bodies. As per the report by Li et al., (2009) in their study, BOD of grey water has been reported to lie in the range 47mg/L - 466 mg/L.

High BOD is contributed by kitchen waste water due to the presence of food particles whereas higher COD for laundry water as well as kitchen water due to the use of chemical cleansing agents, detergents and soaps (as cited in Ayaz & Regelsberger, 2012). Further, Ajit (2016) claims that the pathogenic bacterial load in grey water will be less, but occasionally enteric pathogenic bacteria like Salmonella, E. coli and Campylobacter will be present in kitchen waste water during food handling.

One significant characteristics of wastewater is the presence of the fecal coliform bacteria, the most common member being Escherichia coli. E. coli is a preferred indicator organism to monitor the bacteriological quality of wastewater (Rompre et. al., 2002). The fecal coliform group includes all of the rod-shaped bacteria that are non-spore forming, Gram-Negative, lactose-fermenting in 24 hours at 44.5 °C. Oram (2020) in the study concludes that

the presence of fecal coliform bacteria in aquatic environments indicates that the water has been contaminated with the fecal material of humans or other animals. E. Coli bacteria may occur in ambient water as a result of the overflow of domestic sewage or nonpoint sources of human and animal waste. E. Coli bacteria indicate the presence of sewage contamination of a waterway and the possible presence of other pathogenic organisms.

Helminths are another characteristic which cannot be substituted by other indicators, and helminth eggs are determined directly in laboratory tests. However, the eggs of nematodes, such as Ascaris and Trichuris be used as indicators of other helminths (cestodes, trematodes and other nematodes), which are removed in wastewater treatment by the same mechanism (e.g. sedimentation), being thus indicators of treatment efficiency (Sperling, 2007).

The waste water produced from the hostels has the following harmful effects:

Habitat contamination: Waste water pollutes and destroy natural ecosystems and the wildlife that lives there by exposing them to dangerous chemicals that would not otherwise be present in nature.

Soil degradation: The chemicals contain in the waste water end up in the soil which affects the growth of plants. The soil will produce less crops at a slower rate as a result of these contaminants. Eventually when people consume this crop, it will lead to many harmful effects on health.

Hazardous: Many chemicals and pathogens are present in waste water. It will pose numerous risks to people, animals, and the environment. This chemical may also be flammable, corrosive, reactive, poisonous, and/or acidic.

Effect on water bodies: Aquatic habitats are disturbed by toxic substances in the wastewater. When a large number of biodegradable substances end up in the water, organisms will start to break them down, and they use a lot of dissolved oxygen. For marine life to thrive, dissolved oxygen is essential, and when its levels drop, fish may face a serious threat to their lives.

Similarly, grease and oil in wastewater are harder to degrade and have a tendency to float to the top of the water. This blocks the light that aquatic plants use for photosynthesis. Serious health consequences could also result from consuming fish that was caught in a tainted water source, either as food or drink. Other aquatic flora and animals will also be affected.

Other harmful effects: Untreated wastewater is frequently warm or even hot when dumped, which can raise the water's temperature and further disturb the ecology. Because fish have cold blood, they depend on the water to control their body temperature. The warmth of the water can make animals move more quickly and breathe more heavily. The amount of oxygen in the water is also impacted by its temperature.

Available strategies to minimize the water wastage in the hostels. Management of waste water to the hostel residents.

Limitations

1. No measuring instrument is installed to record the water discharged from the main tank.

2. Data was collected for a short period of time; therefore, the findings cannot be generalized.

Recommendation

1. Drainage maintenance could be done for smooth discharge of the wastewater

2. The college can install a purifying tank to purify the wastewater.

3. Sensitize the users with the water management strategy to minimize wastewater.

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Wastewater in Samtse College of Education

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Background

Wastewater in a college refers to the water that is used for various purposes such as washing, cleaning, flushing toilets, and other activities, and then discharged into the sewage system. This wastewater may contain various pollutants such as organic matter, nutrients, pathogens, and chemicals that can have adverse effects on the environment and human health if not treated properly.

