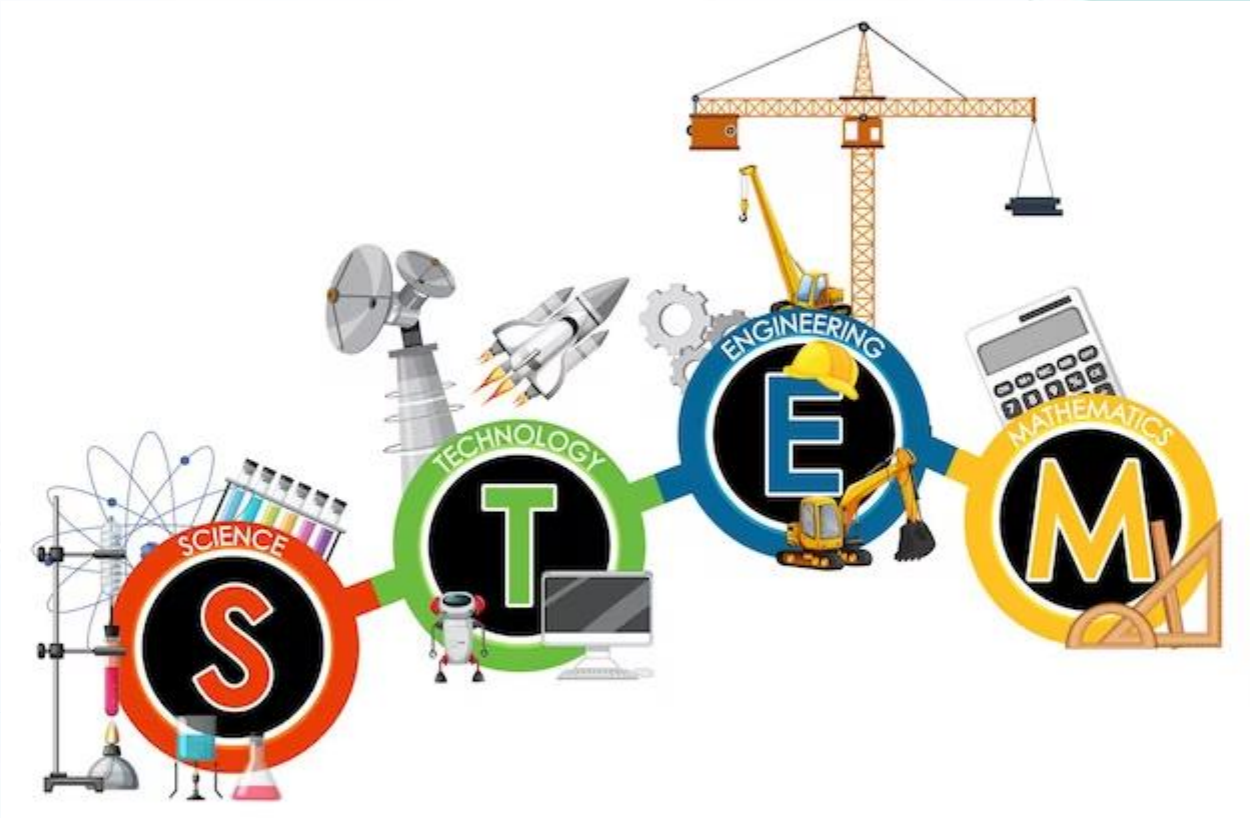

STEM

EDUCATION IN PUNJAB

Learn technology to expedite the economy

QUAID-E-AZAM ACADEMY FOR EDUCATIONAL DEVELOPMENT
GOVT. OF THE PUNJAB

PREFACE

STEM education in Pakistan has garnered heightened attention and significance in recent times. STEM, an acronym for Science, Technology, Engineering, and Mathematics, holds a pivotal role in contemporary education systems globally. It is instrumental in arming students with the requisite skills and knowledge to thrive in today's swiftly evolving, technology-centric landscape. Pakistan, with its rich history and diverse culture, grapples with various educational challenges. Despite these obstacles, there is a growing acknowledgment of the importance of STEM education as a catalyst for innovation, economic growth, and societal problem-solving.

This recognition has spurred numerous initiatives geared towards promoting STEM education at all levels, from primary schools to higher education institutions. In recent years, Pakistan has initiated educational reforms to align more closely with global standards and better equip its youth for the demands of the 21st century. Efforts are being made through upgrading infrastructure, developing curricula, and enhancing teacher training in STEM subjects. Both governmental and non-governmental organizations have collaborated to introduce inventive STEM programs and competitions to engage and motivate students.

However, STEM education in Pakistan encounters challenges such as inadequate resources, unequal access to quality education, and gender disparities. Ongoing efforts aim to surmount these obstacles, with a heightened focus on increasing accessibility, particularly for marginalized communities and girls. The government and diverse stakeholders are collaborating to narrow these gaps and cultivate a more inclusive STEM education ecosystem.

In essence, STEM education in Pakistan is undergoing a substantial transformation, recognizing the imperative of preparing the next generation for the demands of a technology-driven world. While challenges persist, the country is progressing towards establishing a more accessible, and robust STEM education system, empowering its youth, and contributing to social and economic development.

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DAY WISE OVERVIEW OF THE MODULE

Day-1

Session 1: Introduction of STEM

- Overview of STEM Education
- Advantages of STEM (WHY?)
- Integration of STEM in National Curriculum
- Cross Curriculum connections in STEM Learning

Session 2: Role of Teacher in STEM

- Teacher as a Facilitator for STEM Learning
- Traditional vs STEM teaching
- Role of teacher in integrating cross-curricular connections in STEM
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- Effective Pedagogical Practices for STEM learning
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- Digital resources for STEM Learning

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- STEM activities using low-cost/no-cost material
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- Preparation of a STEM Box of no-cost/low-cost material that can be used in STEM

Day-2

Session 1: Integration of STEM in Subject Teaching

- Understanding the STEM Pedagogical cycle and its application.
  - Practical Application of STEM Pedagogical cycle
  - Boundary Crossing elements of STEM subjects.

- Learning Dialogical processes
- Active Learning
- Communities of Practice (facilitation in learning)
- Problem Solving process

Session 2: Integration of STEM in Subject Teaching

- Practice Sessions of the STEM Pedagogical cycle
    - STEM Activities with the participants for each subject (Science, Math, Computer Science, Physics, Chemistry, and biology)

Session 3: Integration of STEM in Subject Teaching

- Practice Sessions of the STEM Pedagogical cycle
    - STEM Activities with the participants for each subject (Science, Math, and Computer Science)
- Assigning selected SLOs for Microteaching to participants (Group work)
- Planning of Microteaching by participants

Session 4: Planning and Preparation for Microteaching

- Planning of Microteaching by participants
- Preparation of Microteaching of STEM Lesson Plans

Day-3

Session 1: Microteaching Presentations based on STEM Activities

- Microteaching of STEM Lesson Plans

Session 2: Microteaching Presentations based on STEM Activities

- Microteaching of STEM Lesson Plans
- Reflection and feedback regarding Microteaching

Session 3: Orientation on STEM Clubs

- Orientation on STEM Clubs (Process)

Session 4: Orientation on STEM Clubs

- Development of Roadmap on STEM Clubs (School Group)

Day: 1 **Session 1**

INTRODUCTION OF STEM

Duration: 90 Minutes

Learning Outcomes:

At the end of session, the participants will be able to:

- describe STEM as an integrated approach encompassing Science, Technology, Engineering, and Mathematics.
- list at least three specific benefits of STEM education and explain how it enhances critical thinking and problem-solving skills.
- understand the importance of aligning STEM with the national curriculum and be able to identify strategies for successful integration.
- identify cross curriculum connections in STEM learning.

Materials:

- Sticky notes / blank paper stickers.
- Activity 3: (newspaper, paper tape, spaghetti, marshmallows, toothpicks, sweets, balls, balloons etc.) according to the strength of the participants
- Chart papers /Markers/ Tape
- Handout 1: Discover your Superpowers
- Handout 2: Case Studies for STEM Integration
- PPT slides

Opening	**05 minutes**

- Ask one of the participants to recite a few verses of the Holy Quran.
- After the recitation, welcome the participants on the first day of the training.
- Display/share the learning outcomes of Session 1 with the participants.

Activity-1: Discover your Superpower	**15 minutes**

- Display a list of various STEM-related "superpowers" or skills (use **Handout 1: Discover your Superpower**) on a chart paper or PPT slide.
- Ask each participant to choose any of the superpowers which matches their interest or skills and write them on a sticky note or blank paper stickers.

- Ask them to find the person in the room with the same superpower or any other of your interest and ask them about their name, place of residence, experience as teacher and how they use this superpower in their life.
- Choose a few random participants and encourage them to share their experience with the whole class.

Activity-2: Overview of STEM Education	10 minutes

- Elicit the full form of STEM/STEAM from the participants.
- Explain that **STEM is an interdisciplinary and applied approach on the idea of educating students in four specific disciplines of Science, Technology, Engineering and Mathematics. STEM integrates these disciplines into a cohesive learning paradigm based on real life applications. Highlighting the addition of Arts and the creativity it brings to STEM.**
- Show the video: https://youtu.be/AlPJ48simtE on STEM.
- To conclude, ask a few participants to share their learning with the whole class.

Activity-3: Advantages of STEM Education (WHY?)	30 minutes

- Divide the participants into 4 groups.
- Inform them that they are being challenged to make a Bridge/Tower using the given materials. The bridge/tower must be able to stand on its own for a minute and can withhold some weight.
- Distribute the materials (newspaper, paper tape, spaghetti, marshmallows, toothpicks, sweets, balls, balloons etc.) for the game to each group.
- Allocate 5 mins to each group to build their bridge/tower using the given materials.
- Ask each group to present their bridge/tower to the whole class.
- Conclude the activity by asking the participants to list what they learnt from the previous activity.
- Elicit a few responses from the participants.
- Ask the participants how they can relate to the importance and advantages of STEM education after the activities.
- Provide each group with a chart paper and markers.
- Instruct them to brainstorm and list as many advantages of STEM as they can think of within two minutes.
- Ask each group to present and share their list with the others.
- Generate a brief discussion on the advantages listed by all the groups.
- Summarize key points from the discussion, emphasizing the multifaceted advantages of STEM.

- Encourage participants to reflect on how these advantages can be applied in their respective fields or areas of interest.

Activity-4: Integration of STEM in National Curriculum — 15 minutes

- Briefly explain the importance of aligning STEM with the national curriculum.
- Explain the following steps of integration of STEM /STEAM in National Curriculum.
  1. Framework Development
  2. Cross-Disciplinary Approaches
  3. Project-Based Learning
  4. Inquiry-Based Learning
  5. Professional Development for Teachers
  6. STEM Laboratories and Resources
  7. Assessment Strategies
  8. Integration at all educational levels
- Share **Handout: 2 Case Studies for STEM Integration** and ask participants to read the case studies and share their understanding with the whole class.

Activity-5: Cross curriculum connections in STEM Learning — 10 minutes

- Ask the participants to work in pairs and share one thing that they find interesting about STEM, and why it holds their interest.
- Briefly explain the concept of cross-curricular connections in STEM Learning. **Cross-curriculum connections involve integrating concepts and skills from different subjects to provide a more holistic and interconnected learning experience. In STEM, this means merging science, technology, engineering, and math with other subjects like literature, art, and history**.
- Explain **Why Cross-Curriculum Connections Matter?**
  1. **Real-world Relevance:** Many real-world problems require a combination of skills. By connecting STEM with other subjects, students see how these skills are applied in the real world.
  2. **Interdisciplinary Problem-Solving:** The ability to solve complex problems often requires a blend of knowledge from multiple domains. Cross-curriculum connections foster interdisciplinary thinking.
  3. **Increased Engagement:** Integrating STEM with other subjects can make learning more engaging and relevant, catering to diverse interests and learning styles.
- Share a few examples of Cross-Curriculum Connections.
  1. **Math and Art:** Explore the mathematical principles behind art, such as symmetry, patterns, and geometry. Create geometric shapes or fractal art.

2. **Science and History:** Investigate historical events through a scientific lens. For example, study the impact of diseases on historical populations or analyze the science behind inventions.
3. **Technology and Literature:** Connect literature with technology by exploring how technology is portrayed in science fiction or analyzing the impact of technology on society.
4. **Engineering and Language Arts:** Have students design and build projects related to literature. For instance, create a model of a setting from a novel.

- To conclude, share examples of successful cross-disciplinary projects that integrate STEM.

Wrap-up	**05 minutes**

- Distribute sticky notes in the class.
- Ask the participants to write at least three take-away from the session.
- Take 2-3 responses to conclude the session.

Handout 1: Discover your Superpowers	
Coding Wizardry	Proficient in programming languages and coding techniques.
Data Dynamo	Skilled in data analysis, interpretation, and visualization.
Problem Solver	Excels at identifying and solving complex problems.
Robotics Guru	Expertise in designing and building robots.
Math Maestro	Master of mathematical concepts and applications.
Innovative Inventor	Known for creative thinking and innovative solutions.
Science Detective	Investigative skills and a knack for scientific inquiry.
Engineering Marvel	Proficient in designing and building engineering solutions.
Tech Tactician	Strategic and skilled in leveraging technology for solutions.
Biotech Trailblazer	Knowledgeable in biotechnology and life sciences.
Physics Phenom	Mastery in understanding and applying principles of physics.
Environmental Curator	Dedicated to sustainability and environmental solutions.
Chemistry Connoisseur	Expertise in chemical analysis and laboratory work.
Astronomy Enthusiast	Passionate about celestial bodies and space exploration.
STEM Communicator	Skilled in effectively communicating STEM concepts.
Mathematical Magician	Proficient in creating and using math models and puzzles.
Tech Ethicist	Concerned with ethical considerations in technology and science.
STEM Educator	Passionate about teaching and promoting STEM education.
STEAM Storyteller	Narrates compelling stories about STEAM.
Creative Conductor	A master at orchestrating creativity across diverse disciplines.

Handout 2: Case Studies for STEM Integration

Singapore: Singapore has been recognized as a global leader in STEM education, ranking first in the 2015 and 2018 Program for International Student Assessment (PISA) tests1. Singapore's national curriculum emphasizes the development of 21st century competencies, such as critical and inventive thinking, communication and collaboration, and information and communication technology skills. Singapore also promotes STEM integration through various initiatives, such as the Applied Learning Program (ALP), which allows schools to design and implement interdisciplinary projects that connect academic subjects with real-world applications. For example, one school implemented an ALP on sustainable living, where students learned about environmental issues and applied their knowledge and skills in science, mathematics, and engineering to design and build eco-friendly products.

Finland: Finland is another country that has achieved high performance in STEM education, ranking among the top 10 in the 2015 and 2018 PISA tests1. Finland's national curriculum emphasizes the integration of different subjects and the development of transversal competencies, such as thinking and learning to learn, cultural competence, and participation and involvement. Finland also encourages STEM integration through phenomenon-based learning (PBL), which is an inquiry-based approach that engages students in exploring real-world phenomena from multiple perspectives and disciplines. For example, one school implemented a PBL project on climate change, where students investigated the causes and effects of global warming and learned about the scientific, social, and ethical aspects of the issue.

Australia: Australia has also made efforts to integrate STEM into its national curriculum, which aims to develop students' capabilities in critical and creative thinking, personal and social capability, and ethical and intercultural understanding. Australia supports STEM integration through various programs and resources, such as the STEM Connections project, which provides teachers with professional learning and curriculum materials to design and implement integrated STEM units. For example, one unit involved students in designing and testing a prototype of a water filter that could be used in a developing country, where they applied their knowledge and skills in science, technology, engineering, and mathematics.

Transfer of STEM Research for Designing Contextually Relevant Curriculum in Pakistan: A Case Study:

This presents a multiple case study of design, enactment, and redesign of contextually relevant curricular units reflecting how in-service teachers' varied understanding of Science, Technology, Engineering and Mathematics (STEM) shaped the curricular units differently. The study involved 18 teachers from a school in Sukkur, Sindh, who

participated in a STEM-focused professional development and coaching support. The study used Design Based Research (DBR) as a methodological approach and found that engineering design challenge was a canvas for the varied level of integration and local contextually relevant problems captivated both teachers and students' attention. The study also found that the introduction to STEM offered active learning affordances to teachers and a visible inclusion of some STEM pedagogies was noticed in the classrooms.

Another study provides an overview of previous STEM education research studies carried out in Pakistan to clarify the current condition in STEM education in Pakistan. A qualitative research method was used to conduct this study, and 13 previous studies were selected (2008-2020) as the sample. Results indicate that STEM education practices by private sectors are visible more than the public sector. Moreover, it was found that there is a lack of laboratories, equipment, and other resources needed to teach STEM education. In essence, Pakistan's STEM education system is not adequately prepared and centered. There is an exclusive involvement needed by the government to support the efforts of all stakeholders, including the public and private. This study provides some suggestions for future research.

Another study explores the design and implementation of an online teacher professional development (OTPD) program to introduce integration of STEM in Pakistan. The study involved 12 teachers from a private school in Karachi, who participated in a six-week TPD program that consisted of three phases:

(1) Online learning modules,

(2) Online coaching sessions, and

(3) Online community of practice.

The study used DBR as a methodological approach and found that the TPD program supported teachers' understanding of STEM integration and their ability to design and enact integrated STEM lessons. The study also found that the TPD program fostered teachers' collaboration and reflection through the online platform. The study offers implications for designing and implementing TPD programs for STEM integration in Pakistan.

One example of students using STEM integrated curricular approach from Pakistan is the project-based learning (PBL) unit implemented by Khan and Iqbal (2019)1. They designed and enacted a six-week PBL unit for grade 9 students in a public school in Islamabad, which aimed to develop students' understanding of energy concepts and their applications in real-life contexts. The unit involved students in exploring the problem of energy crisis in Pakistan, conducting experiments and investigations on energy sources and transformations, designing, and building a model house that uses renewable energy, and presenting their solutions to a panel of experts. The study used mixed methods to evaluate the impact of the PBL unit on students' learning outcomes, motivation, and attitudes towards STEM. The results showed that the PBL unit improved students' conceptual understanding of energy, increased their interest and engagement in STEM learning, and enhanced their 21st century skills such as collaboration, communication, creativity, and critical thinking.

Day: 1 **Session 2**

ROLE OF TEACHER IN STEM

Duration: 90 Minutes

Learning Outcomes:

At the end of session, the participants will be able to:

- identify the role of a STEM teacher as a facilitator.
- differentiate between traditional and STEM teaching approaches.
- state the role of teacher in integrating cross- curricular connections in STEM.
- draw parallels between 21st-century skills and STEM learning.

Materials:

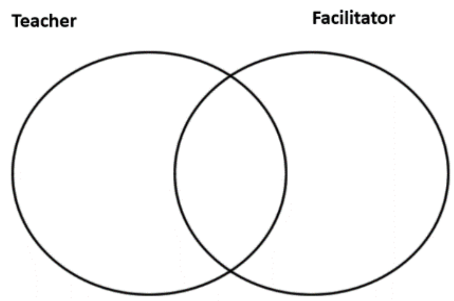
- Blank papers/pencils
- Sticky notes
- Chart papers/Markers
- White board/Board markers
- Handout 1: Escape Room Challenge
- Activity 2: (straws, coloured papers, rocket cutouts, paper clips, baking soda, vinegar, empty small water bottles, paper cups, rubber bands)
- Index cards
- PPT slides

Opening	**10 minutes**

- Divide the participants into 4 groups. Ensure each group has participants from all three subject areas (Science, Computer science and Mathematics).
- Share the scenario of **ESCAPE ROOM Challenge** with the participants.
  They are trapped in a room which is losing oxygen, to get out of the room they must solve 6 puzzles in a sequence. The total time to complete the activity is 6 minutes.
- Distribute the 6 puzzles in separate sealed envelopes (**see Handout 1: Escape room Challenge**), paper, pencil to each group.
- Appreciate the team who finishes on time.
- Ask them to share their experience of solving the puzzles and relate it to their STEM learning.

Activity-1: Teacher as a facilitator for STEM Learning 20 minutes

- Divide the participants into 4 groups.
- Distribute a chart paper and different coloured markers to each group.
- Share a list of characteristics displayed on PPT slide or a chart paper as given in table below.
- Ask them to draw a Venn diagram and sort the statement which describes the role of a teacher or a facilitator or both.



Ask	Tell	plans
Follows a pre-set curriculum	One way flow of information	Give instructions
Shares information	Information flow is two ways	Provides autonomy
Provokes critical thinking	Encourage interaction, discussion, and collaboration	Produces dependent learners
Asking questions	Encourages and value different views	Develop relationship based on trust, respect, and desire to serve
Subject Expertise	Builds formal relationship	Directive role
Provide solutions	Decision making lays with the teacher	Guiding role
Shows adaptability	Empowers students	Moderate discussions

- Ask each group to nominate a writer for their group.
- Ask each group to move to another table leaving their chart papers on the table.
- Spend 2 minutes reading each group’s Venn Diagram.
- Briefly discuss the information and ask the nominated writer to put a star on agreed statement and a question mark on the statement which they disagree with.
- Stop the activity once the groups reach their own table.
- Ask them to see the modifications made on Venn Diagrams.
- To conclude, generate a discussion on the important characteristics of a facilitator and identify its role in STEM education.

Activity-2: Traditional vs STEM Teaching — 25 minutes

- Show the video: https://youtu.be/vSAXJCPC5C4 to the participants.
- Ask participants to work in pairs and list down a few characteristics of traditional teaching and STEM teaching.
- Elicit responses from the participants and note down responses on a flipchart/whiteboard without giving your own input.
- Divide the class into two large groups.
- Provide each group with relevant instructions. Allocate 10 mins to each group to complete their task.

  Instructions for Group 1:

  1. In your own groups, watch the video on how to make a car move using aerodynamics. (video: https//youtube.be/lacekOC-gwl).
  2. Ask each member of the group to complete the following questions individually.
     a. The car was moved due to_____________. (kinetic energy/potential energy)
     b. The inflated stationary balloon possesses_______________energy.
     c. State Newton's third law of motion?
     d. What is the formula for Newton's law of motion.

  Instructions for Group 2:

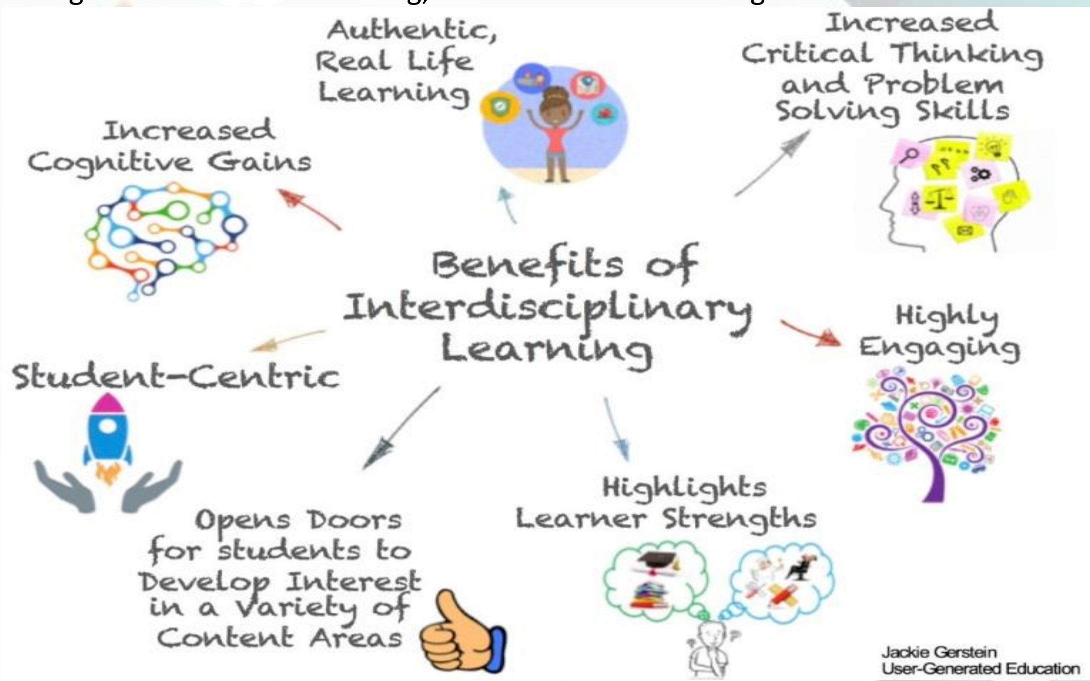
  1. Ask the group members to make 4 teams.
  2. Ask each team to make a working model of a rocket and a flow chart/info graph to explain its working.
  3. Share the following website for help. (http://www.teachingexpertise.com/classroom.idea/rocket.activity/).
  4. Ask them to use low cost/no cost materials for their activity and allocate 5-7 mins to complete their project.
  5. Ask them to present their project and give 1 minute presentation to their own group members.

