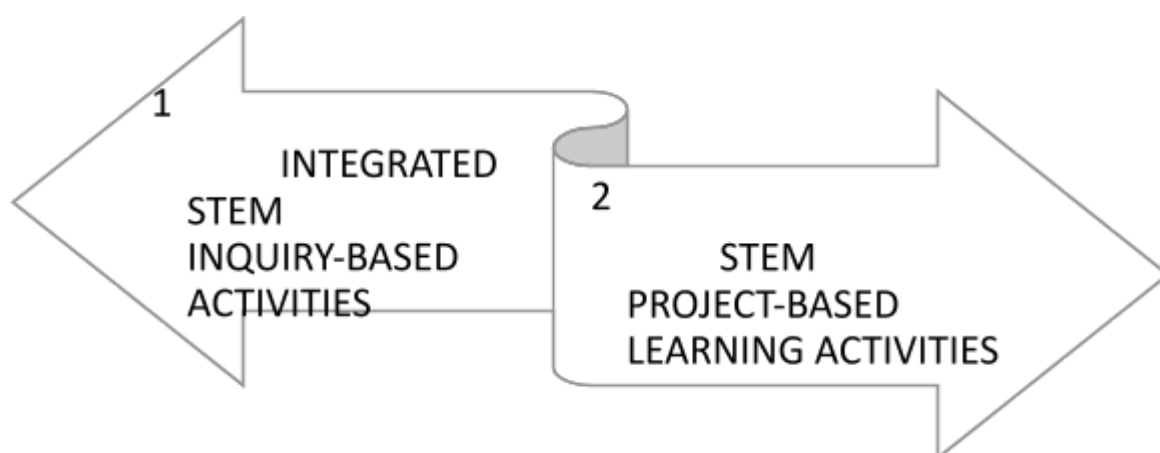


STEM INQUIRY-BASED LEARNING MODULE OF MATRICULATION PROGRAMME MINISTRY OF EDUCATION

INQUIRY-BASED SCIENCE EDUCATION (IBSE): CHEMISTRY



Penulis Modul & Fasilitator

1. Dr. Nurul Fatni binti Abdussyukur (Bahagian Matrikulasi KPM - Fasilitator)
2. Pn. Siti Warda binti Selamat (Bahagian Matrikulasi KPM)
3. Pn. Chia Chew Peng (Kolej Matrikulasi Selangor)
4. Dr. Azraai bin Othman (Kolej Matrikulasi Kelantan)
5. En. Byron MC Michael Kadum (Kolej Matrikulasi Labuan)

CHAPTER 1: INTRODUCTION

- 1.1 Background of the module
- 1.2 Aims and objectives of the module
- 1.3 Theoretical framework of the module
 - a. STEM