Our colleges generate a significant amount of wastewater due to the large number of students, faculty, and staff that use the facilities on a daily basis. This can pose a risk to the health of people who come into contact with the water, as well as to the local ecosystem. To mitigate these risks, it is important to have proper wastewater management systems in place, including regular maintenance and upgrades to treatment facilities, as well as the implementation of water conservation and pollution prevention measures.

Driving Question

How can the college manage the wastewater generated daily inside the campus?

Sub-Questions

1. What is the volume of water consumption in the college?
2. What are the different areas within the college premises where water is utilized?
3. Which group or entity consumes the highest amount of water in the college?
4. What strategies can be implemented to reduce the amount of wastewater generated?

Objectives

By the end of the project, we expect:

1. To calculate the total volume of wastewater in the college.
2. To find methods to manage wastewater so that it can be reused and safe for the environment.

Methods:

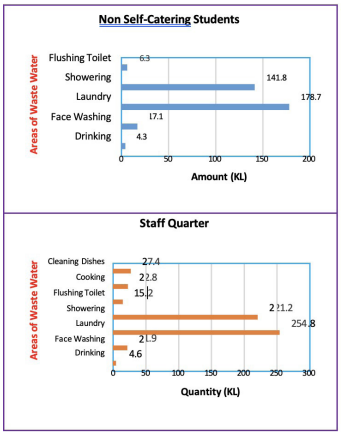
1. Interview
2. Survey Questionnaire

Mathematics used

1. Measurement
2. Estimation, Volume Calculation Graphical Representation

Findings and Discussions

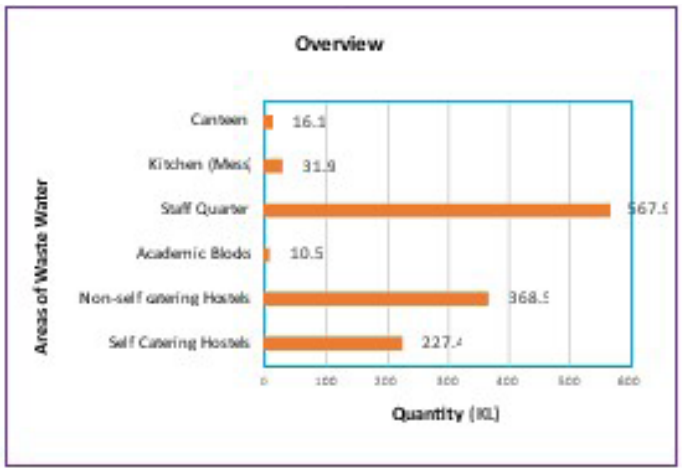
Usage of water in **THREE** different areas

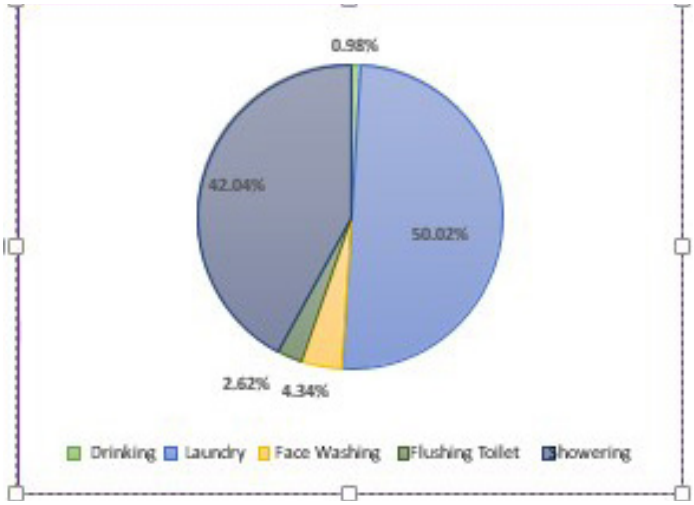


Untreated wastewater in drain

Wastewater in Samtse College of Education

Findings and Discussion





3. Most wastewater generated in the college campus was found to be laundry (50.02%) and the least is drinking (0.98%).

Water Tanks inside College

1. The total amount of wastewater discharged was 1222.3 KL in a week.
2. The daily average of wastewater discharged was 174.6 KL.
3. Staff quarter was found to be producing maximum wastewater (567.9 KL) and academic blocks are the least wastewater discharger (10.5 KL).