- Allocate 10 mins to each group to complete their task.
- Bring both groups together for discussion.
- Ask each group to reflect on their experience and share insights.
- Discuss the differences in communication, collaboration, and problem-solving between the two approaches and the pros and cons of each approach.
- Encourage participants to share their thoughts on when each approach might be appropriate.
- To consolidate, ask the participants to refer to the chart paper /white board where they identified different characteristics of Traditional and STEM Teaching.

Activity-3: Integration of cross-curricular connections in STEM 10 minutes

- Briefly explain the importance of cross-curricular connections in STEM education.

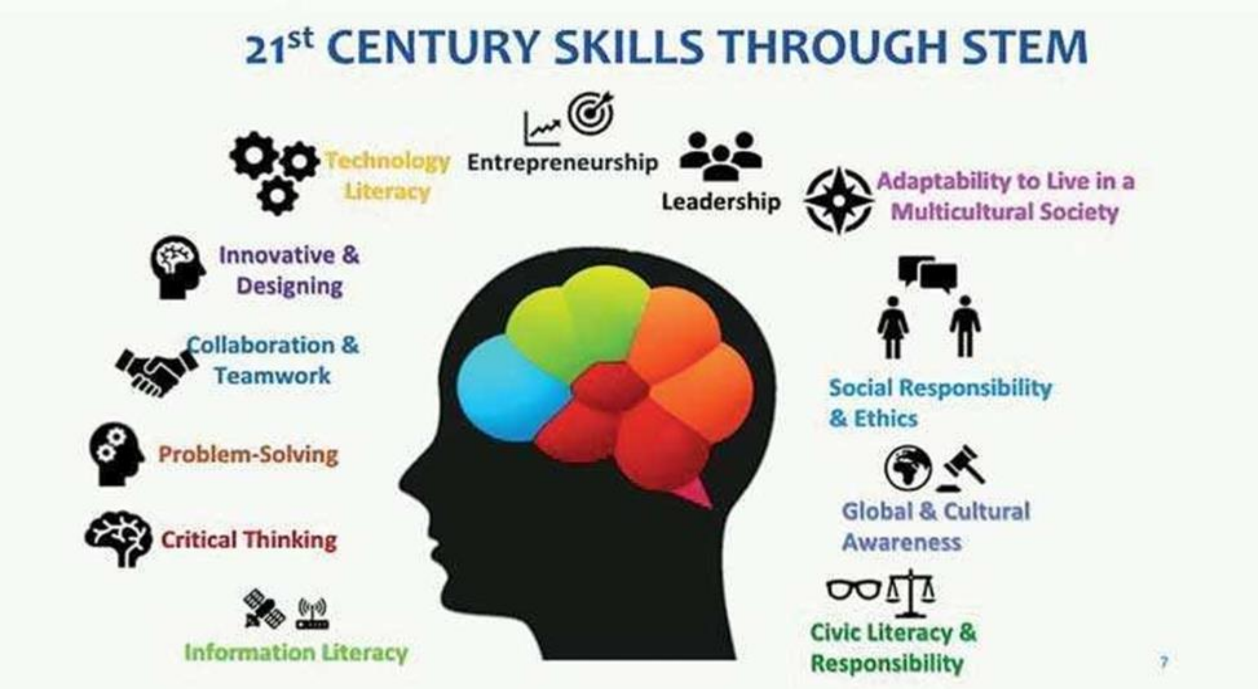
- As educators, we know the importance of providing students with a well-rounded education that prepares them for success in the real world.
- Cross-curricular integration is the practice of connecting a topic which is traditionally taught as a stand-alone subject - such as ELA, math, science, social studies, engineering, or computer science - to a different subject area.
- The benefits of a cross-curricular approach to teaching are numerous and could be the answer to your teaching needs: including supporting students' overall achievement, classroom organization, lesson planning, and educator confidence.
- Cross-curricular integration saves time for educators by allowing for more in-depth discussions while supporting lesson planning. When a lesson or activity integrates two or more subjects, educators can teach and practice more quickly than in two back-to-back single subject lessons. Students also benefit from these timesaving, multifaceted learning opportunities by being exposed to the interconnectedness of different subjects which provide a new perspective on learning [Research].
- Cross-curricular integration is a powerful approach that motivates students, strengthens their understanding, and allows more learning in limited class time.



Adapted from https://blog.eie.org/cross-curriculum-2023

Activity-4: 21st Century Skills and STEM Learning — 20 minutes

- Briefly explain the importance of 21st Century Skills and STEM education in the modern world. Emphasize that both are essential for addressing complex challenges and fostering innovation.



- Divide participants into 4 groups, ensuring a mix of skills and backgrounds in each group.
- Distribute index cards with specific 21st Century Skills (communication, collaboration, critical thinking, creativity) with any one STEM-related challenge written on it to the groups.
- Allocate 5 minutes to each group to discuss how they will approach the challenge and how they can integrate the assigned 21st Century Skill to enhance their solution.
- Ask them to use markers and sticky notes to brainstorm ideas.
- Allocate 2 minutes to each group to pitch their solution to the rest of the group. Emphasize that they should highlight how the assigned 21st Century Skill played a crucial role in their design process.
- To consolidate, facilitate a brief discussion on the parallels between the presented solutions and the importance of 21st Century Skills in the STEM design process.
- Elicit how their assigned skill influenced their problem-solving approach.
- Encourage participants to consider how these skills are applicable not only in the activity but also in real-world STEM scenarios.

STEM-Related Challenges

1. Design a smart energy grid that maximizes the use of renewable energy sources. Implement energy-efficient technologies in buildings, transportation, and public spaces.
2. Create a technological solution to address healthcare challenges in underserved or remote communities. Consider telemedicine, mobile health clinics, or low-cost diagnostic tools.
3. Design a vertical farming system for urban environments to address food security and reduce the environmental impact of traditional agriculture. Integrate automation, sustainable practices, and efficient space utilization.
4. Create a comprehensive plan for improving disaster preparedness and response using technology. Consider innovations in early warning systems, communication networks, and rapid response mechanisms.

Wrap-up **05 minutes**

- Ask the participants to reflect on the following questions:
  - What was the most important thing you learned in this session?
  - What question is still there in your mind?
- Take random responses and encourage the participants to answer the second question of their peers.

Handout 1: Escape Room Challenge

Challenge 1:

I am a fundamental particle.

- I have a negative charge.
- I am much smaller than an atom.
- I am a key component in the flow of electric current.

What am I? ______________________________

Challenge 2:

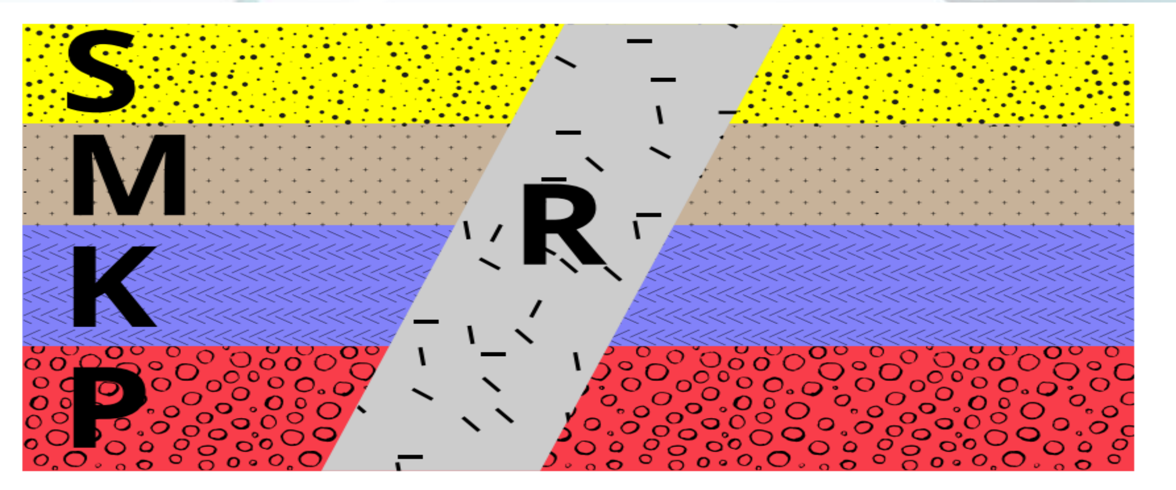
The following word is written in binary Alphabet, decode to find the word.

00011 01000 00001 10100

_____ _____ _____ ______

Challenge 3:

Relative dating is the science of determining the relative (or comparative) order of past events. In general, the oldest units are on the bottom and the youngest units are on the top. Using the cross-section below, what is the sequence of events from oldest to youngest?

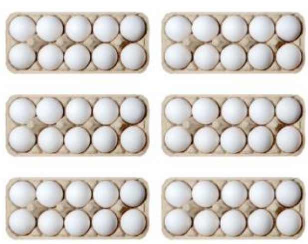


__________, ______________, ______________, _______________, ________________

Challenge 4:

Simplify the ratio of brown eggs to white eggs.

Brown



White

Challenge 5: Unscramble the following formulas and identify the substance. a. "O2H4S" _________________, _______________ b. "CNAl" ________________, __________________ c. "N2O" ________________, ____________________
Challenge 6: I am a structure found in plant cells. • I am responsible for storing water, nutrients, and waste products. • I am often larger in plant cells compared to animal cells. • If a plant cell is like a city, I am the storage warehouse. What am I? ____________________________

Answer Key: Escape Room Challenge
Challenge 1: Electron
Challenge 2: CHAT
Challenge 3: 1: 24
Challenge 4: P,K,M,S,R
Challenge 5: a. H2SO4 Sulfuric Acid. b. NACL Sodium Chloride c. NO2 Nitrogen dioxide
Challenge 6: Vacuole

Day: 1 **Session 3**

TEACHING METHODS OF STEM

Duration: 90 Minutes

Learning Outcomes:

At the end of session, the participants will be able to:

- understand how pedagogical strategies such as inquiry-based classrooms, computational thinking, engineering design process and mathematical modelling can be used in STEM classrooms.
- understand how to inculcate interdisciplinary/multidisciplinary approach in STEM learning.
- create and use a list of digital resources for STEM learning.

Materials:

- Chart papers/Markers
- Scotch tape/ Scissors
- Handout 1: STEM Bingo
- Handout 2: Effective Pedagogical Strategies
- Activity stations in Activity 1: (material is listed in the relevant handout)
- Activity 1: Handout 3(a-d)
- Handout 4: List of Digital Resources
- PPT slides
- Markers/Pens

Opening	**10 minutes**

- Inform the participants that after understanding the importance of STEM in teaching and learning, we will now discuss how an effective STEM classroom can be created.
- Distribute the STEM Bingo Cards (**Handout 1: STEM Bingo)** and markers/pens to all participants.
- Give the following instructions:
  - The aim of the activity is to fill in as many squares as possible by connecting with participants who have STEM-related experiences.
  - The participants have to finish the given task within 5 minutes.
  - Move around the room actively and locate a participant with experiences tied to the listed activities.

  - Write the name of the person with relevant experience in the corresponding square on your card.
  - Note that you can write the same person's name on your card a maximum of two times.
  - The first participant to complete a row (horizontal, vertical, or diagonal) is declared the winner.
- Once the activity is completed (or there is a winner) gather participants back into the whole class group and debrief the activity.
- Ask any three participants to share any interesting discovery / idea they found from discussion with other participants.
- Use participants' experiences as a guide to introduce the importance of varied STEM experiences in teaching.
- Discuss that effective pedagogical practices are the cornerstone of successful STEM education, playing a pivotal role in shaping the learning experiences of students in the fields of Science, Technology, Engineering, and Mathematics.
- Review and make connections to the 21st century skills required for effective STEM learning, covered in previous session.
- Outline that the key areas we will be exploring in this session are Inquiry-Based Learning, Computational Thinking, Engineering Design, and Mathematical Modeling.
- Share the learning outcomes of the session with the participants.

Activity-1: Effective Pedagogical Strategies — 40 minutes

Instructions for Trainer:

- Set up four stations around the room, with appropriate quantities of materials at each station as instructed.
- Label each activity station as:
  - Station 1: Expert Group 1 – Inquiry Based Learning
  - Station 2: Expert Group 2 – Computational Thinking
  - Station 3: Expert Group 3 – Engineering Design Process
  - Station 4: Expert Group 4 – Mathematical Modeling
- Keep appropriate quantities of the relevant activity sheets at each station:
  - Station 1: Handout 3 a: Mystery Substance
  - Station 2: Handout 3 b: Paper Algorithm
  - Station 3: Handout 3 c: The Catapult Challenge
  - Station 4: Handout 3 d: Mathematical Models in Real World

- Divide participants into groups of 4 each. These will be known as "*Home Groups*".
- Provide **Handout 2: Effective Pedagogical Strategies** to each participant.
- Instruct all participants to read the handout for 5 minutes.

- Discuss the information in the handout for 5 minutes. Use the following questions as their guide:
  - How are the ideas and information presented connected with what you already know?
  - What new ideas did you get that extended or broadened your thinking in new directions?
  - What challenges or puzzles have come to your mind from the ideas and information presented?
- Inform participants that we will be using the Jigsaw methodology to develop further understanding of the applicable pedagogical strategies.
- Provide the following instructions:
  - Each group member should select one pedagogical strategy to work on, from the handout.
  - Each group member then joins their relevant "*Expert Group*" and moves to the assigned workstation.
  - You will have 15 minutes to complete the activity as instructed, at your station.
  - Once the activity is completed, all participants return to their *Home Groups*.
  - Each participant will now have 3 minutes each to explain the strategy they worked on to their home group participants.
- Allow participants to settle at their activity stations.
- Provide 15 minutes for the participants to complete the relevant activities.
- Circulate amongst the group and provide guidance wherever needed.
- After 15 minutes, instruct all participants to return to their home groups.
- Assign one member in each group as "Timekeeper".
- Each participant, including the timekeeper, will have 3 minutes to explain their learnings to their home groups.
- Once the round of feedback is complete, gather the participants to the center.
- Ask four volunteers to sum up their learnings from the entire activity.
- Relate the feedback from the participants to the discussions they had at the beginning of the activity and point out any new ideas and information gathered.

Activity-2: Inter-disciplinary Learning	**20 minutes**

- Ask the participants to continue working in the same *home groups*.
- Ask participants to reflect on how different subject groups worked together in the previous activity to complete the assigned tasks.
- Elicit why the inter-disciplinary/multi-disciplinary approach is useful for STEM teaching and learning.

Why an Inter-disciplinary / multi-disciplinary approach?
○ Real-world Relevance: Mirrors the interconnected nature of STEM fields.

- Problem-solving Skills: Encourages students to approach challenges from various perspectives.
- Enhanced Engagement: Makes learning more meaningful and engaging.

- Ask participants to identify the two most important components to allow for inter-disciplinary learning and how they are helpful in creating effective teaching plans.

Components	
Collaboration	**Cross-Curricular Integration**
Among disciplines: Working together across STEM subjects.	Shared Themes: Identifying common themes in STEM subjects.
With Peers: Group projects and discussions.	Integrated Lesson Planning: Combining elements from different subjects in lesson plans.

- In their home groups, ask participants to complete a "STEM Integration Planning".
- Distribute chart papers and markers to each *home group*.
- Provide the following instructions:
  - Ask participants to complete the following task within 8 minutes.
  - Each group chooses a theme or real-world problem that could be explored through STEM subjects.
  - Discuss how they could integrate concepts from various STEM subjects to address their chosen theme.
  - Identify which of the pedagogical strategies will be useful for the teaching of the chosen theme.
  - Create a poster presentation showcasing the connections between various STEM subjects for the chosen theme.
- After completion, ask participants to put up the posters around the room.
- Conduct a Gallery walk.
- To conclude, ask the participants to share their learning with the whole class.

Activity-3: Digital Resources 15 minutes

- Inform participants that digital resources play a crucial role in enhancing STEM education by providing interactive, dynamic, and accessible tools for both educators and students. These resources range from simulations and virtual labs to online collaborative platforms, offering a wealth of opportunities to enrich the learning experience.
- Share with the participants that there are a variety of digital resources available.
- Use the PPT slides, to discuss usefulness of digital resources in various situations:
  - **Scenario 1:** The Physics teacher is trying to explain Newton's Laws of Motion to Grade 9 students.
    (Digital Resource: Phet Simulation)

- **Scenario 2:** Grade 6 students are exploring chemical reactions.
  (Digital Resource: Chem Collective's virtual labs)
- **Scenario 3:** Grade 11 students are studying Cell Structure
  (Digital Resource: Interactive 3D cell models from BioMan, BioMolecule Arcade)
- **Scenario 4:** Grade 8 students are learning about geometrical concepts.
  (Digital Resource: GeoGebra)
- **Scenario 5:** Grade 7 students are learning about programming and algorithmic thinking.
  (Digital Resource: Code.org)
- **Scenario 6:** Grade 6 students are exploring climate change and its consequences.
  (Digital Resource: NASA Climate Kids)

- Reflect on the benefits and challenges of incorporating digital resources.
- Distribute **Handout 4: List of Digital Resources** to all participants.
- Open floor for questions, sharing insights, and addressing concerns.

Wrap up	**05 minutes**

- Ask participants to take a moment to reflect on the session.
  - What key strategies stood out to them?
  - How do they envision incorporating these strategies into their teaching?
- Take responses from 5 volunteers and have them share one key takeaway from the session with the group.

Handout 1: STEM Bingo

INSTRUCTIONS:

1. Locate colleagues with experiences tied to the activities listed below and write their name in the squares.
2. The first one to complete a row (horizontal, vertical, or diagonal) is the winner.

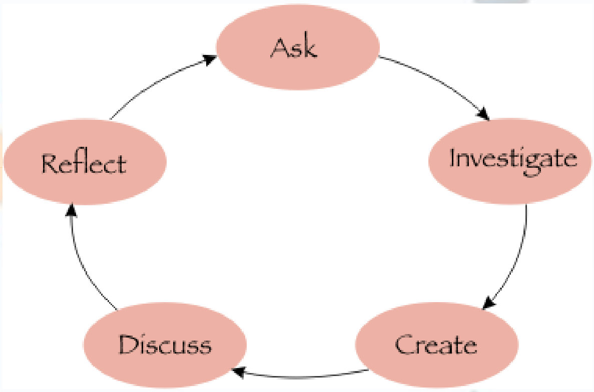
Built a robot at any point in your life	Used coding or programming in a lesson	Participated in a science fair	Integrated technology into a lesson plan	Collaborated on a cross-curricular project
Implemented a hands-on physics experiment	Used a digital simulation tool in class	Incorporated math into a real-world problem-solving activity	Visited a science or technology museum	Designed an engineering challenge for students
Engaged students in a biology dissection activity	Applied computational thinking in a lesson	Used online collaborative tools for teaching	Participated in professional development related to STEM	Implemented a math modeling activity
Joined a STEM-related workshop or conference	Integrated environmental science into a lesson	Collaborated with colleagues from different STEM disciplines	Used augmented reality or virtual reality in a lesson	Engaged students in a chemistry experiment
Collaborated on a STEM outreach program	Used robotics in the classroom	Integrated Augmented Reality or Virtual Reality in a lesson	Implemented a cross-curricular project involving STEM	Used the Engineering Design Cycle in classroom

Handout 2 – Effective Pedagogical Strategies

In the realm of Science, Technology, Engineering, and Mathematics (STEM), the role of educators is pivotal in shaping engaging and impactful learning experiences. Effective pedagogical strategies serve as the cornerstone for unlocking the potential of students in these dynamic fields.

Inquiry-Based Learning (IBL):

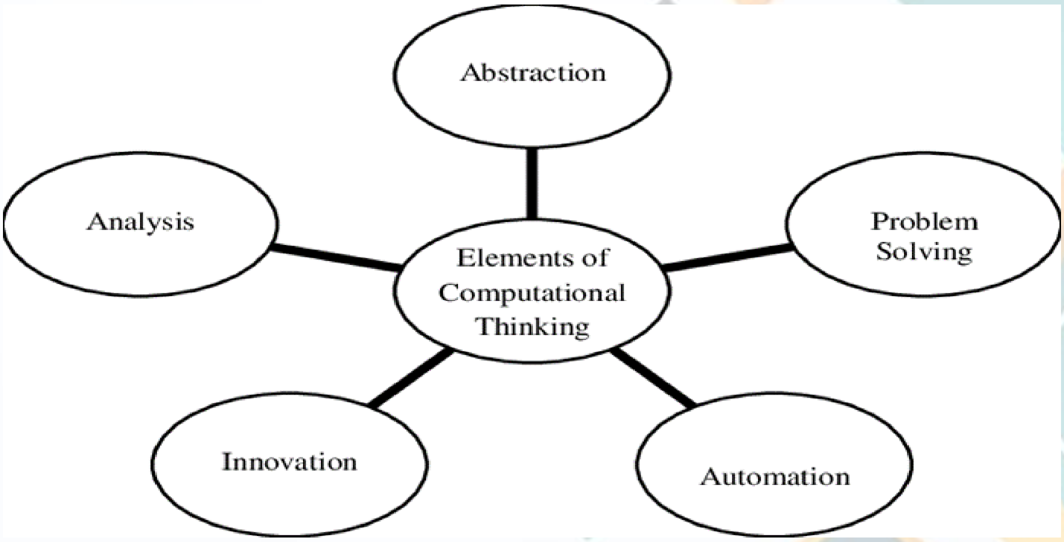
IBL is an educational approach that places students at the center of the learning process, emphasizing exploration, critical thinking, and active participation. In inquiry-based learning, students engage in the investigation of questions, problems, or scenarios, fostering a deeper understanding of the subject matter. Rather than being passive recipients of information, students take on a more active role as investigators and problem solvers.



Key characteristics of inquiry-based learning include:

Curiosity-driven exploration	Hands-on activities	Critical thinking skills	Collaborative learning
Open-ended exploration	Teacher facilitation	Real-world relevance	Reflection

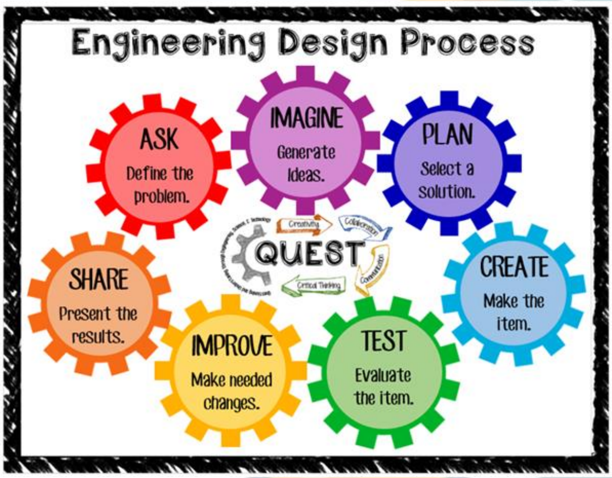
Computational Thinking (CT)



CT is a pedagogical strategy that equips students with essential problem-solving skills rooted in logical reasoning and algorithmic thinking. Grounded in the principles of computer science, this approach encourages learners to break down complex problems into manageable components, identify patterns, and devise step-by-step solutions.

Computational thinking extends beyond coding; it instills a mindset that emphasizes abstraction, generalization, and automation. By incorporating this strategy into education, students not only gain proficiency in programming but also develop critical cognitive skills applicable to a wide array of disciplines. Computational thinking empowers learners to approach challenges with a structured problem-solving methodology, fostering a foundation for analytical thinking in the rapidly evolving landscape of technology and information.