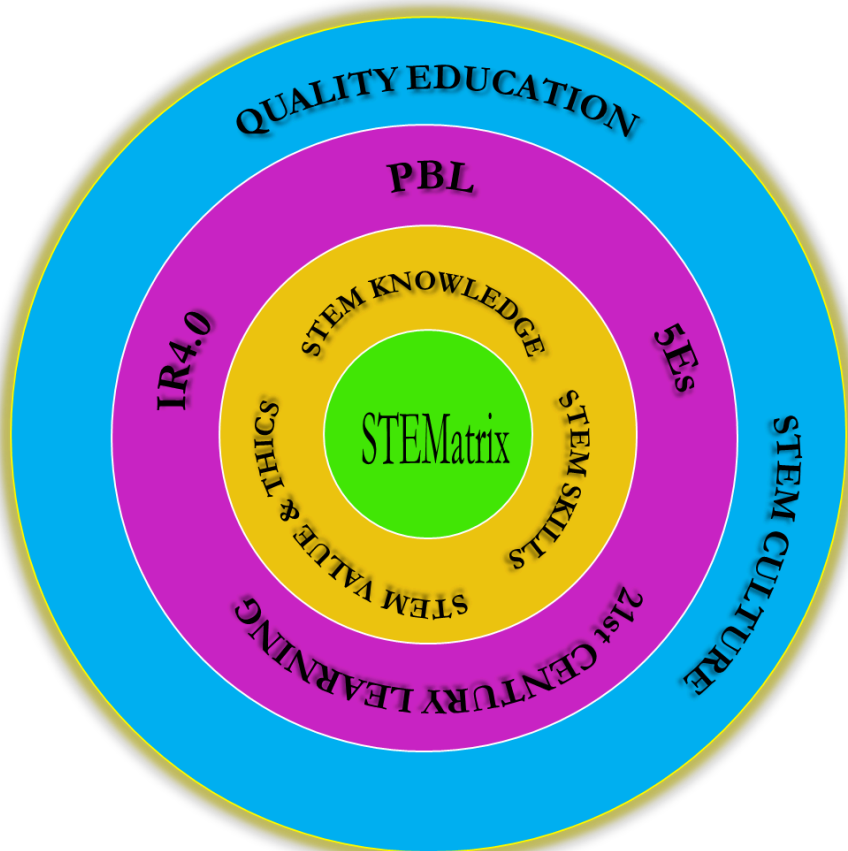


- b. Inquiry-based learning
- c. Project-Based learning

Task: Dr. Fatni

CHAPTER 2: TEACHING AND LEARNING ACTIVITIES

- 2.1 **Teaching methods and strategies:**
IBL, Problem-based learning, Project-based learning (task Dr. Fatni)
- 2.2 **Conceptual Framework:**
(Task: To all module writers, please generate each module's conceptual framework as below)



- 2.3 **Teaching and learning activities:** (Task: Dr. Fatni)
- Integrated STEM IBL Activities
 - STEM Project-Based Learning Activities

2.4 Integrated STEM IBL Activities (Task: to all module writers)

- a. Theme (4)
- b. Lesson plan (4)

2.5 STEM Project-Based Learning Activities (Task: to all module writers)

- a. Theme (4)
- b. Lesson plan (4)

CHAPTER 3: AUTHENTIC ASSESSMENT

3.1 Introduction

- a. Definition of Authentic Assessment
- b. Assessment for Learning
- c. Project-based Outcomes

3.2 Assessment for learning: Integrated STEM IBL Activities

- a. Performance-based assessment (PBA): 100%
- b. 21st -century skills (rubric)
- c. Scientific skills (rubric)
- d. Oral presentation (rubric)

3.3 Project based Outcomes: STEM Project-Based Learning Activities

- a. Proposal (rubric)
- b. Product (rubric)
- c. Presentation (rubric)
- d. Report (rubric)

3.4 Assessment Guideline

- a. Assessment for learning: Integrated STEM IBL Activities
- b. Project based Outcomes: STEM Project-Based Learning Activities

Note: This part will be discussed during the third and fourth series of the workshop (7-18 May 2022)

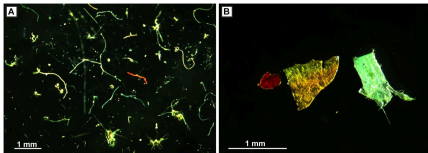
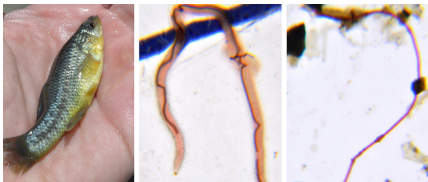



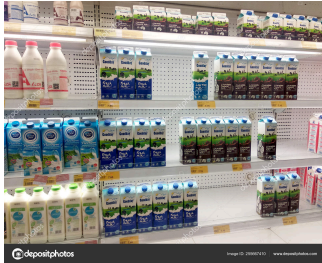

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TEMPLATE: 2.4 AND 2.5

INTEGRATED STEM IBL LESSONS

2.4 INTEGRATED STEM-IBL LESSON ACTIVITIES

a. Theme (4)

THEME	1: Water & Pollution	2: GREEN ENERGY	3: Environmental	4: Food
PROBLEMS	Microplastic Pollution	Efficient energy consumption	Water Pipe Cogging	Pasteurised Food
SCENARIOS	<p>The buildup of microplastics in the marine environment poses a significant threat to marine life and hence to human existence as they have infiltrated the food chain (Yang et al., 2021).</p> <div style="display: flex; justify-content: space-around;">  </div> <p>Images of microplastics (Kane & Clare, 2019).</p> <div style="display: flex; justify-content: space-around;">  </div> <p>Images of microplastics found in fish guts (Talley et al., 2019).</p> <p>In 2022, microscopic particles of plastic debris resulting from industrial waste disposal were discovered for the first time in the lungs and bloodstream of living humans (Jenner et al., 2022;</p>	 <p>A fuel cell is an electrochemical device that converts the energy in chemicals into electricity. A battery is also an electrochemical device that converts chemical energy into electricity, but there is a limited supply of chemicals in a battery, so eventually the chemicals are all consumed and the battery no longer supplies electricity. In a fuel cell, however, the chemicals can be replenished, so the fuel cell can continue to produce electricity</p> <p>Hydrogen gas has the potential for use as a clean fuel in reaction with oxygen. The relevant reaction is</p> $2\text{H}_{2(g)} + \text{O}_{2(g)} \rightarrow 2\text{H}_2\text{O}_{(l)}$	  <p>Drains and pipes are only designed for water and human waste, so they don't do too well when other objects or materials make their way into the system.</p>	  <p>Pasteurisation is a mild heat treatment in which food is heated to below 100 °C whereas ultra-high temperature pasteurisation is a technology to sterilise food at temperature above 135 °C for 2 to 5 seconds.</p>