Water used for washing in College Mess

Interviewing

WASTE WATER IN SAMTSE COLLEGE OF EDUCATION

Qualitative Data Discussion

1. College should come up with a wastewater storage tank and must install purifying machine to purify wastewater (R1 & R3).

2. Drainage system needs to do maintenance and make sloppy for the smooth discharge of the wastewater (R1, R2, R3, R4, & R5).

3. Users can turn off the tap during the lathering period and put it on the tap during the rinsing period to minimize the quantity of wastewater (R4).

4. Sensitizing the users with water management strategies to minimize wastewater in the campus (R3 & R5).

Limitations

1. No measuring instrument is installed to record the water discharged from the main tank.

2. Data was collected for a short period of time; therefore, the findings cannot be generalized.

Recommendations

1. The college can install a purifying tank to purify the wastewater. Sensitize the users with the water management strategy to minimize wastewater.

2. The college may set up rainwater collection methods so that it can be used

3. exclusively for uses other than drinking and cooking.

Reflection on Implementing Six Thinking Hats in the Classroom

Kuenga Legpa
M.Ed II (Physics)

In our journey to introduce the concept of Six Thinking Hats, we delved into a transformative exploration guided by the innovative insights of Edward de Bono. This methodology, distinguished by the use of differently colored "hats" symbolizing unique thinking styles, brought a structured approach to our problem-solving and decision-making processes. Each hat—whether white for factual analysis, red for emotional expression, black for critical examination, yellow for optimistic consideration, green for creative ideation, or blue for metacognitive oversight—served as a distinct lens through which we could navigate the complexities of our academic journey.

The application of Six Thinking Hats in our classroom marked an engaging transition from theory to practice. Through a dynamic group activity, students collaboratively designed hats representing different thinking styles. It not only sparked lively discussions but injected vibrancy into the class. Our classroom transformed into a dynamic arena where ideas converged and diverged, transcending the confines of singular perspectives.

This foundational shift set the stage for a constructivist learning environment, where collaboration and diverse thinking became integral to our academic pursuits. The primary objectives were clear: cultivate essential skills such as communication, critical thinking, and team collaboration, while also

deepening our understanding of the subject matter.

Reflecting on the impact of Six Thinking Hats, it became evident that the approach transcended mere engagement. The strategy's influence extended into our daily decision-making processes, encouraging a holistic consideration of problems from multiple perspectives. This alleviated the need for rigid arguments and impulsive judgments, fostering a more thoughtful and comprehensive decision-making approach.

Moreover, the Six Thinking Hats approach seamlessly aligned with the Social Constructivist philosophy. It empowered us as learners, urging active participation in the learning process. The collaborative nature of the thinking hats method perfectly complemented the philosophy's emphasis on co-constructing knowledge through shared experiences and problem-solving.

The lesson's transformational impact was striking, making the class more student-centered. The departure from traditional lecturing demanded creativity, innovation, and the cultivation of team spirit among students. The sentiment among us is strong – lessons of this nature should be replicated. However, we acknowledge the importance of teachers providing a supportive and open environment, where mistakes are viewed as opportunities for growth rather than grounds for criticism. Such an atmosphere reduces intimidation, fostering a comfortable space for active participation and questioning.

In conclusion, this class using Six Thinking Hats left us feeling more engaged, motivated, and equipped with valuable skills. It served as an exemplary model of creating a positive learning environment that promotes understanding, creativity, and personal growth.