Engineering Design Process

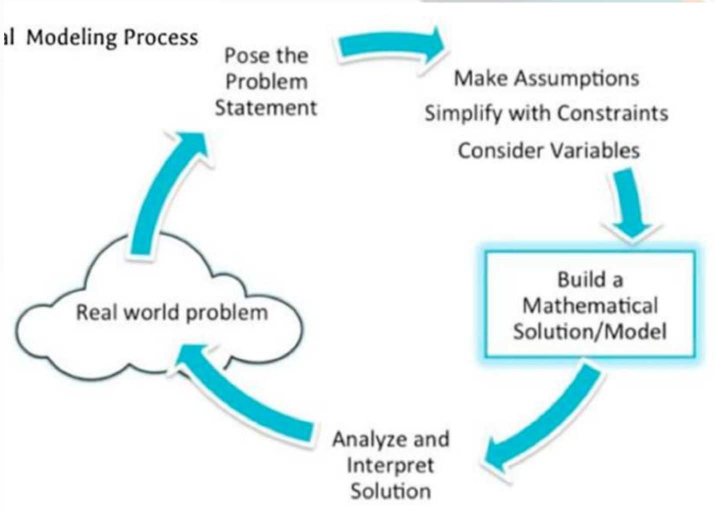


The Engineering Design Process stands as a dynamic pedagogical strategy that empowers learners to address real-world challenges through systematic problem-solving. Rooted in the principles of engineering, this strategy guides students through a series of iterative steps, including problem identification, research, brainstorming, prototyping, testing, and refinement.

Emphasizing creativity and practical application, the Engineering Design Process encourages students to think critically, collaborate, and innovate. It not only develops technical skills but also instills resilience and adaptability as students navigate the complexities of designing solutions that align with both functional and aesthetic considerations. By engaging students in the iterative nature of engineering design, this pedagogical strategy prepares them for the dynamic demands of the 21st-century workforce, where creativity and problem-solving are paramount.

Mathematical Modelling

Mathematical modeling stands as a pivotal pedagogical strategy that bridges theoretical mathematical concepts with real-world applications. Rooted in the utilization of mathematical principles to represent, analyze, and solve complex problems, this strategy encourages students to formulate mathematical models to address a variety of situations. Whether predicting population growth, simulating economic scenarios, or understanding the behavior of physical systems, mathematical modeling empowers learners to abstract real-world phenomena into mathematical expressions.



By engaging in this process, students not only enhance their mathematical proficiency but also cultivate critical thinking skills, as they grapple with the challenge of translating concrete problems into mathematical language and interpreting the results in meaningful ways. Mathematical modeling thus serves as a dynamic tool to illustrate the relevance and versatility of mathematics in addressing multifaceted challenges across diverse disciplines.

Activity-1: Effective Pedagogical Strategies

Handout 3 a: The Mystery Substance

Pedagogical Strategy: Inquiry Based Learning.

You have been provided with four mystery substances: A, B, C and D.
Engage in an inquiry-based exploration to investigate and identify the properties of the mystery substances using simple materials.

Instructions:

- You have the following materials available: water, vinegar, baking soda, and cornstarch.
- Use the spoon to examine the mystery substance's appearance, texture, and color. Note your observations on paper.
- Predict the possible components or properties of the mystery substance based on your initial analysis.
- Perform tests using water, vinegar, baking soda, and cornstarch to observe any reactions or changes in the mystery substance.
- Record your observations after each test. Take note of any fizzing, dissolving, or other noticeable reactions.
- Analyze the results of your tests. What happened during each test, and what does it indicate about the mystery substance?
- Evaluate the reliability of your predictions. Were they accurate based on the test results?
- Reflect on the scientific process. What did you learn from this inquiry-based exploration? How might you apply these skills in a broader context?

Concluding Remarks:

- This hands-on activity encourages inquiry-based learning by fostering curiosity, observation, and analysis.
- The mystery substance provides a context for applying scientific processes and developing critical thinking skills.
- Share your findings and reflections with your home group.

Activity-1: Effective Pedagogical Strategies

Handout 3 b: Paper Algorithm

Pedagogical Strategy: Computational Thinking

The objective of the task is to develop an understanding of algorithms, sequencing, and clear instructions by creating paper algorithms to guide a drawing process.

Instructions:

- Create a simple drawing using geometric shapes and lines on their paper. The goal is to create a drawing that can be accurately replicated by the drawer based on instructions.
- Write down a step-by-step algorithm describing how to recreate their drawing. This algorithm should be clear and concise, using simple language and symbols.
- All group members swap instructions with each other.
- Follow the instructions to replicate the drawing on your own sheet of paper.
- Complete the activity in 7 minutes.

Reflection:

For the next 8 minutes, reflect and discuss the following:

- What challenges did you encounter in creating or following the algorithm?
- How did clarity in instructions impact the outcome?
- Discuss how small steps contribute to the overall success of the task.
- Evaluate the effectiveness of the algorithms.
- How might the skills developed in this activity be applied to problem-solving in different contexts?

Concluding Remarks:

- The Paper Algorithm activity provides hands-on experience in creating and following algorithms, reinforcing the importance of precision and sequencing in computational thinking.
- Share your findings and reflections with your home group.

Activity-1: Effective Pedagogical Strategies

Handout 3 c: The Catapult Challenge

Pedagogical Strategy: Engineering Design Process

Engage in the engineering design process by designing and building a simple catapult to launch a small object.

Instructions:

- Design a catapult to launch a small object as far as possible.
- Brainstorm and discuss ideas for design and working of the catapult.
- Sketch the catapult designs, identifying materials and dimensions.
- Using the provided materials, build the catapult based on your plans.
- Test your catapult by launching small objects.
- Complete the activity in 10 minutes.

Reflection:

For the next 5 minutes reflect and discuss the following:

- What design elements contributed to longer distances?
- How did the engineering design process guide the creation of effective catapults?
- Evaluate the effectiveness of the engineering design process in guiding the creation of functional catapults.
- What challenges did you encounter, and how did you overcome them?

Concluding Remarks:

- The Catapult Challenge provides a brief yet comprehensive experience in the engineering design process, fostering creativity, problem-solving, and collaboration.
- Share your findings and reflections with your home group.

Activity-1: Effective Pedagogical Strategies

Handout 3 d: Mathematical Models in Real-world

Pedagogical Strategy: Mathematical Modeling

Analyze and model data trends through coin flips, applying mathematical modeling to understand patterns in random events.

Instructions:

- Your task is to model data trends from coin flips to uncover patterns and understand the probabilistic nature of random events.
- Individually, flip a coin multiple times and record the outcomes (heads or tails) in a table.
- Aim for at least 20-coin flips to gather sufficient data.
- Analyze the dataset to identify any patterns or trends. Look for consecutive heads or tails, streaks, or any other observations that stand out.
- Create a mathematical model that represents the observed data trends. Consider statistical measures, probabilities, and any patterns identified during the analysis.
- Share your dataset, data trends, and the corresponding mathematical models with the group.
- Discuss how mathematical modeling aids in understanding and predicting random events.
- Complete the activity in 8 minutes.

Reflection:

In the 7 minutes, reflect and discuss the following:

- Are there common patterns? How did mathematical modeling enhance the interpretation of these trends?
- Analyze the effectiveness of the mathematical models in representing the observed data trends.
- Reflect on the strengths and limitations of the models.
- Evaluate the overall success of the activity in promoting an understanding of probability and data trends.
- Discuss how mathematical modeling pedagogy contributed to the learning experience.

Concluding Remarks:

- The Data Trends with Coin Flips activity provides a brief yet immersive experience in mathematical modeling pedagogy, fostering an understanding of probability and randomness. Offers a hands-on introduction to the principles of mathematical modeling. Share your findings and reflections with your home group.

Handout 4: List of Digital Resources

Here's a list of useful digital resources that can support STEM teaching and learning across various subjects and grade levels.

Note, this list is not an exhaustive list, and you can find various other more useful resources online.

Simulations and Virtual Labs

- PhET Interactive Simulations: Free interactive math and science simulations.
- ChemCollective: Virtual labs and scenarios for chemistry education.
- ExploreLearning Gizmos: Interactive math and science simulations.

Online Collaborative Tools:

- Google Workspace for Education: Collaborative documents, sheets, slides, and more.
- Microsoft Teams: Communication and collaboration platform with document sharing.
- Padlet: Virtual wall for collaborative brainstorming and sharing ideas.

Coding and Computational Thinking:

- Code.org: K-12 computer science curriculum and coding activities.
- Scratch: Creative coding platform for students to create and share projects.
- Tynker: Coding lessons and activities for K-12.

Engineering Design and 3D Modeling:

- Tinkercad: Create 3D designs for printing and modeling.
- Autodesk Fusion 360: 3D CAD, CAM, and CAE tool for product design.

Science

- BioMan BioMolecule Arcade: Biology-themed games and virtual labs.
- Virtual Cell Animation Collection: Animations illustrating various cellular processes.
- The Physics Classroom: Multimedia physics tutorials and simulations.
- ChemGuide: Clear explanations of chemistry concepts.
- Mystery Science: Engaging video lessons and hands-on activities that cover a wide range of science topics, fostering curiosity and exploration.
- Nova Labs: Interactive virtual labs and activities covering a variety of science topics, fostering inquiry-based learning.

Mathematics:

- Desmos: Interactive online graphing calculator.
- GeoGebra: Dynamic mathematics software for all levels of education.
- Khan Academy: Extensive video lessons and practice problems for math.

General STEM Resources:

- STEM Learning: Resources, training, and support for STEM teaching.
- National STEM Centre e-Library: Collection of STEM teaching resources.

- PBS Learning Media: An extensive collection of multimedia resources, lesson plans, and interactive activities aligned with STEM standards.

Robotics and Electronics:

- VEXcode: Coding platform for VEX robotics.
- Arduino Education: Educational resources for Arduino projects.

Environmental Science:

- NASA Climate Kids: Educational resources on climate science.
- National Geographic Education: Geospatial resources and materials.
- Google Earth for Education: Explore the world through interactive maps, historical imagery, and virtual tours, enhancing understanding of geography and Earth sciences.

Day: 1 **Session 4**

USE OF LOW COST/NO COST MATERIALS IN STEM LEARNING

Duration: 90 Minutes

Learning Outcomes:

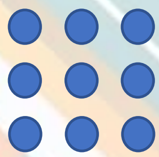
At the end of session, the participants will be able to:

- identify activities using low cost/no cost material.
- describe low cost/no cost materials used for STEM Learnings.
- experience hands-on STEM activities using the available resources.
- prepare a STEM Box of no cost/low cost material that can be used in STEM sessions.

Materials:

- Paper sheets/Scissors
- Sticky notes
- Plant leaf/Ink (blue and red)
- Disposable plates/ Scotch Tape/Glue
- Handout 1: SUPARCO Engineers
- Handout 2: STEM Box Material.
- PPT slides

Opening	**05 minutes**

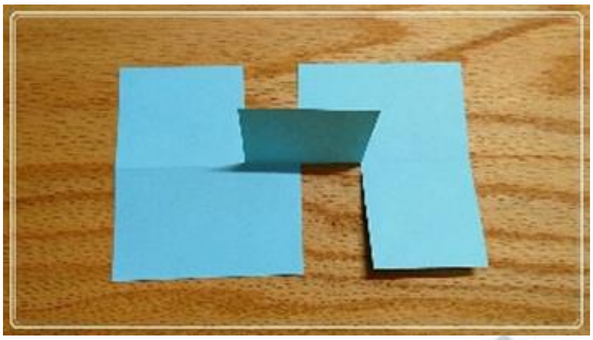


- Ask the participants to work in pairs.
- Draw/show nine dots on the chart paper/board/PPT slide.
- Share the rules with the participants.
  - Connect all nine dots using four straight lines.
  - The lines cannot be curved.
  - Once you start drawing you cannot pick up your pen/pencil.
- Encourage participants to think out of the box to find the solution.
- After a few minutes share the solution with them.
- Elicit the purpose of the activity from the participants.
- To conclude, ask them to share their learning with the whole class.
- Display/ Share the learning outcomes of the session with the participants.

Activity-1: Activities using low cost/no cost materials	20 minutes

a. Paper Puzzle

- Instruct the participants to follow the instructions of the trainer.
- Place the paper object on the table in front of the room.



- Ask the participants to work in pairs and distribute sheets of paper and scissors.
- Share the following instructions with them.
    - Design the paper object as placed in front of you using the paper and scissors only.
    - You can only look at the object.
    - You are not allowed to touch it.
- After 5 minutes, share the solution with them.

b. Magic with Diffusion.

- Inform the participants that they will now do **Magic with Diffusion**.
- Divide the participants into groups of 4.
- Provide each group with the following material.
    - Leaf of a plant
    - Ink
    - Water
    - Disposable plate
- Share the following instructions with the participants.
    - Pour water on a disposable plate and add a few drops of ink in it.
    - Now dip the stem of the leaf into the ink water and leave the apparatus for an hour.
- Ask the participants to observe the leaf which was kept in water for some time.
- Ask them to reflect on what changes have occurred in the leaf and why that is.
- Ask the participants to reflect on both the activities done earlier.
- Ask them to identify the purpose of such activities.
- Guide the discussion towards the following points.

- A STEM Activity can be performed using a single sheet of paper and scissors. We do not require fancy equipment for conducting a STEM Activity. We can use daily life material to conduct a successful STEM activity.

Activity-2: What are low cost /no cost materials?	**15 minutes**

- Ask participants to work in pairs.
- Ask them to use sticky notes to make a list of the materials and topic of any STEM activity which they can do in their classrooms using low cost/no cost resources.
- Paste all the sticky notes on one side of the board.
- Now randomly choose a few sticky notes and ask them to present their STEM activity and the material selected with the whole class.
- To conclude, briefly generate a discussion with participants about low cost/no cost material.

Activity -3: Hands-on STEM activities	**35 minutes**

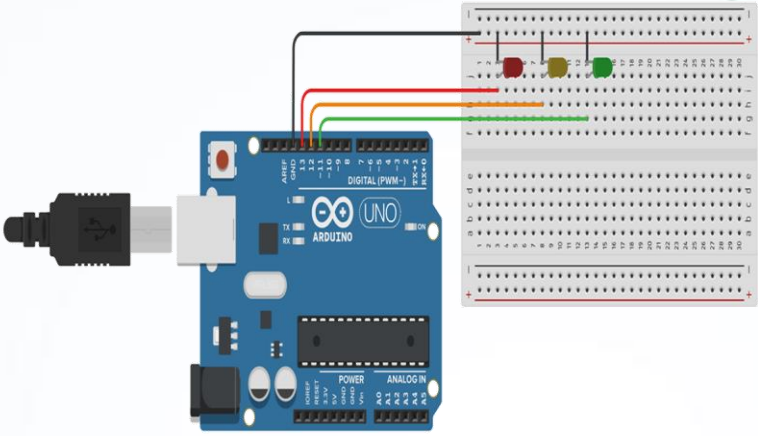
a. SUPARCO ENGINEERS

- Divide participants into groups of four.
- Inform the participants that they all are going to be **SUPACRO Engineers.**
- Allocate 20 minutes for this activity.
- Provide each group with paper sheets, tape, scissors, glue, and print of data sheet.
- Give groups 10 minutes to make their prototype airplane.
- Share the following instructions with them.
  - **SUPARCO Pakistan** wants to design a project. They want you to design a prototype of an aircraft.
  - The team that will design the best airplane will work on their upcoming project.
  - Only that team will win whose plane will fly the farthest and smoothest.
  - After your prototype is complete you will test it and note down the data in the Data Collection Sheet. (See **Handout 1: SUPARCO Engineers**)
- After completion of the task, invite each group to test their prototype airplane.
- Ask them to note down the distance covered by the plane, estimated time of flight, and speed of the plane.
- After testing give them 5 minutes to reiterate and improve their designs,
- Now again, call one member of each group to test their prototype and record the data.
- Take responses how this activity is a STEM activity and what concepts do they think they have learned in it.
- After discussion share the following chart with them.

Science	✓ Concept of aerodynamic. ✓ Concept of distance, time and speed.
Technology	✓ Understanding the technology behind the large airplane we use to travel.
Engineering	✓ How a problem solver thinks? ✓ Understanding the engineering design process. ✓ How to implement engineering design process while solving a basic problem.
Arts	✓ Designing a paper airplane using creative art skills.
Mathematics	✓ Measure length (distance) ✓ Calculating speed using distance and time. ✓ Converting units (inch, meter, centimeter) ✓ Angles

b. Designing a Traffic Light System

- Divide the participants into small groups making sure that each group has a member of Computer science.
- Allocate 15 minutes for this activity.
- Ask the participants to write a flowchart for a single traffic light system.
- After 3 minutes, open TinkerCAD.com and design a circuit of Traffic Light system with participant's input.
- Alternatively show the video: TPS Robotics Series (Lesson 9) Traffic Light Project. (https://youtube.be /OXP6aPSw2kA)




```
// C++ code
//
void setup()
{
  pinMode(13, OUTPUT);
    pinMode(12, OUTPUT);
    pinMode(11, OUTPUT);
}

void loop()
{
  digitalWrite(13, HIGH);
  delay(1000); // Wait for 1000 millisecond(s)
  digitalWrite(13, LOW);
  delay(1000); // Wait for 1000 millisecond(s)

  digitalWrite(12, HIGH);
  delay(1000); // Wait for 1000 millisecond(s)
  digitalWrite(12, LOW);
  delay(1000); // Wait for 1000 millisecond(s)

  digitalWrite(11, HIGH);
  delay(1000); // Wait for 1000 millisecond(s)
  digitalWrite(11, LOW);
  delay(1000); // Wait for 1000 millisecond(s)
}
```

- Now write the code of Traffic light system with participant's input.
- Ask them to reflect what is STEM in it.
- Ask them to relate this activity with cross curriculum connections done in previous sessions.

Activity-4: Preparing a STEM Box	10 minutes

- Inform the participants, that they will be designing a STEM box using low cost/no cost materials.
- Ask participants to name low cost/no cost items that can be added in the STEM box.
- Enlist all those items on the board.
- Ask participants to read **Handout 2: STEM Box Material.**
- Ask participants to discuss the usage of every item in conducting STEM activities.

Wrap-up	05 minutes

- Provide sticky notes to the participants.
- Ask the participants to write 3 things they have learned in today's lesson, two things they liked, and one question they still want to ask.
- Ask them to paste the sticky notes on the side of the board.
- Skim through the sticky notes and answer the questions of the participants (if any).

Handout 1: SUPARCO Engineers

Data Collection Sheet

Group member Names:

1.	2.	3.
4.	5.	6.

Cheat Sheet

Speed = $\frac{Distance}{Time}$	1 m = approx., 40 inches
1 m = 100 cm	1 cm = 10 mm

1st Prototype Testing

Time of flight: ______________________________ (secs)

Estimated distance covered: ________________________________ (m)

Speed of the prototype: = ________________________(m/s)

Wingspan of the prototype: ______________(mm)

Length of the prototype: _________________ (mm)

After Redesigning

Time of flight: ______________________________ (secs)

Estimated distance covered: ________________________________ (m)

Speed of the prototype: = ________________________(m/s)

Wingspan of the prototype: ______________(mm)

Length of the prototype: _________________ (mm)

Handout 2: STEM Box Material	
General Equipment	**Robotics Equipment**
1. Scissors 2. Straws 3. Ruler 4. Colored markers/pencils 5. Geometry Equipment 6. Toothpicks 7. Disposable plates and cups 8. Rubber bands 9. Glue gun 10. Boxes (e.g. shoe box, juice box, cartons, etc) 11. Stapler and pins 12. Thermophore 13. Cotton 14. Water bottles 15. Tin cans 16. Colorful A4 sheets 17. Chart Paper 18. Colored Inks 19. Old toothbrushes 20. Thread 21. Piece of cloth 22. Cells/batteries 23. Toy motors 24. Colorful LEDs 25. Wires 26. Balloons 27. Stones	1. DC motors 2. Colored LEDs 3. Breadboard 4. Wires 5. Arduino UNO 6. Servo motor 7. Joystick 8. LDR 9. RGB LED 10. Ultrasonic sensor 11. Infrared sensor 12. LCD
Some activity ideas that can be planned with the above general equipment	**Some activity ideas that can be planned with the above robotics equipment**
1. Robotic arm 2. Catapult 3. Microphone 4. Straw Rockets 5. Parachute lander 6. Art bot/Bristle bot 7. Simple Circuit 8. Water Filtration system 9. Seed germination 10. Water boats 11. Insulation 12. Ripple tank 13. Simple pendulum	1. LED Blink 2. Traffic light system 3. Controlling LEDs with joystick 4. Controlling Servo motor with joystick 5. Home Automation 6. Distance detector 7. Object detector 8. Smart Garage system 9. Printing message on LCD 10. RGB LED

Day: 2 **Session 1**

INTEGRATION OF STEM IN SUBJECT TEACHING

Duration: 90 Minutes

Learning Outcome:

At the end of session, the participants will be able to:

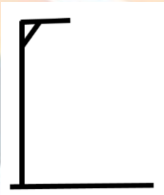
- understand and explore practical applications of STEM Pedagogical cycle in the following:
  - Boundary Crossing elements of STEM subjects.
  - Learning Dialogical processes
  - Active Learning
  - Communities of Practice (facilitation in learning)
  - Problem Solving process.

Materials:

- White board/markers
- Chart papers/coloured marker
- Handout 1: Elements of STEM Pedagogical Cycle
- Small basket/shoebox
- Paper slip/sticky notes
- PPT slides

Opening	**10 minutes**

- Ask any one participant to recite the few verses of Holy Quran to start the day.
- Display/share the learning outcomes of Session 1 on a chart paper/ PPT slide.
- Inform the participants that they will play hangman together.
- Draw eight dashes and hangman pole on the board and ask them to identify the word.



________ ________ ________ ________ ________ ________ ________ ________

- Share the following rules with them.
  - Guess the word before the stick figure is hung.
  - For every wrong answer, a piece of stick figure is drawn.
  - Raise hand to give a response.

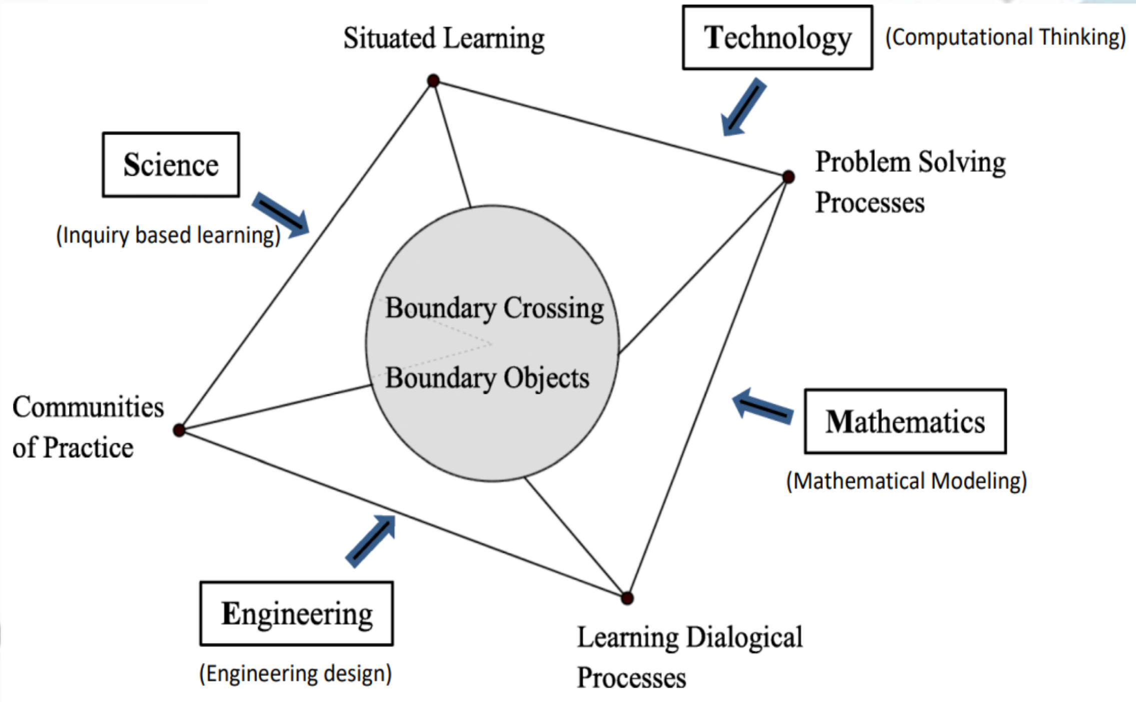
- Once they have identified the word or lost, share with them that the word is **pedagogy**.

