

# Fostering Innovations and Nurturing Diversity in STEM Education

- FIND STEM -

2024-1-EL01-KA210-SCH-000249907

**Continuous Professional Development Curriculum  
and Teacher  
Training**

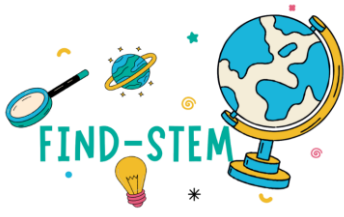
**Module 3: Methodological Framework for Hands-on  
Learning**



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## Description

Hands-on learning plays a crucial role in making STEM education more interactive and relevant. This module explores practical experiments, real-world problem-solving, and student-led investigations that encourage exploration and independent thinking.

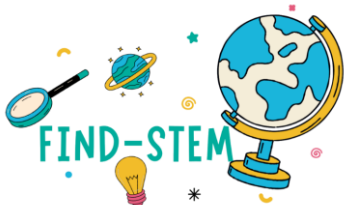
## Key Topics

- Effective hands-on activities and experiments in STEM education
- Using real-world problems to enhance learning relevance
- Techniques for facilitating pupil-led investigations

## General Learning Outcomes

Upon the completion of the module educators will:

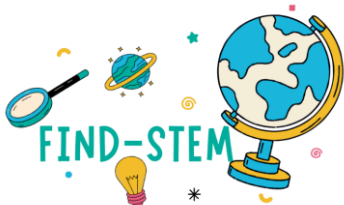
- Plan and execute hands-on STEM activities and experiments that make abstract concepts tangible and engaging.
- Use real-world problems and case studies to enhance the relevance and practical application of STEM subjects.
- Facilitate pupil-led investigations, encouraging student autonomy, inquiry, and collaborative learning.
- Assess the effectiveness of active learning techniques in improving student engagement and comprehension.
- The specific skills and knowledge learners will acquire



## Activities

<b>Activity 1</b>	
<b>Building Simple Machines</b>	
<b>Specific Learning Outcomes</b>	Understand the basic principles of simple machines. Design and build a simple machine prototype.
<b>Teaching Methods and Approaches</b>	<ul style="list-style-type: none"> <li>• Project-Based Learning</li> <li>• Hands-on Experimentation</li> </ul>
<b>Duration</b>	20 min
<b>Delivery format</b>	Face to face
<b>Activity description</b>	
<p>This session helps teachers experience how hands-on learning makes STEM concepts accessible through physical construction and problem-solving.</p> <p><b>Session Flow:</b></p> <ol style="list-style-type: none"> <li>1. <b>Concept Introduction:</b> <p><b>Introduction to Hands-On Learning:</b> Hands-on learning is an experiential approach to STEM education that engages students through direct, physical interaction with materials and real-world scenarios. It enhances problem-solving skills, critical thinking, and collaboration. This module will explore strategies for incorporating hands-on learning into STEM education, focusing on real-world problem-solving, inquiry-based learning, and effective hands-on activities.</p> </li> <li>2. <b>Group Challenge:</b> <ul style="list-style-type: none"> <li>• Divide participants into small groups.</li> <li>• Challenge: Design and build a simple machine to perform a practical task (e.g., lift a small object 10 cm off the table).</li> <li>• Provide materials: cardboard, rubber bands, rulers, string, glue, plastic wheels, etc.</li> <li>• Instruct groups to document:               <ul style="list-style-type: none"> <li>○ Type of machine chosen</li> <li>○ Problem being solved</li> <li>○ Construction process and challenges faced</li> </ul> </li> </ul> </li> <li>3. <b>Presentations:</b> <ul style="list-style-type: none"> <li>• Each group presents their machine and explains:               <ul style="list-style-type: none"> <li>○ How it works</li> <li>○ Scientific principles involved</li> <li>○ Improvements they would make</li> </ul> </li> </ul> </li> <li>4. <b>Reflection:</b> <ul style="list-style-type: none"> <li>• Ask: “How did physically building the machine change your understanding?”</li> <li>• “How could this type of activity benefit diverse learners?”</li> </ul> </li> </ol> <p><b>Expected Outcomes:</b></p> <ul style="list-style-type: none"> <li>• Participants recognise the power of tangible learning to reinforce abstract scientific concepts.</li> <li>• Teachers gain experience facilitating group-based design tasks.</li> </ul>	