Data Encryption

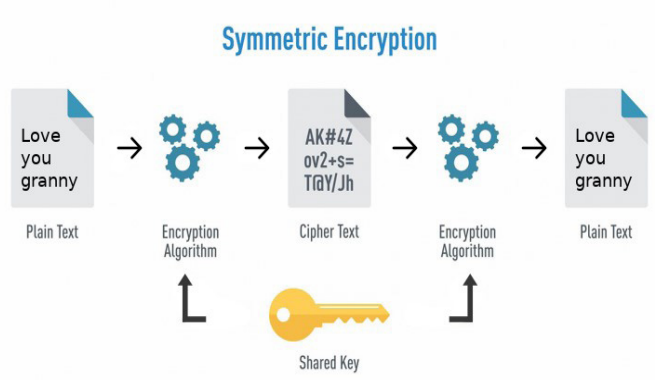
Mr. Ugyen Dorji
Associate Lecturer

The widespread adoption of instant messaging platforms like WhatsApp, Telegram, and WeChat has greatly enhanced communication, enabling the easy exchange of various types of sensitive information. However, it is crucial for users to exercise caution and prioritize security when choosing and using these apps to mitigate the risks associated with global cybercrimes and unauthorized data access. Encryption involves converting human-readable text (plaintext) into incomprehensible text known as ciphertext. It is the basic building block of data security and is the simplest and most important way to ensure a computer system's information can't be stolen and read by someone who wants to use it for malicious purposes.

Cryptography: It is the study of secure communications techniques that allow only the sender and intended recipient of a message to view its contents. The term is derived from the Greek word kryptos, which means hidden. It is closely associated with encryption.
Brute force attacks: The act of trying random numbers until the correct combination is guessed.

Types of data encryption

1. Symmetric Encryption(Symmetric Key Encryption)



Symmetric key encryption (Diagram)
Symmetric key encryption employs a single shared key (secret key) for both encrypting and decrypting messages in virtual communication. However, if the secret key is intercepted by a third party, such as a hacker, the security of the transmitted messages is compromised, enabling unauthorized decryption and manipulation of the communication. As an analogy for data encryption, consider this scenario: Pema encapsulates a message in a secure digital container and encrypts it with a key. The digital courier carries both the encrypted message and the key, delivering them to Dorji. While Dorji uses the key to decrypt and access the message, the digital courier also possesses the key, potentially compromising the confidentiality of the digital communication.

WeChat Encryption Overview

WeChat doesn't provide its complete encryption overview on its website unlike its rival messaging applications like WhatsApp and Telegram. However, the information gathered from its help centre reveals that our messages/data in WeChat are encrypted using a symmetric key encryption algorithm only. It uses industry-standard encryption practices and technologies, including specifically the Advanced Encryption Standard (AES) 256 to ensure security and confidentiality of data during transit and at rest. AES-256 is a symmetric key encryption algorithm that uses 256 bits to encrypt data and is currently the maximum available under the AES algorithm. 256-bit encryption refers to the length of the encryption key used to encrypt a data stream or a file. In comparison, the letter A in ASCII (American Standard Code for Information Interchange) code is only an 8-bit binary representation (01000001).

Summarizing the AES algorithm in a sentence or two is not feasible due to the intricate nature of the complex calculations involved. In simpler terms, envisioning the process, if Pema sends a message 'A' to Dorji in WeChat, the binary value (01000001) of the message is enveloped by a 256-bit encryption key, resulting in encrypted text. A potential hacker can only decipher this text and access the message if they possess the highly secure 256-bit symmetric key, an impractical feat due to the vast number of possible combinations (2^256=115,792,089,237,316,195,423,570,985,008,687,907,853,269,

984,665,640,564,039,457,584,007,913,129,639,936). This complexity offers robust protection against known cryptographic attacks such as Brute-Force and Statistical Attacks.

Within WeChat's encryption system, the server facilitates the sharing of a secret key among users, retaining knowledge of this key. Initially, our messages undergo encryption with this key before the server forwards the message as encrypted text to the recipient. While external cryptographic attacks are minimal, the presence of WeChat's access to the secret key and storage of messages on its server introduces a potential risk of user data being utilized for their benefit, particularly through targeted advertising.