Activity-1: Board Race **15 minutes**

- Divide the participants in pairs and ask them to recall their learning of Day 1.
- Allocate 5 mins for discussion.
- Now divide the participants into two teams.
- Inform that they will play a game called **"Board race".**
- Each member of the team will write one term they recall from Day 1 on the board.
- Allocate 2 min to each team to write on the board.
- Stop the game after 2 minutes.
- Ask teams to briefly explain the terms written on the board.
- The team with the highest number of terms will win.

Activity-2: Elements of STEM Pedagogical Cycle **40 minutes**

- Divide the participants into 4 groups and distribute chart papers and markers.
- Inform them that they will pick up any one component from a box/ small basket having the following components (taken from the Handout 1: Elements of STEM Pedagogical Cycle) written on the sticky notes/ slips of paper.
  - Situated Learning (Active Learning)
  - Problem Solving Process
  - Communities of Practice
  - Learning Dialogical Process
- Ask them to read the given handout and generate a discussion on the chosen component. They can also take help from internet to make their presentation more interesting.
- Allocate 20 minutes for discussion and making presentation.
- Encourage them to present their chosen component using the following questions:
  - Brief explanation of the component?
  - How this component will make STEM learning applicable in our own context.
  - Relate the usefulness of the given component on any one activity performed in Day 1?
- Allocate 3 mins to each group for their presentation.
- After the presentations, encourage groups to give constructive feedback to each other.
- To consolidate, share the STEM pedagogical cycle and brief about each corner element using the PPT slides.



Activity-3: Boundary Crossing	15 minutes

- Ask the participants to look at the center of the STEM Pedagogical Cycle.
- Instruct them to discuss in pairs what boundary objects/boundary crossing means.
- Take random response.
- To consolidate, explain the term "Boundary crossing" in STEM education relating it with cross curriculum connections in STEM Learning.

"Boundary crossing" refers to the integration and collaboration between different disciplines, fields, or domains. It involves breaking down traditional barriers between subjects to create a more holistic and interconnected approach to learning and problem-solving.

This concept recognizes that many real-world challenges and innovations exist at the intersection of multiple disciplines, and effective STEM education should reflect this complexity. Boundary crossing is seen as essential in preparing students for the challenges of the modern workforce, where interdisciplinary collaboration is often necessary to tackle complex issues.

It aligns with the idea that STEM education should go beyond teaching isolated subjects and instead foster a more interconnected and dynamic learning experience.

Key aspects of boundary crossing in STEM include:

- **Interdisciplinary Collaboration:** Encouraging collaboration and communication between individuals with diverse expertise and backgrounds. This may involve scientists working with engineers, mathematicians collaborating with biologists, and so on.
- **Integration of Knowledge:** Breaking down the silos of individual subjects and integrating knowledge from various disciplines to address complex problems. This can lead to a more comprehensive and nuanced understanding of the issues at hand.
- **Real-World Relevance:** Emphasizing the application of STEM knowledge to real-world problems and scenarios. This helps students see the practical implications of what they are learning and how it can be used to address significant challenges.
- **Problem-Based Learning:** Focusing on problem-based or project-based learning approaches where students work on authentic, complex problems that require knowledge and skills from multiple disciplines.
- **Innovation and Creativity:** Recognizing that many breakthroughs and innovations occur when ideas and approaches from different disciplines come together. Encouraging students to think creatively and innovatively by drawing on a diverse range of knowledge and perspectives.
- **Flexibility and Adaptability:** Developing students' ability to adapt to new situations and navigate across different domains of knowledge. This involves cultivating a mindset that is open to learning from various sources and applying knowledge in flexible ways.

Wrap up	**10 minutes**

- Ask the participants to write a reflective passage with a word limit of 50 words on the given sticky notes.
- Answer the following questions in your reflective passage.
  - Learning outcomes of the session
  - What new you have learned today?
  - What was your favorite part of the session?
  - Anything you still have doubts?

Handout 1: Elements of STEM Pedagogical Cycle

Is STEM a subject?

STEM is not a subject but rather an interdisciplinary approach of boundary crossing into multiple disciplines through a specially designed activity that not only targets the learning domains but also develop 21st century skills in learner. To further understand STEM, we will discuss the STEM pedagogical framework.

Introduction:

STEM lesson is not only for students; an important stakeholder is the teachers. The readiness and openness of the teachers are deterministic factors for the success of a STEM lesson. To understand the dynamics of STEM, let us first discuss some of the crucial areas which play a key role in defining the STEM environment or lesson in a school.

Communities of Practice:

The concept of Communities of Practice is rooted in an aim to develop accounts of the social nature of human learning. Three crucial elements distinguish a Community of Practice from other social groups: domain, community, and practice. That is, it is a group of people with a shared domain of interest (i.e., Teachers and Students) who engage together in different types of social activities (learning activities) to pursue this shared interest (i.e., learning), consequently forming a community of practitioners to develop a shared collection of resources. A key idea in Communities of Practice is that learning is seen as the production of social structure.

Problem Solving in STEM:

Problem solving plays a central role in STEM education. STEM learning and thinking is usually situated in the context of problem solving. A view for STEM boundary crossing is to regard the problem-solving process as a boundary object. Different STEM disciplines have their own problem-solving process (which are inquiry-based learning, computational thinking, engineering design, and mathematical modeling, respectively).

A STEM activity is often about asking students to solve a relevant authentic, usually ill-defined, problem in multiple creative ways. Collaboration across different domains is crucial. Participants (teachers and students) in a STEM class work together to shape the problem-solving processes.

Situated learning (Active Learning):

Situated learning is an instructional approach which states that students are more inclined to learn by actively participating in the learning experience. Situated learning is a matter of creating meaning from the real activities of daily living. The student is “situated” in the learning experience and knowledge acquisition becomes a part of the learning activity.

Overall, situated learning in STEM aims to bridge the gap between theoretical knowledge and practical application, preparing students for the challenges and complexities they may face in their future STEM careers. This approach aligns with the idea that learning is most effective when it occurs in authentic, meaningful contexts.

Key features of situated learning in STEM include:

- Real-world context
- Problem-solving orientation
- Integration of theory and practice
- Hands-on experiences
- Authentic assessment

Dialogic learning process:

Dialogic education emphasizes the importance of dialogue for learning. The aim of the approach is to engage the students in sustained stretches of talk which enables speakers and listeners to explore and build on their own and other's ideas.

In the STEM context, dialogic learning helps students develop a deeper understanding of scientific principles and promotes the skills needed for problem-solving and innovation. It aligns with the idea that learning is a social process and is enhanced through active engagement and meaningful interactions.

Key features of dialogic learning in STEM include:

- Interactive Communication
- Collaborative Learning
- Questioning and Inquiry
- Reflection
- Active Participation
- Critical Thinking
- Scaffolding
- Adaptability

Day: 2 **Session 2 & 3**

INTEGRATION OF STEM IN SUBJECT TEACHING

Duration: 180 Minutes

Learning Outcomes:

At the end of session, the participants will be able to:

- practice various STEM activities to understand the impact on student learning.
- apply their learnings to create STEM related activities for different subjects.

Materials:

- Chart Papers /coloured markers
- Paper/ pencils/pen
- Trainers Note: STEM Carousel Learning Stations
- STEM Carousel Learning Stations activity: (material for each station is listed in the relevant handout)
- Handout 1: Selected SLOs for Lesson Planning
- PPT slides

Opening	15 minutes

- Display/share the learning outcomes of the session with the participants.
- Divide participants into seven groups.
- Distribute a chart paper and markers to each group.
- Assign one topic, from the following to each group:
    - 21st Century Skills and STEM Learning
    - Inter-disciplinary / multi-disciplinary approaches in STEM Learning
    - Inquiry-based Learning
    - Computational Thinking
    - Engineering Design Process
    - Mathematical Modeling
    - STEM Pedagogical Cycle
- Instruct groups to prepare a small poster to review the assigned topics.
- Allow 5 minutes for the poster-making.

- Each group is given 2 minutes to present their posters and recap the learnings of the module for all participants.
- Inform participants that we will now be looking at some practical STEM activities related to curriculum SLOs.

Activity-1: STEM Activities for Each Subject	130 minutes

Instructions for the Trainer:

- Read Trainer's note before setting up **STEM Carousel Learning Stations**
- Arrange the room with designated areas for each STEM subject station.
- Place Learning Station Handouts on each station.
- Ensure that each station has all necessary materials and instructions.
- Clearly label each station.
- Provide the participants with reflection sheets to be filled after each activity.
- The following Learning Station should be created:
  - Learning Station 1: Paper Roller Coaster Challenge
  - Learning Station 2: pH Express
  - Learning Station 3: Snap DNA Model
  - Learning Station 4: Rapid Geometry Hunt
  - Learning Station 5: Speed Coding Unplugged
  - Learning Station 6: Water Filter
  - Learning Station 7: Aluminum Foil Boats
  - Learning Station 8: Mathematics in daily life

- Divide participants into groups of 6 each. Ensure each group has two participants from Science, two from Mathematics and two from Computer Science domains.
- Inform participants that we will be using **STEM Carousel Learning Stations**.
- Provide each group with the following instructions:
  - Each group is assigned one Learning Station.
  - Each group has 15 minutes to complete the task of each Learning Station.
  - As soon as the 15 minutes are up, place all materials in the same way you found and move clockwise to the next station.
  - Wait for the timer to start. You will now have 15 minutes again to complete the task of next Learning Station.
- Stop the activity once the groups have visited all 8 learning stations and completed all the tasks.
- Ask the participants to move around and look at the work done by other groups.
- Taking 5 – 6 random responses, reviewing the activities and participant learnings from the activities.

- Encourage participants to share how these activities can be modified for their classrooms.
- Instruct participants to complete Reflection Journal Entry.
- Allow 3 minutes for the task.

Reflection Journal Entry:

- The participants will work individually to jot down their learnings, ideas and any thoughts from the session in their notebooks to take home and work on.
- The reflection journal entries are personal and will not be shared with the facilitators or other participants.

Activity-2: Lesson Planning — 30 minutes

- Ask participants to remain in the same groups.
- Assign one SLO (see Handout 1: Selected SLOs for Lesson Planning) to each group. Distribute chart papers and coloured markers.
- Instruct each group to design three different STEM activities, using the variety of pedagogical strategies for the assigned SLO. They should provide a list of materials required as well as clear instructions for the activities. At least one activity should be designed using an interdisciplinary / multi-disciplinary approach.
- Each group has 20 minutes for this task.
- Once the activities are designed, ask each group to select the inter-disciplinary / multi-disciplinary activity and present it to the whole class in 2 minutes.
- Provide feedback to the activities designed.
- Inform participants that they will now be planning for their microteaching on the assigned SLOs.

Wrap up — 05 minutes

- Ask participants to take a moment to reflect on the session.
  - What key strategies stood out to them?
  - How do they envision incorporating these strategies into their teaching?
- Take responses from 3 volunteers and have them share one key takeaway from the session with the group.

Trainer’s Note

Please note instructions for setting up the learning stations for the STEM Carousel.

Learning Station 1: Paper Roller Coaster Challenge

- Each participant of the group should be provided with the activity reflection sheet to fill in.
- Provide with at least 3 – 4 scissors, depending on the group size.
- Each group should be provided with different colored and sized papers. It is advised to have one set per group ready beforehand since this material cannot be reused.
- Participants can use stopwatches of their mobile phones.
- The constructed roller coasters should be safely put aside for all groups to have a look at, at the end of the STEM activity carousel.

Learning Station 2: pH Express

- Ensure enough materials are available for each group to perform the activity.
- In case red cabbage is unavailable, red onion solution can be prepared beforehand. The instructions for the activity will change accordingly.
- Each participant of the group should be provided with the activity reflection sheet to fill in.

Learning Station 3: Snap DNA Model

- Each participant of the group should be provided with the activity reflection sheet to fill in.
- Provide with at least 3 – 4 scissors, depending on the group size.
- It is advised to have one set of colored papers and straws per group ready beforehand since this material cannot be reused.

Learning Station 4: Geometry in Nature Scavenger Hunt

- Each participant of the group should be provided with the activity reflection sheet to fill in.
- Before beginning, identify the area designated for the hunt. The participants should not be going beyond the designated area.
- The groups will be required to leave the room for the completion of the activity.
- Instead of loose papers, the initial sketches can be completed on participant’s notebook.
- The prepared poster presentations should be safely put aside for all groups to have a look at, at the end of the STEM activity carousel.

Learning Station 5: Speed Coding Unplugged

- Some preparation is required before beginning this activity.

- A series of sequence cards are present at the end of the session document (Handout 1). Print and cut the card sets. Paste these card sets on cardstock to create index cards.
- The three tasks for this activity are: Folding a Paper Airplane, Tying Shoelace and Drawing a House.
- The same set of cards can be reused for all groups.
- Instruct groups not to write anything on the cards.
- Before the next group begins with the activity, shuffle the index card set.
- The prepared poster of codes should be safely put aside for all groups to have a look at, at the end of the STEM activity carousel.
- Each participant of the group should be provided with the activity reflection sheet to fill in.

Learning Station 6: DIY Water Filter

- Ensure enough materials are available for each group to perform the activity.
- The muddy water provided should be prepared beforehand. Enough should be prepared to be used by all groups.
- The prepared filters should be safely put aside for all groups to have a look at, at the end of the STEM activity carousel.
- Each participant of the group should be provided with the activity reflection sheet to fill in.

Learning Station 7: Aluminum Foil Boats

- Ensure enough materials are available for each group to perform the activity.
- Keep available cloth and tissues for drying the surfaces if needed.
- The prepared boats should be safely put aside for all groups to have a look at, at the end of the STEM activity carousel.
- Each participant of the group should be provided with the activity reflection sheet to fill in.

Learning Station 8: Survey and Graphing

- This is a straightforward activity. No specific materials required except for poster presentations.
- Each participant of the group should be provided with the activity reflection sheet to fill in.

Learning Station 1 – Paper Roller Coaster Challenge

Challenge: To create a roller coaster that allows a marble to navigate twists, turns, and loops successfully.

Materials Provided:

- Different sizes and colors of sheets of paper
- Tape
- Scissors
- Marble
- Stopwatch

Instructions:

- You have been provided with paper, tape, and scissors. No other materials are allowed.
- Brainstorm and sketch a design for your roller coaster on a separate sheet of paper. Ensure to include loops and drops to make the roller coaster interesting.
- Based on your design, construct the paper roller coaster. Be careful of the stability and structure of your coaster to ensure the successful navigation of the marble.
- Once you have constructed the roller coaster, test it using the marble provided. Assess the success of the coaster based on the marble's ability to complete the course.

- Make modifications if required.
- Once you have a working roller coaster model, measure, and record the time it takes for the marble to complete the trajectory.
- Completely fill out the activity reflection sheet.

Activity Reflection Sheet – Paper Roller Coaster Challenge

1. Time taken by marble to complete trajectory: ……………………………

2. What modifications would allow you to improve the trajectory time?
………
………
………

3. What was the biggest challenge faced in building this roller coaster?
………
………
………

4. Which SLO(s) would this activity correspond to?
………
………
………

Learning Station 2 – pH Express

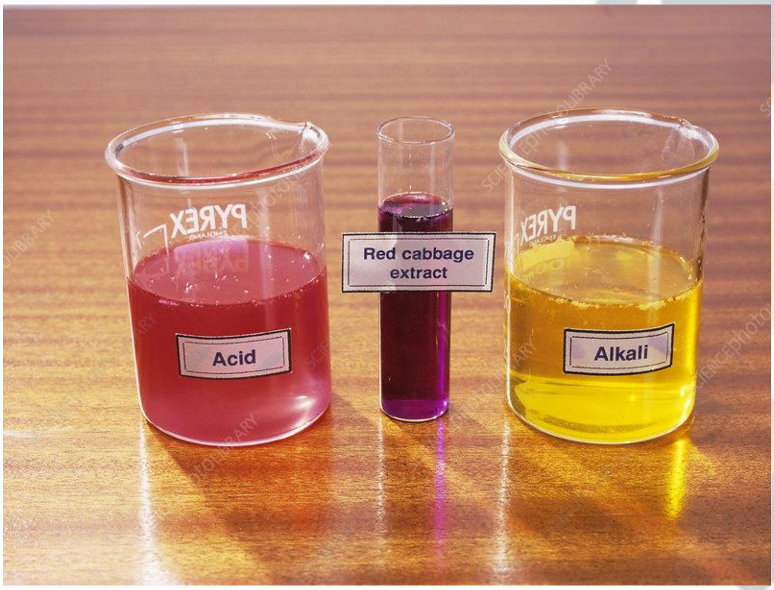
Challenge: To check the concept of pH, create a natural pH scale to measure acidity or alkalinity in substances.

Materials Provided:

- Red cabbage leaves
- Water
- Vinegar
- Baking soda
- Small containers or cups
- Strainer/filter paper
- Small bowls or plates for mixing

Instructions:

- Tear the red cabbage leaves into small pieces and place them in a container.
- Add water to cover the cabbage leaves and let them soak for a few minutes.
- Strain or filter the liquid into another container, creating a natural pH indicator.
- Divide the indicator solution into smaller portions in different containers.
- Add a small amount of vinegar to one portion and observe the color change.
- Add a small amount of baking soda to another portion and observe the color change.
- Compare the color changes to determine the acidity or alkalinity of each substance.
- Completely fill out the activity reflection sheet.



Activity Reflection Sheet – pH Express
1. Determine whether vinegar is acidic or alkaline. ……………………………… 2. Determine whether baking soda is acidic or alkaline. ………………………………… 3. How would you modify the activity to be able to determine exact pH of various solutions? …… …… …… 4. What was the biggest challenge faced in creating and using the indicator? …… …… …… 5. Which SLO(s) would this activity correspond to? …… …… ……

Learning Station 3 – Snap DNA Model

Challenge: To understand the basic structure of DNA, including the double helix, nucleotides, and base pairing.

Materials Provided:

- Coloured paper (representing nucleotide bases)
- Clear plastic straws (representing the backbone)
- Masking tape or glue
- Scissors

Instructions:

- Cut out rectangular strips from colored paper, representing the four nucleotide bases (A, T, C, G).
- Each nucleotide base should have a distinctive color and shape.
- Cut out the straw into small pieces.
- Create a nucleotide by attaching one of each colored paper strip to a clear plastic straw piece using tape or glue.
- Connect additional nucleotides in a sequence along the straw to represent the DNA strand.
- Complete the double helix, ensuring the complementary base pairing rule: Adenine (A) pairs with Thymine (T), and Cytosine (C) pairs with Guanine (G).
- Completely fill out the activity reflection sheet.

Activity Reflection Sheet – Snap DNA Model
1. Why do we need to ensure base pairs are correctly aligned? …… …… …… 2. How would you modify the activity to showcase mutation to the students? …… …… …… 3. What was the biggest challenge faced in creating an accurate DNA structure? …… …… …… 4. Which SLO(s) would this activity correspond to? …… …… ……

Learning Station 4 – Geometry in Nature Scavenger Hunt

Challenge: To be able to identify and appreciate geometric shapes and patterns present in the natural environment.

Materials Provided:

- Chart Papers
- Loose papers
- Pencils
- Rulers
- Markers

Instructions:

- Your goal is to find and sketch geometric shapes and patterns in nature during the scavenger hunt.
- Look for shapes like spirals, symmetry, fractals, circles, and any other geometric patterns.
- Explore the designated natural area for no more than 8 minutes and then return to complete the remaining activity.
- As you find geometric shapes and patterns, sketch and label each feature on the loose paper.
- Identify and label the specific geometric properties of the shapes they find.
- Return to the learning station and prepare a chart presentation of your findings.
- Completely fill out the activity reflection sheet.

Activity Reflection Sheet – Geometry in Nature Scavenger Hunt
1. What sort of geometrical patterns have you identified in nature? …… …… …… 2. How does your perspective affect the geometrical shapes you identify around you? …… …… …… 3. What was the biggest challenge faced in this scavenger hunt? …… …… …… 4. Which SLO(s) would this activity correspond to? …… …… ……

Learning Station 5 – Speed Coding Unplugged

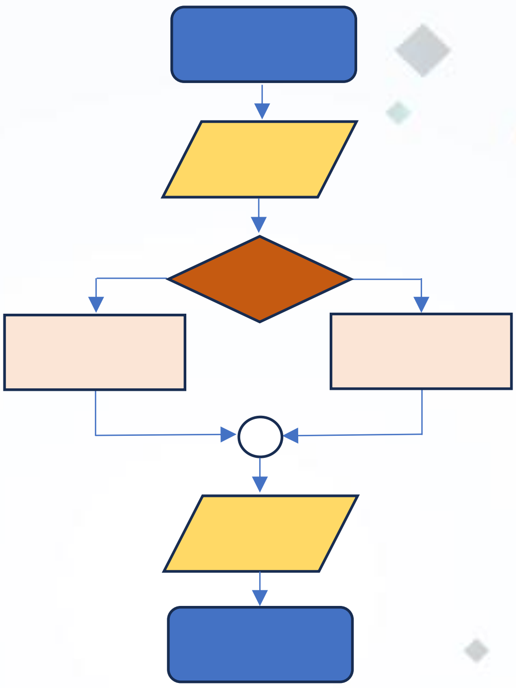
Challenge: To understand the basics of algorithmic thinking fostering problem-solving skills crucial in computer science.

Materials Provided:

- Index Card Set (see Handout: Index cards)
- Chart Papers
- Markers

Instructions:

- You have been provided with a set of index cards which contains steps for three different tasks.
- Arrange the steps in a sequence that allows completion of task.
- Once you are satisfied with the sequence, on the chart paper, translate the steps into a "CODE". (flow chart)
- Each step should be a separate line of code.
- Completely fill out the activity reflection sheet.



Handout: Index Cards for Learning Station 5

Hold one lace in each hand.	Add a triangle on top of the square for the roof.
Unfold the paper and fold the top edges to the center crease.	Pull both loops to tighten the knot.
Draw a circle above the roof for the sun.	Fold the entire plane in half along the original crease
Fold the top point down to meet the bottom edge.	Fold the paper in half lengthwise.
Draw a square for the base of the house.	Cross the right lace over the left.

Take a rectangular sheet of paper.	Color the house, door, window, and sun.
Pull the right lace under the left.	Add a smaller rectangle inside the door for a window.
Draw a rectangle on one side of the square for the door.	Cross the right loop over the left.
Tuck the right loop under the left.	

Activity Reflection Sheet – Speed Coding Unplugged

1. Review your coded algorithm. Is it clear and unambiguous.?

………

………

2. Reflect on the efficiency of your algorithm. Could the steps be improved for better clarity or speed?

………

………

………

3. What was the biggest challenge faced in preparing the algorithm?

………

………

………

4. Which SLO(s) would this activity correspond to?

………

………

………

Learning Station 6 – DIY Water Filter

Challenge: To understand the basic principles of water filtration.

Materials Provided:

- Plastic bottles (2 per participant or group)
- Cotton balls or filter paper
- Sand
- Gravel or small pebbles
- Coffee filters or cloth
- Dirty water source (can be simulated with muddy water)
- Measuring cup
- Timer or stopwatch
- Paper Cutter

Instructions:

- Your task is to create a water filter using the provided materials to clean the dirty water and obtain the clearest water in the shortest time frame.
- Determine the order in which the materials should be layered: cotton balls or filter paper, sand, gravel, or pebbles.
- In the second bottle, layer materials for filtration in the determined order.
- Pour the dirty water through your DIY filter into a measuring cup.
- Use the timer to keep track of the filtration time.
- Measure the amount of water filtered within the time limit.
- Observe the clarity of the filtered water.
- Completely fill out the activity reflection sheet.