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	<p>Leslie et al., 2022). This is alarming as microplastics can potentially trigger the growth of cancerous cells and DNA-related diseases (Campanale et al., 2020).</p> <p>Human consumption drives the production of these artificial polymers up to 2000 million tonnes by 2050 (Coyle et al., 2020).</p> <p>As a responsible citizen, how would you solve this problem?</p>	<p>By using suitable data/article/report, shows the fuel cell method (using hydrogen) is more efficient than the combustion method (using fossil fuel) for vehicles.</p>	<p>One of the biggest threats to drains and pipes, especially in the kitchen, is “FOG”</p> <p>FOG refers specifically to fats, oils and grease entering the sewer system when poured down drains in homes, apartments, restaurants, industry and public facilities.</p> <p>All the fats, oils and grease are disposed of improperly during food preparation and kitchen clean-up.</p> <p>When poured down the drain (sink or floor). FOG can build up, blocking sanitary sewer lines when solidified. This accumulation not only reduces the capacity of the wastewater collection system, but it also alters its effectiveness.</p> <p>What is the main material clogging the pipe in the kitchen? What is the effect on the environment when the sewer system is blocked? How to solve the problem?</p>	<p>Both pasteurisation methods are used to minimise health hazards from pathogenic microorganisms in low-acid foods and to extend the shelf-life of acidic foods such as milk and <u>fruit juices</u> for several days or weeks by destruction of spoilage microorganisms and/or <u>enzyme inactivation</u>.</p> <p>Today, pasteurization is an important food processing process in the food industry to ensure food preservation and food safety.</p> <p>In supermarkets, we can see some milk are kept in the refrigerator and some are kept unrefrigerated for a certain period of time.</p> <p>Why must some milk be kept refrigerated while some could be kept at room conditons? What is the effect of different pasteurisation techniques toward the shelf life of a milk ?</p>
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SYLLABUS LINKS	SK025 Benzene & Its Derivatives Polymers	SK025 1.0 Thermochemistry 3.1 (e) Explain hydrogen – oxygen fuel cell.	SK015 4. Chemical Bonding 4.4 Intermolecular force 5.0 State of matter 5.2 Liquid 2.3 Solid	SK025 1. Rate of reaction
STEM LINKS	Science: Chemistry & Biology Technology: ICT & Multimedia Engineering: Engineering Design Process Mathematics: Calculation involved in proposing a solution. Data management & representation (i.e., graphs and tables).	Science: Chemistry Technology: Green technology Engineering: Engineering Design Process Mathematics: Amount of voltage produce, Energy release	Science: Chemistry Technology: Solution of Pipe Clogging Engineering: Engineering design Mathematics: f material to cause pipe clogging.	Science: Chemistry, Food Safety and Quality Assurance Technology: Food technology Engineering: Engineering Design Process Mathematics: Rate of bacterial activity in milk.
BLOOM'S TAXONOMY	Level: C3 (Application), C4 (Analysis), and C5 (Evaluation).	C3 Analysing C4 Applying	Level: C3 (Application), C4 (Analysis), and C5 (Evaluation).	Level: C3 (Application), C4 (Analysis), and C5 (Evaluation).
EXPECTED FINDINGS	Students are expected to propose a solution that can help to mitigate the problem of microplastic pollution.	Solution : Fuel cells are more efficient than combustion engines as they operate at a higher thermodynamic efficiency. Combustion engines must first convert their fuel into heat, then into mechanical energy, and finally into electricity	Students are expected to propose the <ul style="list-style-type: none"> list out the cause of pipe clogging list the effect of reused oil to the environment Propose the solution to manage the reused cooking oil to reduce the environmental problem. 	Students are expected to <ul style="list-style-type: none"> compare the quality of pasteurised milk stored in the refrigerator and kept at room conditions using the methylene blue. compare the quality of pasteurised and UHT milks stored at room conditions using methylene blue. determine the effect of temperature on the rate of bacteria growth and the shelf

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				<p>life of a pasteurised milk.</p> <ul style="list-style-type: none"> • determine the best milk pasteurisation method for room conditions storing. • able to transfer the pasteurisation methods and storage conditions knowledge into fruit juice context.
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Theme 2: GREEN ENERGY

Title of Integrated STEM Activity: Efficient energy consumption

<p>Syllabus link: 3.1 (e) Explain hydrogen – oxygen fuel cell</p>	<p>Topic: FUEL CELL</p>	<p>STEM links: Science: Chemistry Technology: Green technology Engineering: Engineering Design Process Mathematics: Calculation involved in proposing a solution. Data management & representation (i.e., graphs and tables).</p>	<p>Bloom's Taxonomy: C3 Applying C4 Analysing</p>	<p>Estimated Duration (hours): 2 hours</p>
	<p>Teaching methods and techniques:</p> <ul style="list-style-type: none"> • Problem-based learning • Inquiry-based instruction • Blended learning 		<p>Tools and Materials:</p>	<p>Assessment for learning (AFL)</p>