2. Public key Cryptography (Asymmetric Encryption)

In user communication, individuals receive a distinctive pair of keys known as public and private keys. Public keys are made accessible, while private keys remain confidential. The sender encrypts the message (plain text) with the receiver's public key and delivers the message as encrypted text to the receiver. The receiver decrypts the encrypted message using his/her private key and reads the plain text (original message). A message encrypted with the public key can be decrypted only with the corresponding private key.

Public-key encryption

In the image above, Alice can freely distribute her public key so that only she (the owner of the private key) can read data that was encrypted with her public key. In general, to send encrypted data to someone, you must encrypt the data with that person's public key, and the person receiving the data decrypts it with the corresponding private key.

WhatsApp Encryption Overview

With over 1.6 billion active users, today WhatsApp is the most used messaging app worldwide. It allows people to exchange text messages, images, audios/videos and files, share status posts, and make calls around the world. As a result of Asymmetric encryption, WhatsApp not only uses a 256-bit encryption algorithm for encrypting our messages/data but also ensures that they are end-to-end encrypted. Only the sender and the recipient are able to access our messages. No third party (hacker) including WhatsApp can read them and therefore, WhatsApp-enabled messages/data are highly secure.

How does end-to-end 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 explanation of its end-to-end encryption system. A user first downloads an app (WhatsApp) from a google play store and during the app installation time which also involves a user registration, a unique private & public key pair is generated for each user. A user then transmits its public key to be stored in the server. A WhatsApp server in general will store millions of public keys for transmission to other users who intend to send their messages/data to the respective public key holder.

Public Key Types

- `Identity Key Pair` – A long-term Curve25519 key pair, generated at install time.
- `Signed Pre Key` – A medium-term Curve25519 key pair, generated at install time, signed by the `Identity Key`, and rotated on a periodic timed basis.
- `One-Time Pre Keys` – A queue of Curve25519 key pairs for one time use, generated at install time, and replenished as needed.

Session Key Types

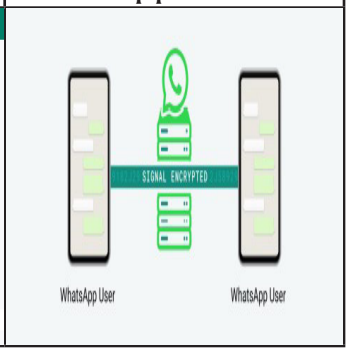
- `Root Key` – A 32-byte value that is used to create `Chain Keys`.
- `Chain Key` – A 32-byte value that is used to create `Message Keys`.
- `Message Key` – An 80-byte value that is used to encrypt message contents. 32 bytes are used for an AES-256 key, 32 bytes for a HMAC-SHA256 key, and 16 bytes for an IV.

From WhatsApp Technical White Paper

For communication, a WhatsApp user first needs to establish an encrypted session. If Pema desires to send a message to Dorji, then he has to first request for Dorji's public key and consequently the server returns the requested public key values. Pema uti-

lizes the returned public key of Dorji (receiver) to encrypt his message/data and the encrypted message is sent to Dorji by the server. Then Dorji uses his private key to decipher the scrambled (encrypted) message and access the plain text.

WhatsApp server does not store the users private key and hence the messages/data remains encrypted in it. Even if a WhatsApp employee wants to read the message, he/she will not be able to do so. Once a session has been established, users exchange messages that are protected with a Message Key using AES256 in CBC mode for encryption and HMAC-SHA256 for authentication.

WhatsApp simplified E2E encryption	E2E verification in WhatsApp
	

The Bougainvillea Tree: A Legendary Tree on the campus of Samtse College of Education

Mr. Purna Bahadur Subba
Lecturer

The Bougainvillea Tree stands as an iconic fixture, gracing the heart of the Samtse College of Education (SCE) campus, a distinguished teacher training institute nestled in Samtse, Bhutan. The college was established in 1968 by Bhutan's Third Dharma King, the late His Majesty Jigme Dorji Wangchuck. However, when exactly this venerable Tree have stood watch is not clear.