Activity Reflection Sheet – DIY Water Filter

1. How long did it take to get clear water? ……………………………………
2. What volume of water did you get? ……………………………………
3. Assess how well your DIY water filter cleaned the water. Note any changes in water clarity and quality.

……

……

……

4. Discuss potential improvements for enhancing filtration.

……

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……

5. What was the biggest challenge faced in creating the water filter?

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6. Which SLO(s) would this activity correspond to?

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Learning Station 7 – Aluminum Foil Boats

Challenge: To understand the buoyancy principles and material engineering by designing and testing aluminum foil boats.

Materials Provided:

- Aluminum foil sheets
- Small plastic basin or tub filled with water
- Small weights (e.g., coins, erasers, pebbles etc)
- Ruler
- Timer or stopwatch

Instructions:

- Your task is to design and build an aluminum foil boat that can float and carry the maximum weight.
- Brainstorm on the shape and structure of your boat. How can you create a design that maximizes buoyancy?
- Construct your aluminum foil boat using the provided materials, based on your design. Ensure it is well-sealed to prevent water from entering.
- Place your boat in the water and gently add weights to it one at a time. Use the ruler to measure how much weight your boat can hold.
- Completely fill out the activity reflection sheet.

Activity Reflection Sheet – Aluminum Foil Boats

1. What is the maximum number of weights your boat was able to sustain?

……

2. Evaluate the performance of your boat.

……

……

……

3. Reflect on the design. What possible improvements can maximize the amount of weight the boat could carry?

……

……

……

4. What was the biggest challenge faced in creating and testing the boats?

……

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……

5. Which SLO(s) would this activity correspond to?

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Learning Station 8 – Survey and Graphing

Challenge: To practice collecting data, creating a graph, and interpreting the results, enhancing skills in data analysis and representation.

Materials Provided:

- Survey Activity Sheet
- Pens
- Chart Papers
- Markers

Instructions:

- Your task is to collect data about your group members using the provided survey questions and represent the findings through a graph.
- Record responses of your group members to the survey questions.
- Determine the type of graph that you will be creating.
- On the chart paper, create the graph based on the collected data.
- Ensure labels, titles, and other necessary components are included.
- Analyze the graph to identify trends, patterns, or noteworthy insights from the collected data.
- Completely fill out the activity reflection sheet.

Survey Questions

Demographic Questions:

1. What is your age?
2. What is your gender?

Personal Preferences:

3. Do you prefer indoor or outdoor activities?
4. What type of music do you enjoy the most?
5. Are you a morning person or a night owl?
6. Do you prefer reading physical books or e-books?

Health and Lifestyle:

7. How many hours of sleep do you typically get per night?
8. How often do you engage in physical exercise each week?
9. What is your favorite healthy snack?

Educational Preferences:

10. Do you prefer learning through visual, auditory, or kinesthetic methods?
11. How do you feel about group projects?
12. How do you feel about the use of technology in education?

Entertainment and Hobbies:

13. What is your favorite type of movie/TV show?
14. Do you play any musical instruments?
15. What is your favorite hobby or recreational activity?

Future Aspirations:

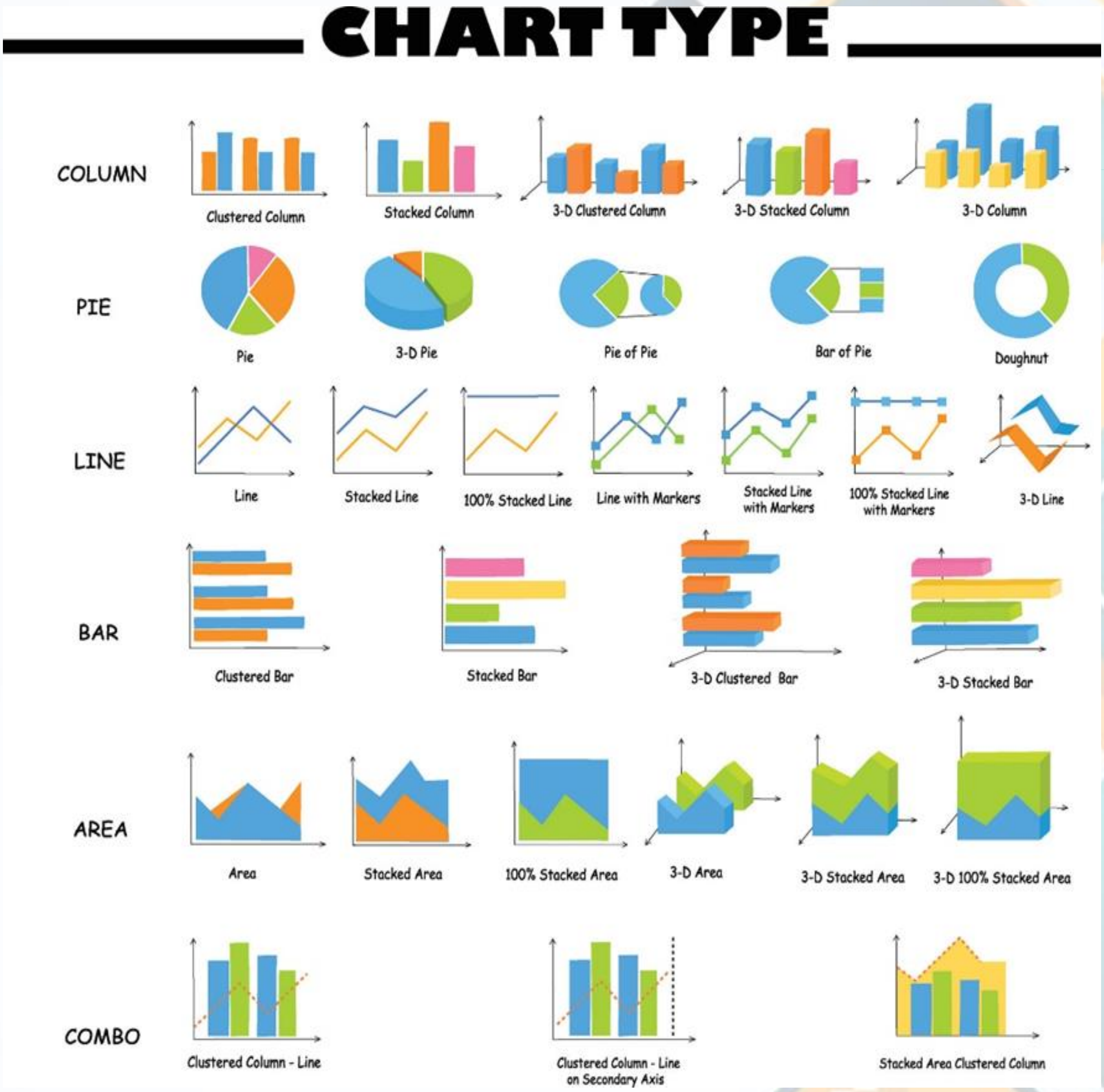
1. Do you have a specific goal you want to achieve within the next five years?

Environmental Concerns:

2. How often do you recycle?
3. What steps do you take to reduce your carbon footprint?
4. Are you conscious of sustainable practices when making purchasing decisions?

Creativity and Expression:

5. Do you enjoy participating in creative activities (drawing, writing, etc.)?
6. What form of artistic expression do you find most appealing?
7. How do you express yourself when faced with a challenge?



Activity Reflection Sheet – Survey and Graphing

1. Analyze any patterns or trends visible in the graph.

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2. Identify any unexpected or standout data points.

....

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....

3. Evaluate the clarity and effectiveness of your graph in communicating the survey results.

....

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....

4. What was the biggest challenge faced in creating the graphical representations?

....

....

5. Which SLO(s) would this activity correspond to?

....

....

....

Day: 2 **Session 4**

PLANNING AND PREPARATION FOR MICROTEACHING

Duration: 90 Minutes

Learning Outcomes:

At the end of session, the participants will be able to:

- gain insight into the role and significance of microteaching in enhancing teaching skills, specifically within the context of STEM subjects.
- acquire practical skills in planning effective microteaching sessions tailored to STEM lesson plans.
- learn and plan how to effectively prepare and organize materials for microteaching sessions.

Materials:

- White board/chalk/board markers
- Chart papers/coloured markers/sticky notes
- STEM model lesson plan resource pack (see appendix: 1)
- PPT slides

Opening	**05 minutes**

- Display/share the learning outcomes of Session 4.
- Elicit the importance of micro teaching sessions in capacity building of the participants.

Activity-1: Reflection of Day 1 & 2	**25 minutes**

- Divide the participants into 7 groups.
- Allocate 1 session from Day 1 and Day 2 to each group.
- Ask each group to make a poster to recall the learning of their allocated session.
- Allocate 10 minutes for discussion and poster preparation.
- Ask each group to remain on their places and circulate the posters to other groups.
- Read the information provided and note down the main points from the poster.
- After two minutes clap so the chart paper is given to another group.

- Stop the activity once the groups reach their own table.
- To conclude, take random responses and ask participants to share their learning from the posters.

Activity-2: Planning a Microteaching Session	55 minutes

- Divide participants into groups of 6 each. Ensure each group has two participants from Science, two from Mathematics and two from Computer Science domains.
- Ask participants to choose any lesson plan from STEM model lesson plan resource pack. (see appendix: 1)
- Ask the participants to read the lesson plans thoroughly and decide how to effectively deliver the lesson plan.
- Encourage them to choose a lesson that aligns with their interests for planning a microteaching session.
- Write numbers on paper slips corresponding to the class's strength. Place the slips in a basket.
- Have each participant pick a slip from the basket in a randomized manner. The number on the slip will determine the presentation sequence.
- Prior to the microteaching activity, set up a flip chart. Instruct participants to write their assigned number, name, and the chosen SLO topic on the flip chart.
- Remind the participants to keep the following points in mind while planning.
    - getting attention
    - explaining the selected content
    - organizing class into pairs or groups
    - using teaching methodologies learnt in the previous sessions
    - using low cost/no cost materials
    - encouraging and being positive
- Tell them that each member of the group must deliver an equal amount of the microteaching session, i.e., 5 minutes each.

Wrap up	05 minutes

- Distribute sticky notes in the class.
- Tell them to write at least three take-aways from the session.
- Take 2-3 responses to conclude the session.

Day: 3 **Session 1 & 2**

MICROTEACHING PRESENTATIONS BASED ON STEM ACTIVITIES

Duration: 40 Minutes

Students Learning Outcome:

At the end of session, the participants will be able to:

- teach one or more activities using the methods they have learnt in this training in a microteaching session.
- confidently conduct STEM based activities using variety of methods.
- give constructive feedback to their peers.

Materials:

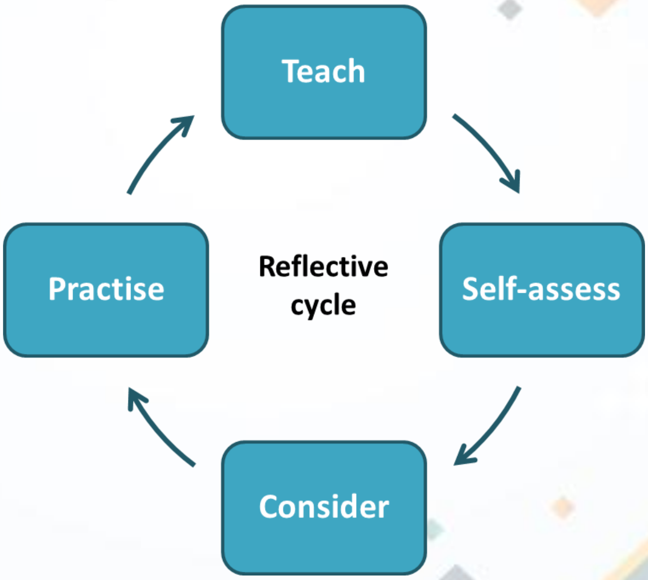
- Writing board/chalk/markers
- Chart papers/coloured markers
- Handout: Micro teaching feedback form
- PPT slides
- Markers
- Prints of guidelines sheet

Opening	**10 minutes**

- Ask any one participant to recite the few verses of Holy Quran to start the day.
- Display the topic and learning outcomes of Session 1 & 2 on a chart paper/ PPT slide.
- Ask the participants to reflect on the following questions:
    - What was the most important thing you have learnt during Day 1 & Day 2?
    - What question remains in your mind?
- Encourage them to share their experience with the whole group.

Activity-1: Reflective Practices in Teaching	**15 minutes**

- Brainstorm the word “Reflective Practices in Teaching”.
- Ask the participants to first think and then share their thoughts with their partner.
- Take a few random responses.
- To conclude, explain: **Reflective Practices in teaching.**



- **Reflective practices** in teaching refer to the deliberate and systematic process of reflecting on one's teaching practices, experiences, and interactions with students to gain insights, improve instructional techniques, and enhance student learning outcomes. These practices involve self-reflection, self-assessment, and critical thinking to continuously refine and develop teaching approaches.
  The process of reflection is a cycle which needs to be repeated.
  - Teach
  - Self-assess the effect your teaching has had on learning.
  - Consider new ways of teaching which can improve the quality of learning.
  - Try these ideas in practice.
  - Repeat the process

Activity-2: Micro Teaching Sessions — 150 minutes

- Share the **Handout: Micro Teaching Session Feedback.**
- Ask any volunteer to read the given criteria.
- Inform the participants that the trainer will give feedback to everyone.
- Call the participants in their respective groups to present their microteaching sessions in front of other participants.
- Allocate time to each group according to the number of participants. (5 minutes per member)
- Tell them that it will be a demonstration activity and group members will act as STEM teachers.
- Remind the participants that this is not an assessment, but rather a chance to enhance their facilitation abilities.

- After each group presentation, encourage all the participants to do self and peer-reflection keeping the following questions in mind:
    - What went well? Why?
    - What didn't go so well? Why?
    - What have you learnt from planning and preparing for micro teaching sessions?

Wrap up	**05 minutes**

- Ask the participants to think how this session will help them in their own classroom scenarios.
- Ask any two or three volunteers to share their ideas with the whole class.

Handout: Micro Teaching Session Feedback Form

Subject: ____________________ Name of the participant: ___________________

Sr.#	Lesson Presentation	Not achieved	Achieved to some extent	Achieved well
1.	SLO achieved through the activities using STEM pedagogies. (situated learning, dialogic learning, problem solving)			
2.	Clear explanations to concepts, words, etc.			
3.	Giving clear instructions for an activity			
4.	Encouraging and supporting facilitating learners			
5.	Use different interaction patterns: individual, pairs, groups, mingle, teams, whole class.			
6.	Incorporating Engineering Design process throughout the activities.			
7.	Integrated at least two subjects in their lesson			
8.	Used low-cost/no-cost material			
9.	Voice: good volume, friendly tone			
10.	Monitoring and supporting learners in their work			
11.	Assessment is according to the SLO			
12.	Effective Time management of pace			
13.	Effective use of materials			
14.	Facilitators Role			

Day: 3 **Session 3 & 4**

ORIENTATION ON STEM CLUBS

STEM MODEL PLANS

Grade: 7 **STEM Plan-1**

Physical and Chemical Changes

Duration: 40 Minutes

Students Learning Outcome:

- Differentiate between physical and chemical changes while considering daily life examples.

Materials:

- Textbook 7
- Board and Marker
- Matchbox
- Candles
- Ice cubes
- Paper sheets
- Baking soda
- Vinegar
- Prints of observation sheet
- Chart papers
- Markers
- Prints of guidelines sheet

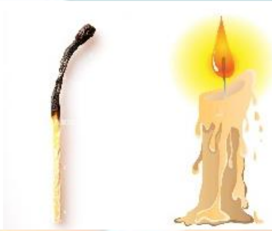
Information for Teachers:

- In STEM lessons, the role of the teacher is of a facilitator. Make sure you are not providing straight-on facts/knowledge to the students instead provide guided prompts/questions/ hints to direct their learning toward the desired goal.
- Inquiry based learning is the best way to develop new concepts. It engages students by making real world connections through hands on explorations and high-level questioning.

Introduction 07 minutes

- Tell the students that we are going to look at how physical and chemical changes happen.
- Divide the students into groups of five.

- Give the following instructions:
  - You will be provided with a matchstick and a candle.
  - Carefully light the candle using the matchstick.
  - Observe carefully what happens.
  - In your groups discuss the questions written on the board.
  - You will then be asked to present your findings to the whole class.



- Write the following questions on the board.
  - What changes do you observe after lighting the *matchstick*?
  - What changes do you observe after lighting the *candle*?
- Provide each group with a matchstick and a candle.
- Ask the groups to carefully light the candle using a matchstick.
- Ask them to discuss the questions and note down the responses in their notebooks as a group.
- Allow students 5 minutes to complete this activity.
- Call two groups in front of the class and ask them to share their findings.
- Build on their responses that burning the matchstick is an irreversible process as the chemical composition of the matchstick is completely changed.
- On the other hand, burning a candle is a reversible process as the chemical composition of the candle does not change upon burning.
- Share with them that a change during which the structure of a substance does not change is called physical change whereas a change during which the structure of a substance is changed is called chemical change.

Development

Activity 1 — 15 minutes

- Continue with the students divided in the same groups.
- Write the following on the board.

Imagine you are a chemical engineer, working with a chemical factory to identify and categorize their changes as physical and chemical changes.
You have been provided with the required materials.
Conduct investigations using the materials, record your observations and identify which are physical and which are chemical also.

- Provide each group with a piece of paper, an ice cube, baking soda, vinegar, a matchstick, and the observation sheet.
- List the following investigations on the board for students to perform:

  - Metling of Ice cube
  - Tearing of pieces of paper
  - Adding baking soda to vinegar
  - Burning a piece of paper.
- Ask the groups to observe/conduct these investigations and note down their observations in the observation sheet.
- Allow 10 minutes for the groups to complete investigations and record observations.
- Circulate amongst the groups and provide facilitation where necessary.

Note to Teacher:			
			
Melting of Ice cube Physical Change	Torn pieces of paper Physical Change	Baking soda and Vinegar Chemical Change	Burning paper Chemical Change

Activity 2 15 minutes

- Inform students that we will now be learning how to present our results and observations.
- Students continue in the same groups.
- Provide each group with chart paper, markers.
- Distribute the "Rubric" to all groups.
- Explain that the rubric lists down what is needed to complete a given task successfully.
- Allow 1 minute for the groups to go through the rubric. Explain any items that may be needed.
- Instruct groups to design infographics or posters of physical and chemical changes based on their observations.
- Inform they have 10 minutes for the task after which they will be presenting to the whole class.
- Once the posters are ready, put up the posters around the class.
- Conduct a gallery walk with the students and provide feedback to each poster.

Conclusion/ Sum up/ Wrap up 03 minutes

- Sum up the lesson by consolidating the following points.

Physical Change	Chemical Change
It involves a change in the physical properties of a substance.	It involves a change in the chemical properties of a substance.
The chemical composition of the substance does not change.	The chemical composition of the substance changes and new substances with different properties are formed.
It is easily reversible.	It is not easily reversible.

Assessment

- Task: Compile a list of processes from your surroundings that reflect physical and chemical changes.

Follow up

- Textbook 7, Page 66: Q1

Observation Sheet

Use this sheet to record your observations for each investigation you carry out.

Investigation 1: …………………………………………………………		
Choose the correct option:	Physical Change	Chemical Change
Your Observation: …………………………………………………………………………………………… …………………………………………………………………………………………… …………………………………………………………………………………………… ……………………………………………………………………………………………		

Investigation 2: …………………………………………………………		
Choose the correct option:	Physical Change	Chemical Change
Your Observation: …………………………………………………………………………………………… …………………………………………………………………………………………… …………………………………………………………………………………………… ……………………………………………………………………………………………		

Investigation 3: …………………………………………………………		
Choose the correct option:	Physical Change	Chemical Change
Your Observation: …………………………………………………………………………………………… …………………………………………………………………………………………… …………………………………………………………………………………………… ……………………………………………………………………………………………		

Investigation 4: …………………………………………………………		
Choose the correct option:	Physical Change	Chemical Change
Your Observation: ………………………………………………………………………………………………… ………………………………………………………………………………………………… ………………………………………………………………………………………………… …………………………………………………………………………………………………		

Group Members:

………………………………………………………………

………………………………………………………………

………………………………………………………………

………………………………………………………………

………………………………………………………………

Rubric for Poster Presentation

Before submitting your work, check if:

The poster has:

- A title which is large and clear
- A definition for physical changes
- A definition for chemical changes
- At least 3 examples of physical changes which include pictures.
- At least 3 examples of chemical changes which include pictures.

The text is:

- A good size (not too big or too small)
- In a format that is easy to read
- All spelled correctly.

The pictures:

- Are a good size (not too big or too small)
- Show the chemical changes described.
- Have labels explaining what is in each picture.

The layout:

- Has a good use of color (uses complementary or contrasting colors)
- Has a good use of shapes (uses similar shapes)

Has a good use of negative space (space with no pictures of text)

Grade 7 **STEM Plan-2**

TOPIC: Distance, Speed and Time

Duration: 40 Minutes

Students Learning Outcome:

- Calculate arrival time, departure time and journey time in a given situation (on the previous day and the next day).

Materials:

- Textbook
- Whiteboard and Marker
- Charts

Information for Teachers

- Begin the lesson by discussing with students the importance of understanding time in various STEM fields, such as physics, engineering, and computer science.
- Explain that the concepts of arrival time, departure time, and journey time are essential for planning and analyzing real-world scenarios.

Introduction 05 minutes

- Elicit from the student what arrival time, departure time, and journey time means.
- After discussion share with them:
  - **Arrival Time:** The time when you reach your destination.
  - **Departure Time:** The time when you leave for a destination.
  - **Journey Time:** The duration of travel or the time an event lasts.

Development 27 minutes

Activity 1 20 minutes

- Divide students into small groups.
- Assign one of the following scenarios to each group.
  - "You are planning a field trip to a local museum. The museum opens at 10:00 AM, and you want to be there when it opens. The trip will take 45 minutes to get there. Calculate the departure time."
  - **Time Travelers: Calculating Arrival, Departure, and Journey**
    "Yesterday, a friend started a journey at 3:45 PM and arrived at the destination at 8:30 PM. Today, the same friend plans to leave the destination at 9:15 AM. Can you help calculate the total journey time, departure time on the previous day, and arrival time on the next day?"

- Ask the groups to first come up the solutions in their respective groups.
- Ask them to discuss and then make a list of real-life situations where understanding time calculations is important, such as planning a trip, catching a train, or meeting a deadline.
- Be a facilitator and move around the class.
- After 5 minutes, ask each group to present their calculated departure time and arrival time using chart papers.
- Discuss different strategies students might have used to calculate the times.

Activity 2 — 7 minutes

- Briefly introduce the concept of motion and speed.
- Discuss how time is an essential factor in understanding motion and distance.
- Discuss real-life situations where understanding speed and time calculations are crucial, such as travel planning, sports, or vehicle safety.
- Instruct them to calculate the average speed, arrival time, departure time, and total journey time based on the information given in the previous activity.
- Ask the students to discuss it in pairs.
- After 3 minutes, take responses from 3 random pairs.
- Guide the discussion towards the point that increasing the speed decreases the journey time and hence can affect our departure and arrival time.

Conclusion/ Sum up/ Wrap up — 03 minutes

- Summarize the key points of the lesson, emphasizing the importance of time concepts in STEM.
- Encourage students to explore more STEM-related scenarios and apply their knowledge to solve problems in science, technology, engineering, and mathematics.

Assessment — 05 minutes

- Assign the following task to the students and check their learning.
    - A train left the train station at 07:05 AM and reached the destination one hour later than its actual time of arrival which was 12:30 PM on the next day. Calculate the journey time.

Follow up

Assign question from the textbook to the students for practice.

Grade 8 **STEM Plan-3**

TOPIC: Uses of Microsoft Excel Tools

Duration: 40 Minutes

Students Learning Outcome:

- Create a spreadsheet (i.e. result card, home budget, timetable, etc)

Materials:

- Laptop/Computer with Microsoft Excel installed
- White Board
- Board Marker/Chalk
- Multimedia
- Grade 8 Computer Textbook

Information for Teachers

- Microsoft Excel, commonly referred to as Excel, is a powerful spreadsheet software developed by Microsoft. It is widely used for data entry, analysis, and visualization, making it an essential tool for businesses, students, and professionals.