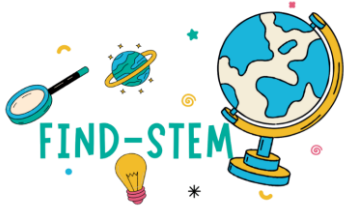




<b>Assessment Methods</b>	<ul style="list-style-type: none"> <li>• Group presentations</li> <li>• Peer feedback on design effectiveness</li> </ul>
<b>Resources</b>	<ul style="list-style-type: none"> <li>• NASA STEM Learning: <a href="#">Hands-on Science Experiments for Students</a></li> </ul>

<b>Activity 2</b>	
<b>Real-problem solving with data</b>	
<b>Specific Learning Outcomes</b>	Apply data analysis to address real-world STEM challenges. Develop critical thinking skills through data interpretation.
<b>Teaching Methods and Approaches</b>	<ul style="list-style-type: none"> <li>• Problem-Based Learning</li> <li>• Data Analysis</li> </ul>
<b>Duration</b>	20 min
<b>Delivery format</b>	Face to face/online
<b>Activity description</b>	
<p>This session explores how real-world data can be used to drive STEM learning and encourage students to become critical thinkers and problem solvers.</p> <p><b>Session Flow:</b></p> <ol style="list-style-type: none"> <li><b>1. Introduction to Real-World Problem Solving in STEM:</b>            Real-world problem-solving in STEM education involves applying theoretical knowledge to practical, everyday challenges. This method enhances students' ability to think critically, innovate, and develop solutions that have tangible impacts.</li> <li><b>2. Hands-On Analysis:</b> <ul style="list-style-type: none"> <li>• In pairs or small groups, participants investigate local environmental issues (e.g., water pollution, waste management, renewable energy) and develop solutions, such as designing a water filtration system using household materials or creating models for sustainable cities.</li> </ul> </li> </ol> <p><b>Steps:</b></p> <ol style="list-style-type: none"> <li>1. Identify a local environmental challenge.</li> <li>2. Research current solutions and their limitations.</li> <li>3. Design and prototype an innovative solution using STEM principles.</li> </ol> <ol style="list-style-type: none"> <li><b>3. Presentations and Peer Feedback:</b> <ul style="list-style-type: none"> <li>• Each group shares findings and prototypes.</li> <li>• Peers offer feedback on clarity, insight, and relevance.</li> <li>•</li> </ul> </li> <li><b>4. Reflection and Wrap-Up:</b> <ul style="list-style-type: none"> <li>• Ask: “What is the impact and feasibility of your solutions?”</li> <li>• “How might your students engage with this process?”</li> </ul> </li> </ol> <p><b>Expected Outcomes:</b></p> <ul style="list-style-type: none"> <li>• Teachers learn how to integrate real-world problems into engaging classroom activities.</li> </ul>	





	<ul style="list-style-type: none"> <li>Participants reflect on the importance of evidence-based reasoning in STEM.</li> </ul>
<b>Assessment Methods</b>	<ul style="list-style-type: none"> <li>Data analysis presentations</li> <li>Group discussion on data interpretation</li> </ul>
<b>Resources</b>	<ul style="list-style-type: none"> <li>TED-Ed: <a href="#">Hands-on Learning</a></li> <li>Code.org: <a href="#">Data Visualisation Tutorials</a></li> </ul>

<b>Activity 3</b>	
<b>Student-Led Investigations in STEM</b>	
<b>Specific Learning Outcomes</b>	<ul style="list-style-type: none"> <li>Encourage independent exploration through student-driven projects.</li> <li>Develop inquiry-based teaching techniques.</li> </ul>
<b>Teaching Methods and Approaches</b>	<ul style="list-style-type: none"> <li>Inquiry-Based Learning</li> <li>Student Autonomy</li> </ul>
<b>Duration</b>	20 min
<b>Delivery format</b>	Face to face

#### Activity description

This session trains teachers to facilitate student-led investigations that build scientific thinking, creativity, and problem-solving.