A delightful and enthralling sight, this magnificent tree carries the weight of a bountiful display of Bougainvillea flowers. It consists of a majestic pine tree, adorned in a profusion of resplendent Bougainvillea blooms, leaving an indelible impression on all who pass between the main academic block and the science block on the campus.

For an extended period, this tree has quietly contributed to the institute without a distinct name that would help students and staff of SCE, the public, and society remember it effortlessly. Comprising two significant components, the tree features a Pine Tree as its central trunk, adorned by the Bougainvillea plant. In 2017, Dr. Kinzang Dorji, a Botany lecturer at SCE, labelled the Pine Tree with its botanical name, Pinus sp., and labelled the Bougainvillea plant with its botanical name, Bougainvillea glabra.

However, up until this point, no appropriate name had been assigned to this unique combination of the pine tree and the Bougainvillea plant. The author decided to give the tree a memorable name, one that would make it an iconic symbol of SCE. As a result, on May 17th, 2023, the author named it `The Bougainvillea Tree`.

The title `Bougainvillea Tree` implies a sanctuary formed by the profusion of Bougainvillea flowers gracing its branches. This conjures feelings of serenity, aesthetic allure, and enchantment, underscoring the tree's identity as a refuge where individuals can discover solace and pleasure amid the opulence of the Bougainvillea blossoms. This name eloquently captures the tree's function as a wellspring of natural marvel and a tranquil escape.

Reflection on STEM Fest

Dr. Kinzang Dorji
Head of STEM Education Department

STEM Education Department of Samtse College of Education organized it inaugural STEM Fest on April 22, 2023, under the theme “Engaging with STEM in Education''. The primary goal was to enhance the joy and excitement of STEM education while providing the student teachers at Samtse College of Education with opportunities to conceive innovative and creative teaching ideas for STEM subjects.

The fest aimed to bridge the gap between theory and practice, encouraging both students and audience to apply their knowledge to solve real-world challenges. It created an environment where curiosity was not only encouraged but celebrated, fostering intellectual exploration and hands-on experimentation. The event stood as a testament to the unwavering dedication and collaborative spirit within the STEM education community. A panel of four STEM teachers from neighbouring schools evaluated all exhibits, and prizes were awarded to the winners.

The STEM Fest featured subject wise exhibits, where M. Ed and Postgraduate Diploma in Education students showcased an impressive range of skills. They demonstrated everything from designing complex biological models and conducting intricate chemical experiments to exploring physics principles, unravelling mathematical mysteries, and presenting cutting-edge developments in information technology. The breadth of topics covered underscored the interdisciplinary nature of STEM and the collaborative ethos defining the department.

As the Head of the Department, witnessing the successful execution of the STEM Fest fills me with immense pride. This event wasn’t just a showcase of academic proficiency; it celebrated creativity, critical thinking, and the application of theoretical knowledge into tangible, real-world solutions. It exemplifies the holistic approach we embrace in fostering a well-rounded STEM education.
A rewarding aspect of the event was the seamless collaboration between students and faculty. The fest provided a unique opportunity for mentorship,

with seasoned faculty guiding and supporting our students in transforming ideas into reality.

This collaborative approach not only enhanced individual learning experiences but also showcased the academic community's robustness to neighbouring schools. The success of the event spoke volumes about the dedication and hard work of our students and faculty, evident in the quality of the showcased prototypes.

Moreover, the STEM Fest has set a precedent for future endeavours, laying the foundation for an annual tradition inspiring and challenging our students. It serves as a reminder of the limitless potential within our department and the importance of fostering a culture of innovation, collaboration, and continuous learning.