Introduction 05 minutes

- Start with some thought provoking questions:
  - Have you ever used Microsoft Excel? If so, for what purposes?
  - How do you think Excel can be helpful in everyday life?
  - Why is it important to understand and use software like Excel in today's digital age?
  - How can you apply the skills and knowledge gained from this activity to future academic tasks or personal projects?
- Ask them to gather as much information as they can from you.

Development 30 minutes

Activity 1 14 minutes

- Divide the class into three groups, each consisting of an equal number of students.
- Assign the following tasks to each group.
  - Group 1: Show a video demonstrating how to use MS Excel for creating result cards. (Link: https://www.youtube.com/watch?v=BtTp2XgH-DM)

- Group 2: Show a video illustrating the creation of a home budget using MS Excel. (Link: https://www.youtube.com/watch?v=GXZjTN0RZJw)
- Group 3: Show a video on building timetables with MS Excel. (Link: https://www.youtube.com/watch?v=bHnBmbTn2p4)

- The videos should serve as a refresher of MS Excel tools and functions, with each group focusing on the specific task they will perform.

Activity 2 — 10 minutes

- In their respective groups, ask the students to apply what they've learned from the video to create Excel spreadsheets for their assigned tasks:
  - Group 1: Create a result card for a fictional student, including subject grades and overall percentage.
  - Group 2: Develop a home budget spreadsheet that includes income, expenses, and calculations for savings.
  - Group 3: Construct a weekly timetable for a student, specifying days, time slots, and activities.
- Encourage students to use Excel functions like SUM, AVERAGE, and formatting options to enhance the quality of their spreadsheets.

Activity 3 — 06 minutes

- Now call a student from each group one by one to present their Excel spreadsheet to the class.
- Instruct that each group only has 2 minutes to present their work.
- Tell them that they have to explain the design choices they made, demonstrate the functionalities, and describe how these spreadsheets can be useful in real life.

Conclusion/ Sum up/ Wrap up — 02 minutes

- Sum up the lesson by consolidating the following benefits of the Excel.
  - The Best Way to Store Data.
  - You can perform calculations.
  - All the tools for data analysis.
  - Easy to Create Data Visualizations with Charts.
  - You can Print Reports Easily.
  - So many free templates to use.
  - You can code to automate.
  - Transform and clean data.

Assessment — 05 minutes

- Assess the spreadsheets designed by students by giving them a quick look and provide feedback where needed.

Follow up

Complete the assigned tasks at home.

Grade 8 **STEM Plan-4**

Congruency and Similarity, Construction of Triangles and Transformation

Duration: 40 Minutes

Students' Learning Outcome

- Enlarge a figure with the given scale factor (positive or negative).

Materials

- Textbook Mathematics Grade 8
- whiteboard/ blackboard
- markers/chalk
- cutouts of Handout 1
- rulers
- chart papers/glue
- graph papers
- Math Station Handouts 1-6

Information for Teacher

- This lesson is in continuation of a series of lessons on transformation.
- Students are expected to have covered translation, reflection, and rotation and so they would understand the concept of transformation and the expected changes in a figure.
- Before the beginning of the lesson, prepare the cutouts from Handout 1.
- Setting up Math stations for Activity 2: Set up 6 tables around the room, as far apart as possible. At each table, place rulers, graph papers, pencils, and the handout for each station. Place enough material so that all 6 groups can use them easily.

Introduction

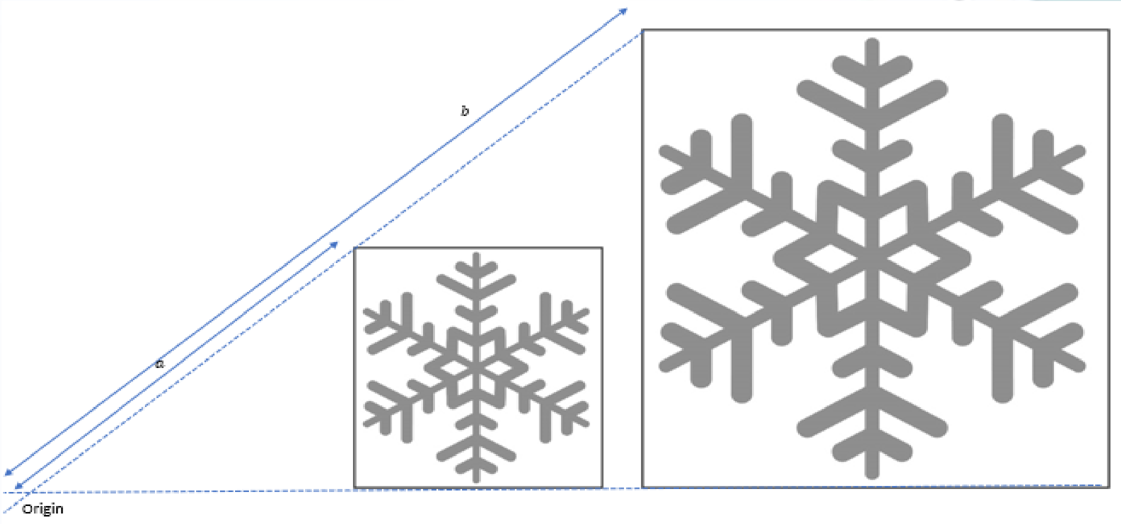
- We will begin the lesson by doing a quick review of their prior knowledge on transformation.
- Divide the students into two equal groups.
- Ask them to stand in two straight lines facing each other.
- Inform the students of the following rules:
    - I will ask a question from the whole class.

  - When I say "start", each student in the first line will give the answer to the student standing in front of them.
  - You will have 30 seconds.
  - When I say "Change", the student in the second line will give the answer to the student in front of them, again in 30 seconds.
  - When I say "Switch", the students in the first line will move one step to their right and the students in the second line will move one step to their left.
  - The process will be repeated for the next questions.
- You may want to demonstrate this to students with a simple starting question such as "How far is your home from school?"
- Ask the following questions. Remember to **say Start** once you read out the question, **Change** after 30 seconds are up and then **Switch** after a further 30 seconds are up.
  - What is meant by transformation of an object?
  - What is meant by translation of an object?
  - What happens to a right-angled triangle when it rotates 90° counterclockwise around the origin?
  - What happens to a right-angled triangle when it rotates 90° clockwise around its center point?
- Once all the questions are completed, ask the students to sit down.

Development

Activity 1

- Explain that we will now be looking at a fourth way of transforming shapes and objects.
- Divide the students into four groups.
- Distribute one set of pictures to each group. (Each set will have a small and an enlarged figure).
- Ask the students to discuss in groups what they see and can conclude about the two pictures.
- Provide each group with a ruler, half a chart paper and glue.
- Instruct groups to paste the cut outs on the chart paper. The cut-outs should be pasted in such a way that the bottom for both is aligned and on the same line.
- Ask the groups to join the lines of the same corners for both the pictures and extrapolate the lines until they meet. This will be marked as the "Origin" for enlargement.
- Next, instruct the groups to use rulers to measure the distance from origin of the small picture as well as that of the large picture. They should clearly mark on the chart paper the length they are measuring in each case. (Marked as a and b on the diagram shown)
- The overall drawing would look something like as shown below:



- Below the pasted pictures, ask students to write down the fraction:

$$\frac{\text{Distance of large picture from origin}}{\text{Distance of small picture from origin}} = \frac{b}{a}$$

- Get the groups to calculate the fraction. (Expected Answer: ~ 2)
- Lead the discussion towards introducing the term "Scale Factor" as the fraction described above.
- Define scale factor as a number by which a quantity is multiplied, changing the magnitude of the quantity. Scale factor is denoted by k.
- Explain that in the diagram above, the scale factor of 2 indicates, the small (original) image, was doubled to get the large image.
- Define the "Origin" in the diagrams as "Centre of Enlargement", a point which tells us where to draw an enlargement.
- Discuss the following points with the students:
  - An enlargement is a type of transformation in which the image is resized to make it larger or smaller.
  - The image obtained by the enlargement is not congruent but similar.
  - Scale factor $= \frac{\text{Distance of image from Centre}}{\text{Distance of object from Centre}}$
  - Scale factor can be negative or positive and shows how large or how small the image of object will be.
- Inform students that we will now investigate the different forms of enlargement.

Activity 2

- Now divide students into a total of 6 groups.
- Follow the instructions provided in the section "Information for Teachers" to set up the math stations.
- Give the following instructions to the students:
  - We will now be doing some Math stations.
  - Each group will be assigned one station.
  - You will have 2 minutes to solve the question given as a group.

   - Once the two minutes are up, rotate clockwise to the next station.
   - Complete the problem at that station in 2 minutes.
   - Repeat until you complete all the 6 stations.
   - Ensure you only use one graph paper per group and write down your group number at the top.
   - Leave all materials when you move to the next station. Only take along your graph papers.
   - You will submit the graph papers at the end of the round.
- Start the Math station rounds.
- Time the activity and allow time for groups to rotate around and settle down at each math station.
- At the end of the activity collect all 6 graph papers from all 6 groups.
- Skim through the solutions to see if there were any major errors. Discuss these errors and any misconceptions.
- Debrief the activity and ask students to settle down in their seats.

Conclusion/ Sum up/ Wrap up

- Do a quick recap of the important points covered in the lesson.
   - An enlargement is a type of transformation in which the image is resized to make it larger or smaller.
   - The image obtained by the enlargement is not congruent but similar.
   - Scale factor $= \frac{\text{Distance of image from Centre}}{\text{Distance of object from Centre}}$
   - Scale factor can be negative or positive and shows how large or how small the image of object will be.
- Inform students that we will be practicing the Exercise questions in the next lesson.

Assessment

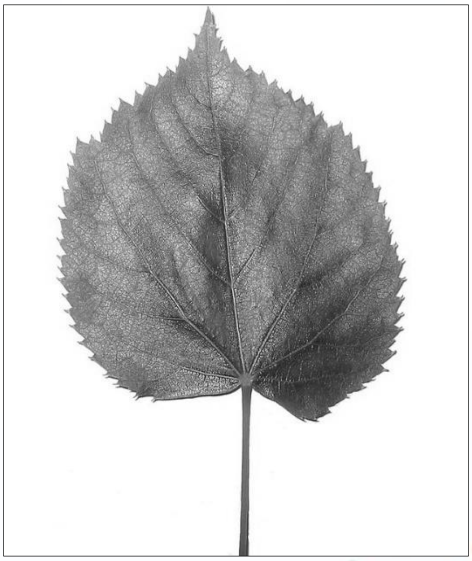
- Ask students to individually solve Question#2 & Question#3, pg#177, Exercise 4.6, Textbook 8 in their notebooks.

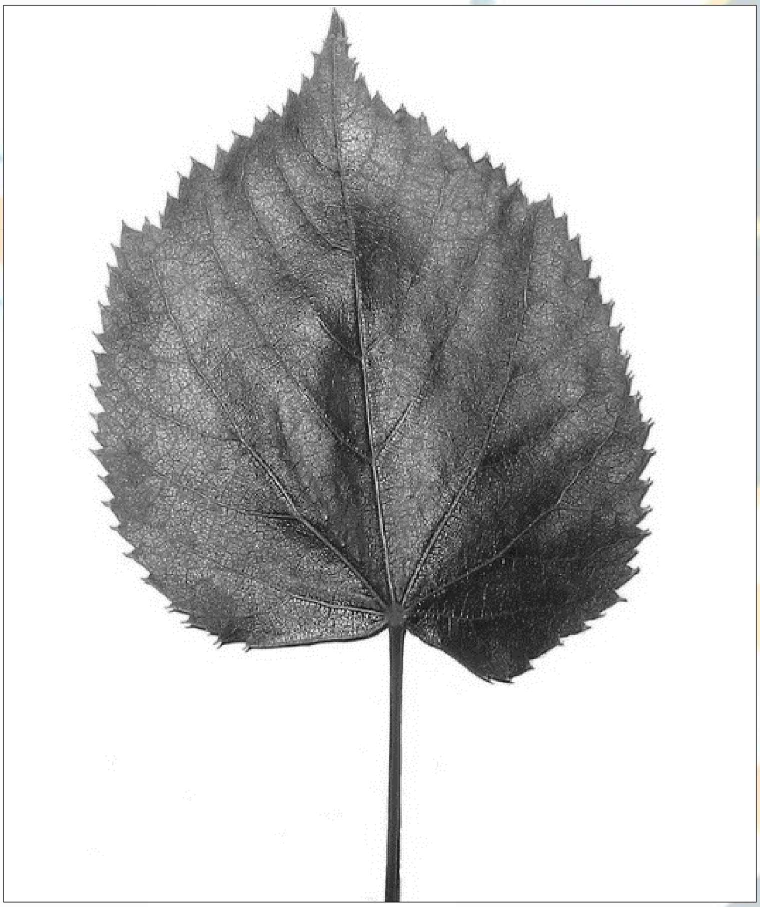
Follow up

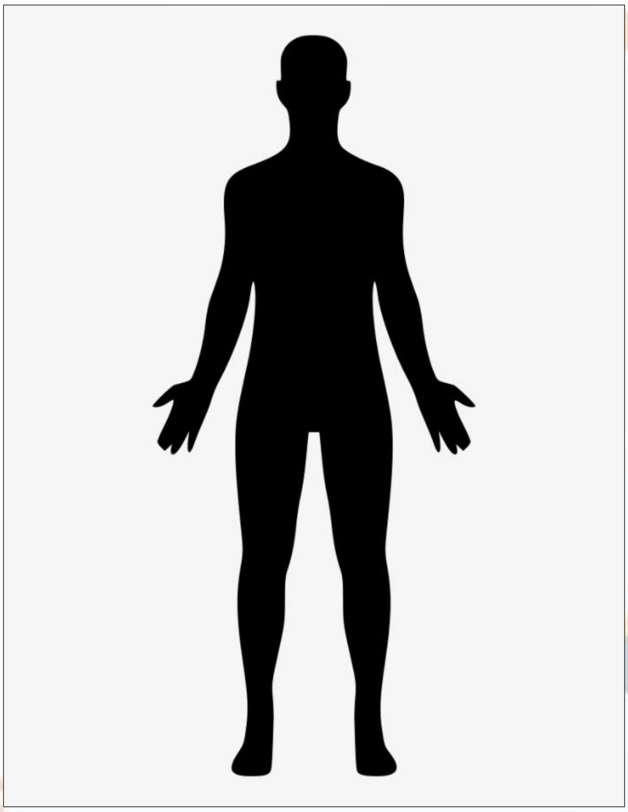
- Ask students to solve Question#1 & Question#4, pg#177, Exercise 4.6, Textbook 8 in their notebooks.

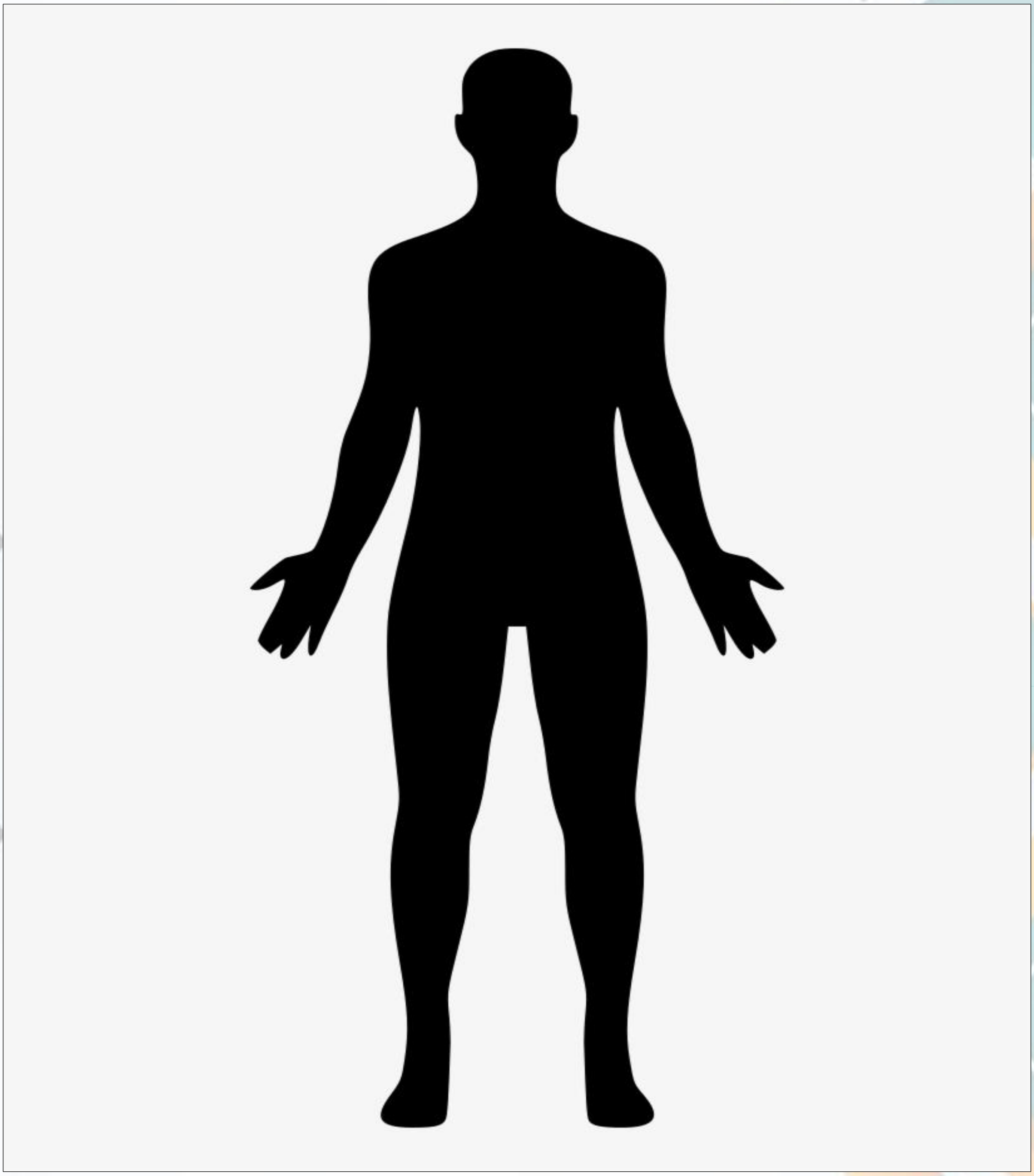
HANDOUT 1

Instructions for teacher: Print the following images and cut them out before the lesson.









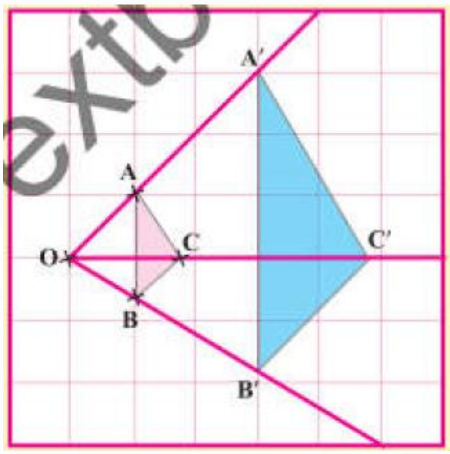
HANDOUT 2

Instructions for teacher: Print and cut out each math station set and paste it on a chart paper / cardboard. Place the chart paper on the math station table prominently.

MATH STATION 1

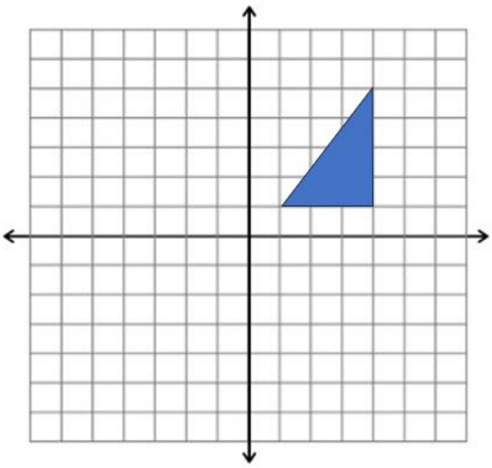
When the scale factor is positive, the object image lies on the same side of the centre.

When scale factor is larger than 1, the image is resized to become larger as in the image below:



Using your understanding, on the given graph paper:

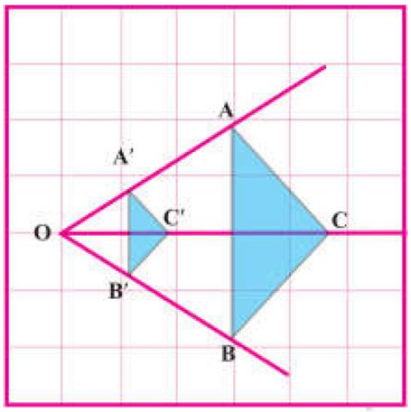
Enlarge the triangle ABC by scale factor 2 with origin as the centre of enlargement.



MATH STATION 2

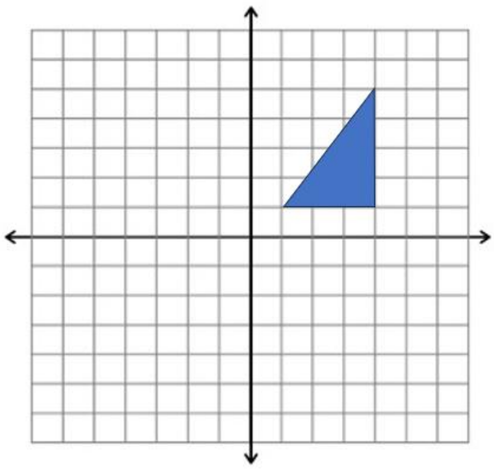
When the scale factor is positive, the object image lies on the same side of the center.

When scale factor is between 0 and 1, the image is resized to become smaller as in the image below:



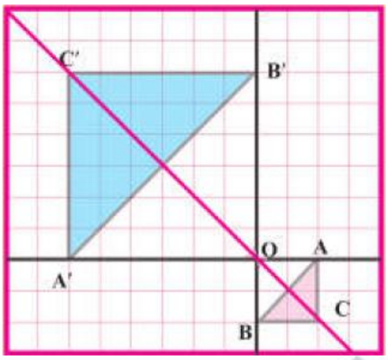
Using your understanding, on the given graph paper:

Enlarge the triangle ABC by scale factor 0.5 with origin as the center of enlargement.



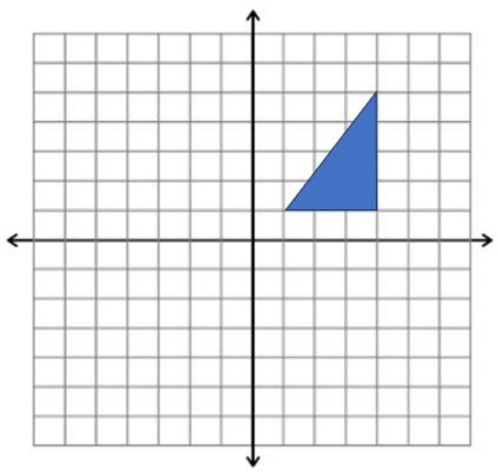
MATH STATION 3

When the scale factor is negative, the object and image lie on the opposite side of the center of enlargement.



Using your understanding, on the given graph paper:

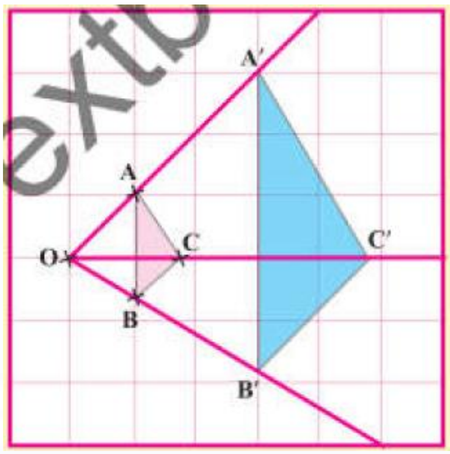
Enlarge the triangle ABC by scale factor -2 with origin as the centre of enlargement.