#### Session Flow:

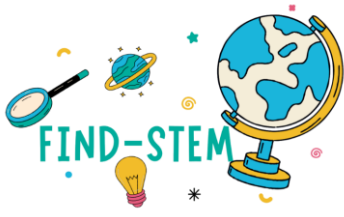
##### 1. Introduction to Inquiry-Based Learning:

Inquiry-based learning (IBL) is a student-centred approach that encourages exploration, questioning, and discovery. It fosters curiosity and deeper understanding by allowing students to investigate STEM concepts through guided inquiry and experimentation.

- Facilitator presents the phases of inquiry: Ask → Investigate → Analyse → Explain.
- Ask: “What are the benefits and risks of letting students lead investigations?”

#### Implementation Strategies:

- Guided Inquiry:** The teacher provides a question or problem, and students explore possible solutions.
- Structured Inquiry:** Students follow teacher-designed procedures to discover answers.
- Open Inquiry:** Students formulate their own questions, develop methods, and conduct investigations.
- Problem-Based Inquiry:** Students work collaboratively on real-world STEM challenges with minimal teacher direction.



**2. Scenario Planning :**

- Groups select a classroom-relevant scenario (e.g., "How much waste does our school produce in a week?").
- Design a student investigation:
  - Guiding question
  - Variables and data collection methods
  - Role of teacher (as coach)

**3. Investigation Blueprint:**

- Groups outline timelines, student responsibilities, tools needed, and assessment strategies.
- Include a plan for how students will present their findings.

**4. Presentations and Peer Critique:**

- Each group shares their plan.
- Feedback focuses on feasibility, engagement, and inquiry quality.

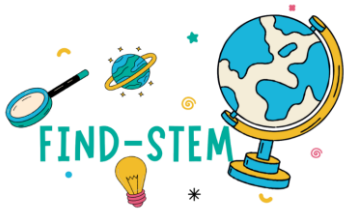
**5. Wrap-Up Reflection:**

- Ask: "How can inquiry shift student motivation?"
- "What support do students need to take charge of their learning?"

**Expected Outcomes:**

- Participants gain confidence in designing student-led inquiry experiences.
- Teachers explore scaffolding strategies to support autonomy.

<b>Assessment Methods</b>	<ul style="list-style-type: none"> <li>● Group presentation of investigation plans</li> <li>● Peer feedback on fostering student autonomy</li> </ul>
<b>Resources</b>	<ul style="list-style-type: none"> <li>● Hmelo-Silver, C. E. (2004). Problem-Based Learning: <a href="https://doi.org/10.1023/B:EDPR.0000034022.16470.f3">https://doi.org/10.1023/B:EDPR.0000034022.16470.f3</a></li> </ul>



## Resources

- TED-Ed: "How Engineering Changed the World" ([YouTube](#))
- NASA STEM Learning: "Hands-on Science Experiments for Students" ([NASA STEM](#))
- Code.org tutorials on integrating programming into STEM ([Code.org](#))

## Summary of key takeaways

- Hands-on learning engages students through active participation and practical application of concepts.
- Real-world problem-solving encourages critical thinking and data literacy.
- Student-led investigations foster independence and inquiry.
- Collaborative challenges build teamwork and engineering skills.

## References:

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Hmelo-Silver, C. E. (2004). *Problem-Based Learning: What and How Do Students Learn?* *Educational Psychology Review*, 16(3), 235–266.  
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