In conclusion, I extend heartfelt congratulations to everyone involved in planning and executing the STEM Fest. Your hard work and dedication have not only made this event a resounding success but have also elevated our department in the broader academic community. I am confident that this initial STEM Fest marks the beginning of a new chapter in our journey towards excellence in STEM education. I express sincere gratitude to the College President, Dr. Rinchen Dorji, for his unwavering support and guidance, playing a pivotal role in making the STEM Fest a triumphant reality.

Learning How to Build a Robotic Telescope

Ms. Rekrith Pelki Pradhan
Class VIII
Samtse LSS

The PANOPTES telescope project is an exciting and innovative initiative designed to involve citizen scientists in the field of astronomy. The project is based on the development and deployment of an affordable robotic telescope called PANOPTES (Panoptic Astronomical Networked Observatories for a Public Transiting Exoplanets Survey).

I feel fortunate to be a part of the PANOPTES project within the Samtse group. Initially, when I encountered the senior members at Samtse College of Education, I was slightly apprehensive, given my lack of prior experience in such projects. However, the senior members of PANOPTES graciously supported me, recognizing my status as the youngest member. I engaged in weekend Zoom meetings with the project team to immerse myself in understanding the workings of a robotic telescope, learning practical skills such as handling a multimeter, drilling, debugging, and more.

Through Zoom sessions, I have learned about exoplanets, robotic telescope and their components. Meeting the professional astronomers from the PANOPTES team from the USA remains one of the most memorable and joyful experiences. I was delighted to work in constructing a robotic telescope especially DSLR camera, incorporating elements like the Raspberry Pi.

Learning to code and connect the Raspberry Pi to the control box was particularly exhilarating. Ultimately, our Samtse group successfully assembled a robotic telescope tailored for scanning the night sky, detecting, and analysing exoplanets—planets orbiting stars beyond our solar system.

Being a part of this captivating project has been a true blessing. I am brimming with excitement to further explore the multifaceted aspects within PANOPTES. This ongoing journey fuels my enthusiasm to uncover and learn countless new elements within this "PANOPTES" project, shaping my path for future endeavours.

Building a Robotic Telescope: My Learning Journey

Ms. Sabitra Subba
Class X
Samtse Higher Secondary School

Building a robotic telescope at Samtse College of Education was an extraordinary journey that ignited my passion for astronomy and science. Being part of the team afforded me the chance to collaborate closely with peers from Samtse HSS, Samtse LSS, alongside students, faculty from the College, and professionals from the USA team. This experience was truly eye-opening and played a pivotal role in shaping both my understanding and aspirations.

The project commenced with insightful online sessions facilitated by the Project PANOPTES team from the USA, which connected us globally and introduced me, a teenager, to the world of brilliant emerging scientists. In addition, the guidance provided by the members of Project PANOPTES at Samtse College of Education laid the foundation for comprehending the intricate parts and mechanisms of the telescope. Transitioning from theoretical knowledge to practical applications during weekend sessions was an invaluable learning experience, equipping us with essential skills in handling tools and equipment.

The highlight arrived in May 2023 when the USA team arrived, and the process of unboxing the building units unfolded an exciting phase. Being part of the camera box group allowed me to explore into the detailed components of the circuit, offering a hands-on understanding of the telescope's intricate workings. Moreover, attending talks on exoplanets and astronomy during this period significantly expanded my knowledge and igniting a deeper curiosity about the vast expanse of the universe.

Reflecting on this enriching journey, I feel overwhelmed by the opportunity to contribute to the construction of a robotic telescope for observing exoplanets. Interacting with inspiring teachers, accomplished scientists, and senior students at the college broadened my perspectives and instilled in me a sense of immense potential. This experience reinforced my love for astronomy and affirmed my belief that this project marks just the beginning of my pursuit of a grand dream. Each step taken in this direction fuels my passion, fostering the hope of achieving greater aspirations in the field of astronomy.

STEM EDUCATION NEWSLETTER

Samtse College of Education, 2024

Volume 4

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

(His Majesty King Jigme Khesar Namgyel Wangchuck, 2020)