MATH STATION 4

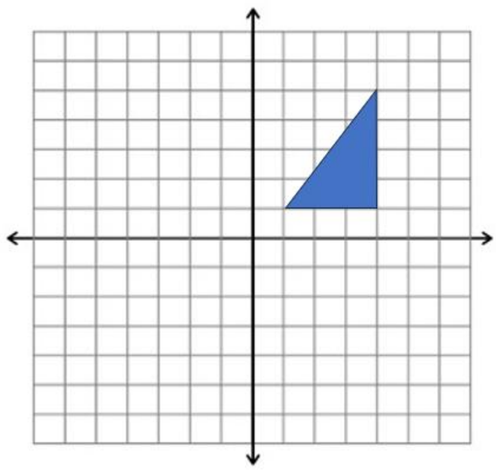
When the scale factor is positive, the object image lies on the same side of the centre.

When scale factor is larger than 1, the image is resized to become larger as in the image below:



Using your understanding, on the given graph paper:

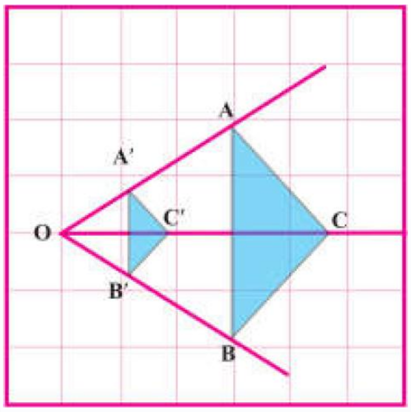
Enlarge the triangle ABC by scale factor 5 with origin as the centre of enlargement.



MATH STATION 5

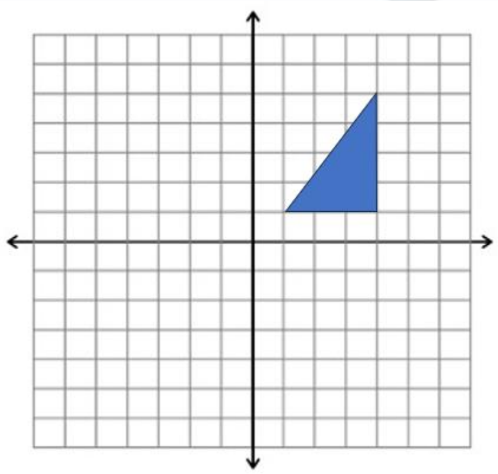
When the scale factor is positive, the object image lies on the same side of the centre.

When scale factor is between 0 and 1, the image is resized to become smaller as in the image below:



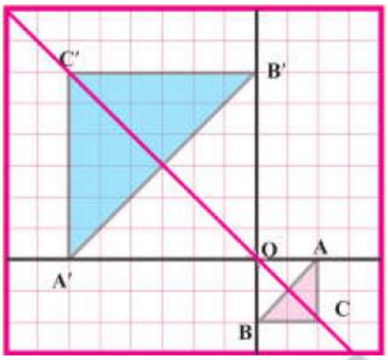
Using your understanding, on the given graph paper:

Enlarge the triangle ABC by scale factor 0.25 with origin as the centre of enlargement.



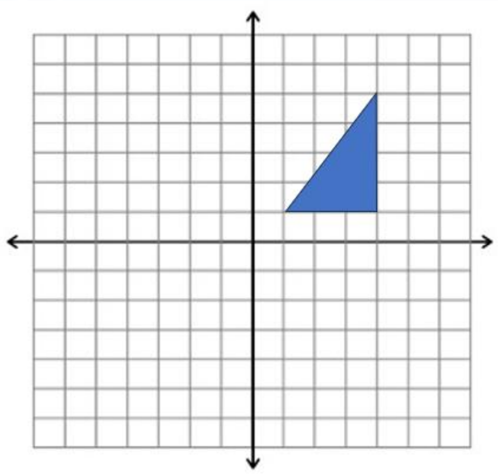
MATH STATION 6

When the scale factor is negative, the object and image lie on the opposite side of the centre of enlargement.



Using your understanding, on the given graph paper:

Enlarge the triangle ABC by scale factor -5 with origin as the centre of enlargement.



Grade: 9 **STEM Plan-5**

Fundamental Forces

Duration: 40 Minutes

Students Learning Outcome:

- State different types of forces (electrostatic force, magnetic force and thrust)
- Differentiate between contact and non-contact forces.

Materials:

- Textbook 9
- Board and Marker
- Handout – A Forces Smorgasbord
- Handout – Observation Sheet
- Balloons
- Tissue Paper
- Plastic Rulers
- Plastic Straws
- Small water bottle
- Grapes
- Magnet
- Thread
- Stand
- Glue
- Lemon
- Coins
- Bowl of water

Information for Teachers

- This lesson introduces students to contact and non-contact forces with practical applications.
- Divide students into four groups for the duration of the lesson. Rotate groups in such a way that all groups are able to perform all experiments.
- It is expected that the students are already aware of what is meant by **force.**
- Set up four stations around the room and place materials on each station as identified in **Handout – A Forces Smorgasbord**.
- Cut out the instructions from the same handout and place it on the relevant station.

Introduction **10 minutes**

- Take random responses from 2 – 3 students and recap the concept of Force, including its SI units and vector nature.
- Ask all students to write down a list of as many examples of forces as they can identify around them in the real world. Expect answers such as: weight of book on the table, push force to close the door, friction between the hands when they are rubbed together etc.
- Allow 2 minutes for the students to compile the list.
- Divide students into pairs.
- Each student in their pair takes a turn to say out loud a force from their list. The second student in the pair strikes the force from his/her list if present. They switch and the second student now says out loud a different force from the list. The process continues until all forces have been discussed.
- Students assess whether their pairs understand what is force and its real-life examples.
- Allow 3 minutes for this activity.
- Take feedback from students and ask them to identify unique examples.
- Make two lists of the examples on the board: in one column add only contact forces and in the second add only non-contact forces. Do not tell the students the difference at the moment.
- Ask students what they can see is similar between forces in column one and in column two and how are they different.

Lead the discussion to identifying the difference between contact and non-contact forces.

Development

Activity 1: **27 minutes**

- Divide students into four groups.
- Provide the following instructions to all groups:
    - Each group is assigned one station to begin the experiment.
    - You will have 5 minutes to complete the activity at your station.
    - Materials and instructions for the activity are placed at each station.

- Once the teacher signals that time is up, rotate clockwise to the next station.
- Complete the activity in the next 5 minutes.
- Continue until all four stations are completed.
- Once you complete the activity at each station, note down your observations on the observation sheet.

- After every 5 minutes, rotate groups so that the next activity can be performed.
- Circulate amongst the groups and facilitate where required.
- Gather all students together once all four stations are completed.
- Ask students to identify the forces at each station and classify them as contact and non-contact forces.
- Take feedback from 2 – 3 students and use the answers to explain how contact and non-contact forces are useful.
- In a whole-class discussion, list a few more real-life examples of contact and non-contact forces.

Conclusion/ Sum up/ Wrap up 03 minutes

Ask students to write down a Two Minute Essay in their notebooks, identifying their key take-aways from the lesson.

Assessment

- Answer the following question:

What would happen if the contact forces started acting as non-contact forces?

Follow up

- Answer the following question:

Describe two situations in which contact forces are useful and two situations in which non-contact forces are useful.

Handout – A Forces Smorgasbord

Experiment 1:

You have been provided with:

Balloons, Tissue Paper, Rulers

1. Tear some tissue paper into small pieces, about 0.5 cm square.
2. Rub the balloon on your hair for about one minute.
3. Predict what will happen when you bring the balloon near to, but not touching the tissue paper.
4. Observe what happens to the tissue paper.

Experiment 2:

You have been provided with:

Plastic straws, small water bottle, plastic ruler

1. Balance the straw on top of the water bottle.
2. Rub the plastic ruler on your head for about a minute.
3. Predict what will happen when you bring one end of the ruler near to, but not touching the straw.
4. Observe what happens to the straw.

Experiment 3:

You have been provided with:

Grapes, Magnet, Thread, Stand, Glue

1. Place one grape at the center of the table.
2. Predict what will happen when you move the magnet over the top.
3. Suspend one of the grapes from the stand using thread and glue.
4. Ensure that the grape is completely still and not moving on the thread. Then move the magnet close to it.
5. Observe what happens to the grape.

Experiment 4:

You have been provided with:

Lemon, Coins, Bowl of water

1. Place the lemon on its side and try to balance the coin on top of the lemon.
2. Now put the lemon in the bowl of water.
3. Predict what will happen when you try to balance the coin on top of the lemon now.
4. Observe what happens to the coin

Handout – Observation Sheet

Science is all about inquiry – but how do we know what questions to ask? Scientific inquiry often starts with some preliminary **observations** which lead us to make a **hypothesis** about how things work. We can then design an investigation to test the predictions we make.
In each of the experiments you have performed, forces are acting. Observe their effects to deduce something about the properties of the different forces.

Experiment 1		
Name of Force	…………………………………………………………………	
Type of Force	Contact force	Non-contact force
Your Observation: ………………………………………………………………………………………………… ………………………………………………………………………………………………… Explanation of your observation: ………………………………………………………………………………………………… …………………………………………………………………………………………………		

Experiment 2		
Name of Force	…………………………………………………………	
Type of Force	Contact force	Non-contact force
Your Observation: …………………………………………………………………………………………………… …………………………………………………………………………………………………… Explanation of your observation: …………………………………………………………………………………………………… ……………………………………………………………………………………………………		

Experiment 3		
Name of Force	…………………………………………………………	
Type of Force	Contact force	Non-contact force
Your Observation: …………………………………………………………………………………………………… …………………………………………………………………………………………………… Explanation of your observation: …………………………………………………………………………………………………… ……………………………………………………………………………………………………		

Experiment 4		
Name of Force	……………………………………………………………….	
Type of Force	Contact force	Non-contact force

Your Observation:

……

……

Explanation of your observation:

……

……

Grade: 10 **STEM Plan-6**

Types of Joints

Duration: 40 Minutes

Students Learning Outcome:

- Describe the types of movable joints.

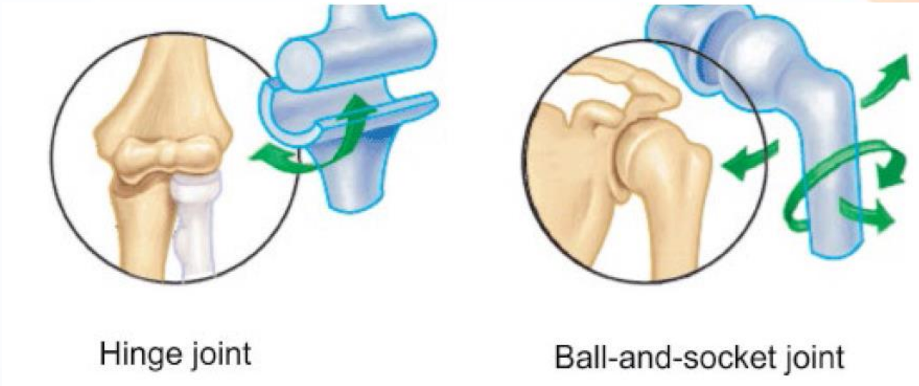
Materials:

- Textbook 10
- Board and Marker
- Lunch box
- Compass of geometry box
- 4 cardboard rolls
- Cutter
- A pair of scissors
- Long bolt with fitting pair of nuts
- Washers
- Rubber ball
- Plastic ball
- Glue
- Handout – Moveable Joints

Information for Teachers

- A **joint** is the location at which two or more bones make contact.
- Joints allow movement and provide mechanical support to the body.
- Joints can be classified on the basis of the degree of movement they allow.
- **Types of joints**: there are three types of joints; immoveable (fixed) joints, slightly moveable joints and moveable joints.
- The joints which help in the movement of body parts are called moveable joints.
- They allow a variety of movements e.g., shoulder joint, hip joint, elbow joint, knee joint etc.

- **Types of moveable joints**: there are two main types of moveable joints; hinge joints, ball - and- socket joints.
- **Hinge joints**: they allow movement in one plane only. They move back and forth e.g., the hinge on a door.
- **Ball–and–socket joints**: the allow movement in all directions. e.g., the hip and shoulder joints.



- To explore the related activities and concepts, visit the following links:
  - https://youtube.com/watch?v=R9LhQxnOqTQ&feature=shared
  - https://youtu.be/0cYal_hitz4?si=rJ-xJt-CDYWVFh3d
  - https://sites.google.com/acads.iiserpune.ac.in/iiserpscienceactivitycentre/home/hinge-joint?authuser=0
  - https://sites.google.com/acads.iiserpune.ac.in/iiserp-scienceactivitycentre/home/ball-socket-joint?authuser=0

Introduction — 10 minutes

- Begin the lesson by asking all students to stand up.
- Tell them you will be asking them to do some movements.
- Ask students to do the following movements: (Show the movements to them while giving instructions)
  - Movement 1: Stand in your place and put your right hand up, then put your right hand to the front, then put your right hand behind and move it round and round.
  - Movement 2: Put your right leg front, now put your right leg back, put your right leg behind and move it round and round.

After each movement ask the students: Is it easy to perform these movements?

- Ask the students: Why are you able to do some movements with such ease and some are restricted?
- Use the discussion to introduce the concept of joints.

- Inform students that there are different types of joints which we will be talking about today.
- Introduce the concept of *hinge joints* by using the following demonstrations:
  - one sided opening of a door.
  - opening of a lunch box.
  - opening of a compass in geometry box.
- Inform students that Movements 1 and 2 used hinge joints in our body.
- Next ask students to rotate their entire hand from the shoulder to imitate drawing a full circle. Repeat the movement in clockwise and anticlockwise direction.
- Explain that the *ball and socket joint* is used in these types of movement.
- Highlight the importance of moveable joints.
- Encourage discussion and give feedback.

Development

Activity 1 — 25 minutes

- Inform students that we will now be doing an investigation to observe the movement of a *hinge joint.*
- Distribute Handout – Moveable Joints to all students.
- Divide the class into two large groups.
  - Group A: Will be working on demonstrating hinge joints first.
  - Group B: Will be working on demonstrating ball and socket joints first.
  - Both groups will rotate once their time is up and work on the opposite joint.
- Divide each large group further into smaller groups.
- Distribute the materials for Hinge Joint to groups of Group A and of ball and socket joint to groups of Group B.

Instruct all groups to follow instructions for their assigned joints and complete their observations.

- They are allowed 10 minutes to complete their observations.
- After 10 minutes, on your signal, Group A should move to the station of Group B and vice versa.
- All groups will then follow instructions for the second observation in the next 10 minutes.
- Once both the observations are complete, gather the class at the center.

- Take 2 responses from Group A and 2 responses from Group B and ask students to share their observations.
- Guide the discussion to how these observations are useful in determining what type of joint exists in different situations.
- Address any questions or confusions that the students might have.

Conclusion/ Sum up/ Wrap up 05 minutes

- Engage the class in discussion, allowing the students to share their insights, ask questions and make connections to real-life examples of hinge and ball- and- socket joint.
- Summarize the key concepts and ensure that students have a clear understanding of the types of movable joints.

Assessment

- Task: Compile a list of examples of Hinge and Ball -and -socket joints in your notebooks.

Follow up

- Answer the following question:
  The neck joint between vertebral column and head allows movements side to side.

Imagine that this joint was replaced with a Ball and Socket Joint. Describe what would be different?

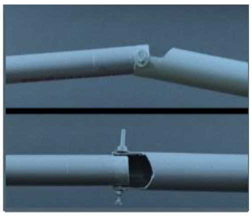
Handout- Movable Joints

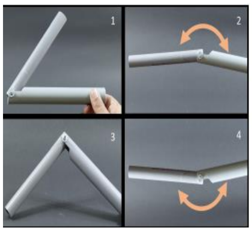
Hinge Joints

Instructions:

1. Make a U- shaped matrix on the bigger pipe.
2. Mark two points on the either side of the U-shape.
3. Cut off the U- shape using a cutter.
4. Make holes with scissors where the points are marked.
5. Make two holes on the diagrammatically opposite sides of the end of the smaller pipe.
6. Insert the bolt assembly through the holes of the pipes and fit it with the washer and nut.
7. Observe the uniaxial movement of model of hinge joint individually.

Precautions: The use of cutter and scissors must be done carefully under the teacher's supervision.





Ball and Socket Joints

Instructions:

1. Mark a circle on the plastic ball and cut it off with a cutter.
2. Make sure the hole is big enough to fit the rubber ball.
3. Make a hole in the rubber ball to fit the smaller cardboard.
4. Fit the cardboard pipe in the hole in the rubber ball.
5. Push the rubber ball in the hole in the plastic ball.
6. Glue the bigger cardboard pipe to the other end of the plastic ball.
7. Observe the movement of model of ball and socket joint individually.
8. Vary the size of the hole in the plastic ball to change the constraint on the movement of the rubber ball.
9. Observe how the movement is affected.

Precautions: The use of cutter and scissors must be done carefully under the teacher's supervision.

Grade 10 **STEM Plan-7**

TOPIC: Calculator Application

Duration: 40 Minutes

Students Learning Outcome:

- Use of Nested Selection Structures.

Materials:

- Computer Lab with Laptop/Computer with IDE installed
- White Board
- Board Marker/Chalk
- Multimedia
- Grade 10 Computer Textbook

Information for Teachers

- The if-else if structure is used for conditional decision-making. It allows you to test multiple conditions and execute different code blocks based on the evaluation of those conditions. The structure looks like this:

```
if (condition1) {
// Code to execute if condition1 is true
} else if (condition2) {
// Code to execute if condition2 is true
} else if (condition3) {
// Code to execute if condition3 is true
}
// You can have more 'else if' blocks as needed
else {
// Code to execute if none of the conditions are true
}
```

- Here's a list of information and knowledge areas that would be valuable for a teacher to have:
  - C Programming fundamentals, input and output handling, Data types and variables, Conditional statements, Loops, functions, Error handling and validation, Data Structures, Testing and debugging etc. (https://www.youtube.com/watch?v=- L4NiLG0fC4)
  - Take printouts of these developed programs and paste on the wall for gallery walk.

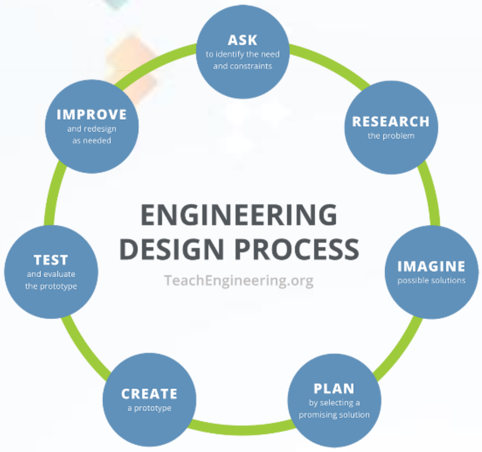
Introduction — 05 minutes

- Show a calculator to the students in the class.
- Ask them to brainstorm on how they think a simple calculator works.
- Instruct them that they can ask as many questions as they want from you but keep in the mind the questions should be indirect in nature. For example, they cannot ask how we can make a calculator but can ask what type of calculator are we planning to build, how many functions do you like it to perform and what are those functions, etc.
- Ask them to gather as much information as they can from you.

Development — 30 minutes

Activity 1 — 15 minutes

- Divide the class in 6 groups.
- Ask them to design a flowchart of a simple calculator that can perform 2-digit addition, subtraction, multiplication, and division
- Paste the engineering design process and problem solving chart on the board.



- Instruct the students to follow these processes while designing the calculator.
- Give each group 5 minutes to discuss the logic of the program. One member will write logic on a paper.
- Give 10 minutes to each group to write the program in C-language on computer and save it with their group number on the computer.
- Instruct each group to compile, debug and execute their program. Ask them to test the program by giving sample data.

Activity 2 — 10 minutes

- Call each group in front of the class and ask them to share their code (how much they have done) in front of the class.
- If the task is still incomplete, ask the groups to share their plan of action of how they were planning to make it and what functions they will use to execute it.

- Give 1 minutes to each group to present their plan and work.
- Share with them that Nested Selection Structures can help you achieve this task.
- Share the following syntax of the nested selection structure with them.

```
if (condition1) {
// Code to execute if condition1 is true
} else if (condition2) {
// Code to execute if condition2 is true
} else if (condition3) {
// Code to execute if condition3 is true
}
// You can have more 'else if' blocks as needed
else {
// Code to execute if none of the conditions are true
}
```

Activity 3 — 05 minutes

- Now ask the students to reiterate and complete the code.
- Move around the class and facilitate the students.
- Provide guided prompts in case if some is stuck.

Conclusion/ Sum up/ Wrap up — 02 minutes

- Sum up the lesson by consolidating the syntax, structure, and application of Nested structures.

Assessment — 05 minutes

- Asses the programs written by the students by giving them a quick look and provide feedback where needed.

Follow up

Complete the simple calculator from home

Grade: 10 **STEM Plan-8**

Hydrocarbons

Duration: 40 Minutes

Students Learning Outcome:

- Draw structural formulae of alkanes, alkenes and alkynes up to 5 carbon atoms.

Materials:

- Textbook 10
- Board and Marker
- Clay
- Cotton balls
- Popsicle sticks / toothpicks / short sticks

Information for Teachers:

- This lesson assumes students have a good understanding of the concept of hydrocarbons and the bonds between the carbon and hydrogen atoms.
- The focus of the lesson is to review the concept of hydrocarbons and to demonstrate how the structural formula of hydrocarbons changes as the number of carbon atoms changes.
- **Hydrocarbons** are those compounds which are made up of only carbon and hydrogen elements.
- **Alkanes** are saturated hydrocarbons, meaning they contain only single bonds between carbon atoms. The general formula for alkanes is C_nH_{2n+2}, where n represents the number of carbon atoms in the molecules.
- **Alkenes** are unsaturated hydrocarbons containing at least one carbon-carbon double bond ($C = C$). The general formula for alkenes is C_nH_{2n}, where n represents the number of carbon atoms in the molecules.
- **Alkynes** are unsaturated hydrocarbons containing at least one carbon-carbon triple bond ($C \equiv C$). The general formula for alkenes is C_nH_{2n-2}, where n represents the number of carbon atoms in the molecules.

Introduction: 10 minutes

- Write down the word "Hydrocarbons" on the board.
- Ask students to come to the board and write down anything they know about hydrocarbons on the board and create a concept map. Take 5 – 7 responses minimum.
- Use the concept map to review Hydrocarbons, covalent bonds and single, double and triple bonds.
- Use the discussion to review / introduce the terminologies: Alkane, Alkene and Alkyne to the students and their general formula.
- Emphasize how each group is different based on the type of Carbon-carbon bond present in the molecule.
- Divide students into pairs.
- Ask each pair to write down the formula for all hydrocarbons (up to 5 carbon atoms) in their notebooks for all three groups.
- Allow three minutes for this.
- Using responses from the students, write down the formulas on the board in three separate columns: Alkanes, Alkenes and Alkynes.
- Inform students that there are various ways in which we can represent these formulas. We will be learning about structural formula today for hydrocarbon representation.

Development:

Activity 1: 25 minutes

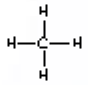
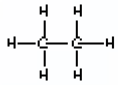
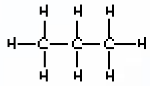
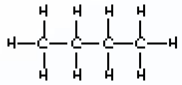
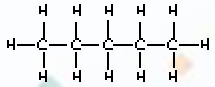
- Divide students into three groups.
- Provide each group with clay, cotton balls and popsicle sticks.
- Assign each group one category of hydrocarbons: Alkanes, Alkenes and Alkynes.
- Instruct the groups to create physical 3D models of the first five hydrocarbons for each of their assigned group.
  The popsicle sticks will represent bonds (single, double and triple), clay can be used to represent carbon and cotton balls to represent hydrogen.
- Emphasize maintaining structural integrity and properties of the hydrocarbons, including the angles.
- Allow 10 minutes for this activity.

- Ask all groups to label their models with their formula and names and display them carefully at their tables.
- Gather all students at the table representing Alkanes and ask them to do the following:
  - Observe how the models are made and what they look like in 3D. Note the bond angles and number of hydrogen atoms in each carbon.
  - Visualize how these 3D models would look on paper.
  - In their notebooks, students should draw the visual representation of the 3D model in 2D.
- Repeat the above steps turn by turn for both Alkenes and Alkynes.
- Gather all students to the center and take responses on what pattern the students have observed.
- Taking responses from students, draw the 2D structures of alkanes, alkynes and alkenes on the board in front of their formula and names.
- Point out that there are specific patterns in the structures drawn, as the number of Carbon atoms increase.
- Inform students that these 2D visualizations are known as Structural Formula for hydrocarbons.
- Emphasize how the structural formula tells us that the hydrocarbons from the groups of alkenes and alkynes cannot have one carbon atom.
- Debrief the activity and open floor to address any questions and confusions the students might still have.

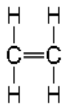
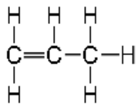
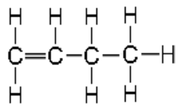
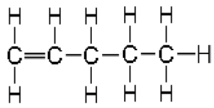
Conclusion/ Sum up/ Wrap up: 05 minutes

- Consolidate the concepts for the students, using information from the tables below:

Alkanes:

# Carbons	Name	Structure
1	methane	
2	ethane	
3	propane	
4	butane	
5	pentane	

Alkenes:

ALKENE	CARBON NUMBER	FORMULA	STRUCTURE
ETHENE	2	C_2H_4	
PROPENE	3	C_3H_6	
BUTENE	4	C_4H_8	
PENTENE	5	C_5H_{10}	

Alkynes:

Name	*Open structure*	*Condensed structure*
Ethyne	H – C ≡ C – H	CH≡CH
Propyne	H H – C ≡ C – C – H H	CH≡C–CH$_3$
Butyne	H H H – C ≡ C – C – C – H H H	CH≡C–CH$_2$–CH$_3$
Pentyne	H H H H – C ≡ C – C – C – C – H H H H	CH≡C–CH$_2$–CH$_2$–CH$_3$

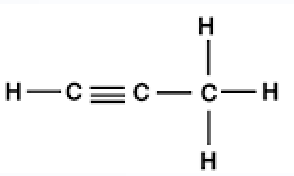
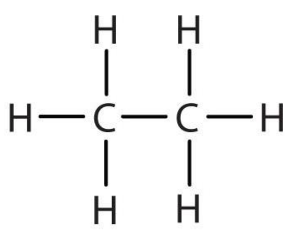
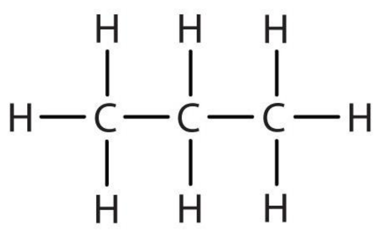
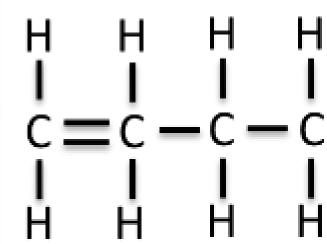
- Ask students to reflect on their learnings and make an entry in their reflection journal.
- Allow students 3 minutes to complete their entry.

Assessment:

- Textbook 10, Unit 12 – Hydrocarbons: Short Questions: 1, 2 and 13

Follow up:

- Identify the following hydrocarbons using their structural formula:

Grade 11 **STEM Plan-9**

TOPIC: Height and Distance

Duration: 40 Minutes

Students Learning Outcome:

Solve problems on height and distance (involving right triangles)

Materials:

- Textbook
- Whiteboard and Marker
- Protractor
- Straws
- String
- A4 paper
- Eraser
- Scissors
- Measuring tape
- Cello tape
- Glue

Information for Teachers

- A clinometer is a tool that is used to measure the angle of elevation, or angle from the ground, in a right triangle.
- You can use a clinometer to measure the height of tall things that you can't possibly reach to the top of, flag poles, buildings, trees.

Introduction 05 minutes

- Elicit trigonometric functions and their ratios from the students. $sin\theta, cos\theta, tan\theta\ and\ sin\theta = \frac{P}{H}, cos\theta = \frac{B}{H}, tan\theta = \frac{P}{B},$ $where\ P, B\ and\ H\ stands\ for\ perpendicular, base\ and\ hypatenous\ respectively.$
- Elicit about right triangle from the students.
- Ask the students to brainstorm on how we can find the height of a pole or a tree using trigonometric function and their ratio.
- Tell them that today we will learn to find the height of a tree or a pole with the help of a clinometer and trigonometric functions and their ratios.

Development 25 minutes

Activity 1 10 minutes

- Divide the class into groups of 4.
- Share with the class that we are going to make a clinometer.
- Share with them that a clinometer is a tool that is used to measure the angle of elevation, or angle from the ground, in a right triangle.
- Now instruct students to take the white paper sheet.
- Apply the glue to the reverse side of the protector and paste this protector to the white paper.
- Cut the paper from the edges of the protector by using scissor.
- Tie the string tightly to the eraser and secure the free end of the string to center line of the protector using cello tape.
- Secure the straw on the 180^0 line of the protector using the cello tape.

Activity 2 15 minutes

- Play the video in the class and ask the students to take notes. (link: https://youtu.be/xKaX6fbJaeU)
- Instruct the students to observe the angle of elevation of the door through the straw of the clinometer.
- Record the angle formed by string on the protector.
- Subtract the recorded angle from the right angle.
- Measure the distance between the observer's position and the door with the help of measuring tape.
- Measure the height of the observer and record it.
- Find the height of the door using the trigonometric function i.e. $tan\theta = \frac{Height\ of\ the\ door\ from\ observer\ eye}{Distance\ between\ the\ observer\ and\ door}$
- Instruct the students to add the height of the observer and the calculated height, which resulted the total height of the door.

Conclusion/ Sum up/ Wrap up 05 minutes

- Sum up the lesson by consolidating the following points:
    - we can calculate the height of a tree or a pole using trigonometric ratios and clinometer.
    - $tan\theta = \frac{Height\ of\ the\ door\ from\ observer\ eye}{Distance\ between\ the\ observer\ and\ door}$
    - A clinometer is a tool that is used to measure the angle of elevation, or angle from the ground, in a right triangle.

Assessment 05 minutes

- Assign the following task to the students and check their learning.
    - Calculate the height of a tree if its shadow is 4-meter-long and makes an angle of elevation of 45 degrees.

Follow up

Assign question from the textbook to the students for practice.

Grade: 11 **STEM Plan-10**

Law of Conservation of Momentum

Duration: 40 Minutes

Students Learning Outcome:

- Use law of conservation of momentum in simple applications between two bodies in one dimension.

Materials:

- Textbook 11
- Board and Marker
- Chart papers
- Markers
- Tennis balls
- Cardboard (to make ramps and obstacles)
- Measuring tape
- Cello tape
- Glue

Information for Teachers:

- This lesson assumes students understand the concept of momentum and conservation of momentum. Students are also aware of elastic and inelastic collisions.

Introduction: 05 minutes

- Begin the lesson by asking a volunteer student to write down the law of conservation of momentum on the board.
- Take 2 – 3 random responses and ask students to share simple examples of where momentum is applicable.
- Review the terminologies: isolated system, elastic and inelastic collisions.

Isolated System: A system on which there is no external force or change of momentum.

Elastic Collisions: A collision in which Kinetic Energy of the system is conserved.

Inelastic Collisions: A collision in which Kinetic Energy of the system is <u>not</u> conserved.

- Inform students that we will now simulate elastic and inelastic collisions.
- Clear a large space in the center of the classroom for students to move about.
- Divide students into two groups.
- Ask each group to stand in a straight line, facing each other, a comfortable distance apart.
- Provide the following instructions:
    - You are all going to be representing human billiards. Your task is to simulate a collision with their peers.
    - For the first round you will be simulating elastic collisions.
    - Walk towards the student across from you and collide.
    - Remember in elastic collision, both kinetic energy and momentum are conserved. So, observe and remember your direction and speed.
- Once the collisions are done, pause the activity and facilitate a discussion about the observed outcomes.
- Ask the following questions:
    - Did everyone continue in the same direction after the collision?
    - How did the speeds and directions compare before and after the collision?
- Relate the observations to the conservation of momentum and the characteristics of elastic collisions.
- Now provide the following instructions:
    - For the second round, you will be simulating inelastic collisions.
    - Walk towards the student across from you and collide, but this time, link arms after the collision.
- Pause the activity again and facilitate a discussion on the outcomes of the inelastic collision.
- Ask the following questions:
    - What happened to the direction and speed of the 'billiard balls' after the collision?
    - How did this compare to the elastic collision?
- Conclude the activity by summarizing the key observations and linking them back to the law of conservation of momentum.

- Reinforce the idea that the outcomes observed in the activity align with the fundamental principles of momentum conservation.

Development:

Activity 1: 20 minutes

- Divide students into groups of 4 – 5 students.
- Provide each group with two tennis balls, cardboard, measuring tape and a stopwatch.
- Instruct the groups to design an investigation, using the materials provided to verify conservation of momentum for elastic and inelastic collisions.
- Allow 5 minutes for brainstorming and finalizing the methodology for the experiment.
- Circulate amongst the students and facilitate discussion where needed.

- Once the design is complete, allow groups a further 10 minutes to carry out the investigation and verify the law of conservation of momentum.
- As the experiments are complete, gather the students to the center and take 2 – 3 responses on what the students learnt and what they found challenging.

Activity 2: 10 minutes

- Students continue in the same groups.
- Provide each group with chart papers and markers.
- Instruct students to create a poster presentation on their findings, including the experiment design.
- Allow 10 minutes for the activity.
- Put up the chart papers around the room once they are completed.

Conclusion/ Sum up/ Wrap up: 05 minutes

- Distribute 4 – 5 sticky notes to each student.

- Conduct a gallery walk for the posters.
- Ask all students to leave feedback for each group.
- Use the feedback and the posters to recap the concept of law of conservation of momentum and its application in simple one-dimensional collisions.

Assessment:

- Task: Use your experimental design and results to discuss how law of conservation of momentum is applicable in the following scenarios:
    - Car crashing with a wall
    - Collision of two moving balls
    - Karate chops to break a pile of bricks.
- Textbook 11, Page 75, Questions 3.6 – 3.8

Follow up:

Textbook 11, Page 73, Questions 3.10, 3.11

Grade: 11 **STEM Plan-11**

Rates of Reaction

Duration: 40 Minutes

Students Learning Outcome:

- Relate rate of reaction and surface area.

Materials:

- Textbook 11
- Board and Marker
- Glasses of water
- Whole tablets of any easily available antacid
- Crushed tablets of the same antacid
- Stopwatch

Information for Teachers:

- The rate of a reaction is the change in the concentration of a reactant or a product divided by the time taken for the reaction.
- The rate of a reaction is affected by the surface area of the reactants.
- The larger the surface area, the more contact the reactants have with each other, and the faster the reaction will proceed. This is because a larger surface area means that there are more active sites for the reaction to occur.

Introduction: 05 minutes

- Begin the lesson by posing the following question to the students:
- Why do you think some reactions happen quickly, while others take longer?
- Allow students to respond and give explanations.
- Review the basic concepts of chemical reactions, emphasizing the idea that reactions involve the breaking and forming of bonds between atoms and molecules.
- Provide a real-world context for understanding the relevance of reaction rates. For example, discuss the impact of fast and slow reactions in everyday life, like the fizzing of an antacid tablet or the rusting of metal.

- Remind students of the factors that can influence the rate of a chemical reaction, such as concentration, temperature, and surface area.

Development:

Activity 1: **15 minutes**

- Divide students into small groups of 3 – 4 students each.
- Inform students that antacids are used to neutralize stomach acid.
- Write down the following question on the board:
  "How might the rate at which an antacid tablet reacts influence its effectiveness in providing relief?"
- Briefly explain the scenario and the activity to the students.
- Ask each group to predict which antacid tablet (whole or crushed) will react faster and why. Encourage them to think about the concept of surface area and its potential influence on reaction rates.
- Allow 3 minutes for this discussion.
- Facilitate a class discussion based on predictions. Encourage students to share their thoughts and reasoning.
- Provide each group with two glasses of water, one whole tablet of antacid and one crushed tablet of antacid and a stopwatch.
- Instruct them to drop both tablets into separate containers of water simultaneously and start the stopwatch.
- Note down the times for when both antacids are completely dissolved in water.
- Ak students to discuss their observations within their groups and come up with an explanation.
- Allow 5 minutes for this activity.
- Gather feedback from all the groups and discuss the findings.
- Guide the discussion towards the concept of surface area and its role in influencing the rate of chemical reactions.

Activity 2: **15 minutes**

- The students continue in the same groups.
- Inform students that we will now be observing a different chemical reaction.
- Provide each group with two pieces of chalk, some vinegar, a container and a stopwatch.

- Tell students that when chalk reacts with vinegar, carbon dioxide is produced and released in the form of bubbles.

- Instruct each group to predict and then investigate how the surface area of the chalk effects its rate of reaction with vinegar. They should use a stopwatch to record time on how fast both reactions take place.
- Take feedback from students on how well their predictions matched the outcome of the investigation.
- Facilitate a brief class discussion on the observations and results.
- Conclude the activity by summarizing key findings and reinforcing the connection between surface area and reaction rates.

Conclusion/ Sum up/ Wrap up: 05 minutes

- Ask the students to write down a One Minute Essay in their notebooks on the learnings of the lesson.
- Allow 1 minute for this.
- Ask 2 – 3 students to share their reflections with the rest of the students.
- Consolidate the concepts for the students, using the written responses.

Assessment:

- Task: Research real-world applications where the relationship between surface area and reaction rate is crucial (e.g., pharmaceuticals, industrial processes). Create a poster presentation of your findings.

Follow up:

- Task: Design an investigation to find how rate of reaction is affected by any one of the following factors:
    - Nature and concentration of reactants
    - Temperature
    - Catalyst

Grade 12 **STEM Plan-12**

Topic: Input/Output Functions

Duration: 40 Minutes

Students Learning Outcome:

- Develop the currency conversion program in C language.

Materials:

- Computer Lab with Laptop/Computer with IDE installed
- White Board
- Board Marker/Chalk
- Multimedia
- Grade 12 Computer Textbook

Information for Teachers

- A currency converter is a program that allows users to convert the value of one currency into another. It is a tool commonly used for calculating the equivalent amount of money in different currencies based on current exchange rates. For more information visit the link https://onecompiler.com/posts/3texv89bc/c-language-program-to-convert-dollars-torupees
- Currency converter helps international travelers, study the price of foreign goods and services, helping visitors find out how much their money is worth while travelling overseas.
- Give demonstration on currency converter in the following link using multimedia/projector.
  https://www.xe.com/currencyconverter/

Introduction 5 minutes

- Pose a question:" You are planning to go to USA and have currency in Pakistani rupees, you want to identify how many dollars your amount will be after conversion.
- Take random responses on how we can do that.
- Guide the discussion to highlight the key components of currency converter that are:
  - Input
  - Exchange rate
  - Conversion process
  - Output
- Map the key components to their related c-functions. scanf() is used for input and printf() is used for output.

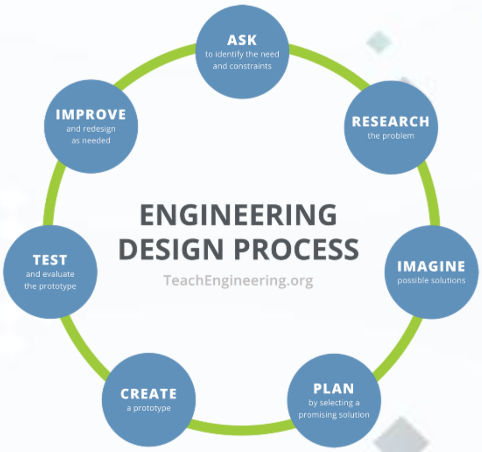
Development

Activity 1 — 15 minutes

- Divide the class in 6 groups.
- Assign the following tasks to each group

Group 1 and 4	Develop a program to convert PKR to US Dollars.
Group 2 and 5	Develop a program to convert PKR to UK pounds.
Group 3 and 6	Develop a program to convert PKR to SAR (Saudi Riyal)

- Paste the engineering design process chart on the board.



- Instruct the students to follow the engineering design process.
- Give each group 5 minutes to discuss the logic of the program. One member will write logic on a paper
- Give 10 minutes to each group to write the program in C-language on computer and save it with their group number on the computer.
- Instruct each group to compile, debug and execute their program. Ask them to test the currency converter program by giving sample data.

Activity 2 — 08 minutes

- Form two Jigsaw groups.
- The first jigsaw group will comprise of 1 member from each group 1, 2, and 3 while the second jigsaw group will comprise of 1 member from each group 4, 5, and 6.
- Instruct the Jigsaw Groups to integrate and launch the currency converter using the programs developed by Groups 1, 2, 3, 4, 5, and 6.
- Allow the Jigsaw Groups to discuss and share their group's currency conversion logic and programming strategies and finalize their programs.

Activity 3 — 05 minutes

- Now call the jigsaw group one by one and ask them to present their code, explaining the logic and functionalities.
- Instruct the whole class to ask questions and provide constructive feedback to finalize the currency converter.
- Test the currency converter program by providing sample data for each currency conversion.
- Verify that the program accurately converts the specified currencies (PKR to USD, UK Pounds and SAR).
- Take pictorial evidence, make a chart of the program and display it on the wall.

Conclusion/ Sum up/ Wrap up 02 minutes

- Sum up the lesson by consolidating the flowchart and code of the Currency Converter.

Assessment 05 minutes

- Ask the students to design a flowchart of a Length Unit Converter (Kilometer to meter, and meter to centimeter)

Follow up

Complete the flowchart of the Length Unit Converter (Kilometer to meter, and meter to centimeter) from home.

Grade: 12 **STEM Plan-13**

Biotechnology

Duration: 40 Minutes

Students Learning Outcome:

- Compare and contrast the advantages of vertical food farms with general agricultural practices prevalent in Pakistan.

Materials:

- Textbook 12
- Board and Marker
- Multimedia with audio
- Cardboard boxes
- Plastic Straws
- Colored Papers
- Colored markers
- Glue
- Chart Papers
- Sticky Notes

Information for Teachers:

- The lesson aims to engage students in a comparative analysis of the advantages of vertical food farms and traditional agricultural practices in Pakistan by using a debate and hands-on STEM activity, assessment, and follow-up tasks using low-cost materials.
- A basic understanding of the prevalent agricultural practices in Pakistan, including common crops, farming techniques, and challenges faced by traditional farmers.
- During the lesson, encourage students to use evidence and critical thinking in their arguments, fostering a constructive and informative debate.
- Continuously circulate among groups to offer guidance and support while ensuring a safe and collaborative learning environment.

- Emphasize the importance of sustainability and consider discussing the broader implications of adopting innovative farming practices.
- **Vertical farming** is a modern agricultural technique where crops are cultivated in vertically stacked layers or inclined surfaces, often within controlled environments like buildings or skyscrapers. This method utilizes innovative technologies such as hydroponics, aeroponics, and controlled environment agriculture (CEA) to optimize resource efficiency, space utilization, and crop yields.
- **Benefits** of vertical farming in Pakistan include Space Efficiency, Year-round Production, Resource Optimization, Reduced Dependency on Weather Conditions and Potential for Localized Production.
- **Traditional farming** in Pakistan often involves conventional methods practiced over generations, with crops being cultivated directly in the soil using conventional irrigation techniques.
- Key features of traditional farming include Land Dependence, Seasonal Dependence, Natural Irrigation, Crop Diversity, Familiarity and Tradition.

Introduction: 15 minutes

- Begin the lesson by asking how many of the students have visited agricultural farms or experienced working on the farms. Try and get responses from students who have visited vertical farms.
- Ask 2 – 3 students to share their experiences and challenges that they are aware of.
- Show the following video to the students:
  https://www.youtube.com/watch?v=QzDHzAgzYiY
- Use the discussion, to emphasize on the key methods and challenges of traditional farming and vertical farming in Pakistan.
- Divide the students into two groups.
- Assign one group to represent proponents of traditional agriculture, and the other group to represent advocates of vertical food farms.
- Give each group time to brainstorm and prepare arguments highlighting the advantages of their assigned agricultural method.
- Allow 5 minutes for brainstorming.
- Each group assigns one speaker to present their findings.

- Conduct a class debate on the comparison of traditional and vertical farming methodologies.
- Encourage students to use critical thinking and evidence-based arguments.
- Summarize the activity with key points from both groups.

Development:

Activity 1: 20 minutes

- Inform students that the objective of today's lesson is to understand and build a DIY Vertical Farm Model.
- Divide students into small groups of 4 – 5 students each.
- Provide each group with the materials listed (Cardboard boxes, Straws, Colored Papers, Colored markers, Glue, Chart Papers)
- Assign each group with one of the following factors: Space efficiency, Year-round production, Resource optimization, Reduced dependency on weather conditions and Potential for localized production.
- Instruct each group to design and build their vertical farm model. Their model should be used to explain the factor they are assigned. They can use chart papers to produce relevant poster presentations.
- Allow 10 minutes for this activity.
- Once the models and their presentation are complete, assign one speaker from each group.
- The speaker will remain with the model and poster to answer any questions and queries from visiting students. The rest of the group members will move around the room to visit and observe models by other groups.
- Encourage students to provide positive criticism and feedback to their class fellows.
- Allow students 5 minutes for this.
- Ask students to return and share their findings and feedback with the speaker of their groups.
- Debrief the activity and open floor to address any questions and confusions the students might still have.

Conclusion/ Sum up/ Wrap up: 05 minutes

- Distribute sticky notes to each student.
- On the board write down the headings: *Traditional Farming* and *Vertical Farming*.
- Allow students three minutes to write down their takeaways from the lesson on different sticky notes and place them under the relevant heading.
- Consolidate the learnings of the lesson using the points on sticky notes.
- Connect the discussion to the broader context of sustainable food production in Pakistan.

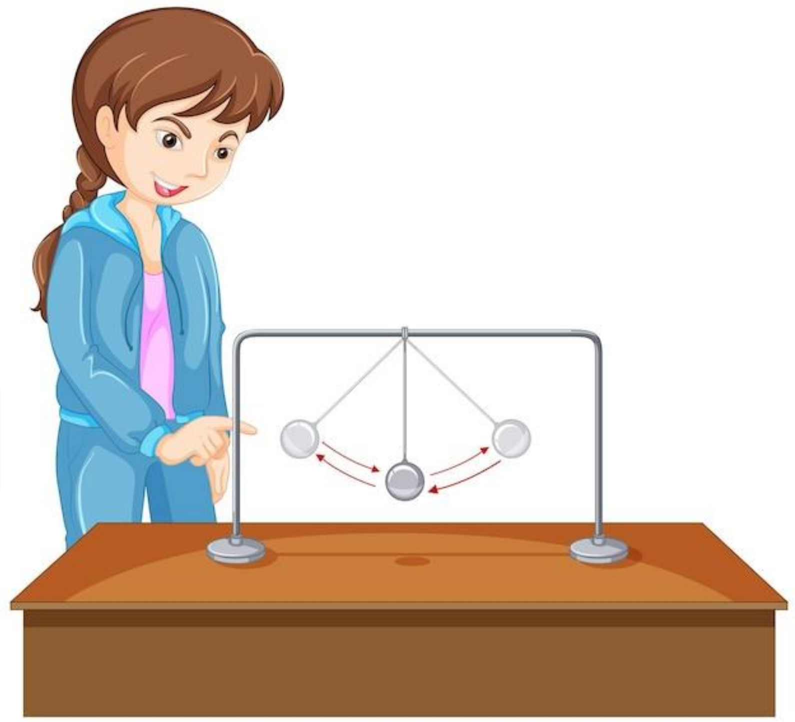
Assessment:

- Task: research a specific case study or real-world example of either traditional agriculture or vertical farming. Write a short reflection on how the chosen method is implemented, its impact on food production, and any challenges faced.

Follow up:

Task: Explore and research on one specific crop that could be well-suited for vertical farming in the context of Pakistan. Create a poster of your findings.

STEM



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