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		<p>Tools: Whiteboard, Telegram/WhatsApp, Google Meet/Microsoft Teams, PowerPoint, YouTube, Google Scholar, Google Slides, Google Docs, and Google search engine.</p> <p>Materials: YouTube video (Hydrogen Fuel Cell technologies & green technology) and SK025 electrochemistry notes.</p>	
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□ **Aim(s)**

At the end of the lesson, students should be able to:

Learning outcomes	<ul style="list-style-type: none"> i. Students will have a comprehensive discussion in solving the problems given. ii. Students will be able to explore and access the information as much as they can to come out with their own tentative proposal. iii. Students will be able to engage in determining whether the fuel cell method (using hydrogen) is more efficient than combustion method (using petrol/diesel) using appropriate data / supported articles / reports.
STEM Competency	<ul style="list-style-type: none"> i. Problem-Solving Competencies (Adaptability and flexibility) ii. Interpersonal Competencies (Awareness of Global Issues)
21 st -century skills	<ul style="list-style-type: none"> i. Critical Thinking ii. Problem Solving iii. Numeracy Skills
Scientific skills	<ul style="list-style-type: none"> i. Measuring & using numbers ii. Making inferences

□ **Preparation notes**

Materials/ Apparatus	Quantity
<ul style="list-style-type: none"> ● Laptop/tablet with internet access ● SK025 Electrochemistry notes 	At least 1 for each group

NO.	STEP AND DURATION	TASK	TEACHER'S ROLE	STUDENTS' ROLE	TEACHING AIDS/ MEDIA/ SOURCES	QUESTIONS BY TEACHERS	LEARNING SKILLS	AFL
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**STEMATRICULATION INQUIRY-BASED LEARNING
MODULE (STEMATRIC-IBL MODULE) _DRAFT V.1**

	INTRODUCTION (5 MIN)	Explain briefly on learning outcome	Explaining the tasks	Taking note	Whiteboard / Online board / Telegram / Google Meet / Microsoft Teams	N/A	N/A	N/A
	ENGAGE (20 MIN)	i. Lecturer provided a YouTube link to students related to: - What is Hydrogen Fuel Cell (Video 1) - energy consumption involving two different vehicle engines (Fuel Cell & Combustion) (Video 2). ii. Students are asked to tell a summary the essence of the video. iii. Students will explain the importance of both engine during a discussion with the lecturer.	Conducting the whole class discussion	Analysing contents Actively exchanging ideas & thoughts	Youtube link Video 1 https://www.youtube.com/watch?v=a4pXAmljdUA Video 2 https://www.youtube.com/watch?v=l6ECwRnJ0Sg	i. What is hydrogen fuel cell based on video 1? ii. What can you conclude based on video 2?	Analysing Communicating	
	EXPLORE (45 MIN)	i. Students are divided into small groups. Each group consists of 4 - 5 students. ii. Lecturer introduces the tasks that need to be carried out by the students. Scenario: Hydrogen gas has the potential for use as a clean fuel in reaction with oxygen. The relevant reaction is $2\text{H}_{2(g)} + \text{O}_{2(g)} \rightarrow 2\text{H}_2\text{O}_{(l)}$ By using appropriate data/supported articles/reports, show the fuel cell method (using hydrogen) is more efficient than the combustion method (using petrol/diesel). iii. Students will discuss and complete the tasks given in their respective groups.	Assigning students into groups of mixed ability Conducting the whole class discussion Facilitating the group discussions	Assigning students into groups of mixed ability Conducting the whole class discussion Facilitating the group discussions	PowerPoint, YouTube, Google Scholar, Google Slides, Google Docs, and Google search engine.	Refer scenario given		
	EXPLAIN (25 MIN)	Group members present the results of the exploration and assignments in the exploration phase	Lecturer acts as a facilitator and monitors the presentation process while guiding the students to provide accurate concepts.	Working collaboratively Conducting research Realising connections between the curriculum	YouTube (Hydrogen Fuel Cell tech. & green tech.), Google Scholar, Google search engine, SK025 electrochemistry notes.	What is/are the connection(s) between this lesson with the chemistry curriculum specifications? What is/are new concept(s) that you have learned	Using digital tools Analysing	

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				specifications & the lesson		through the EXPLAIN phase? What are the benefit of green technology in your daily life		
ELABORATE (10 MIN)	<p>i. Instruct students to work collaboratively to come out with ideas/strategy/solution to the problems given.</p> <p>ii. Each group presents their ideas to the whole class.</p>	<p>Facilitating group discussions</p> <p>Facilitating group presentations</p>	<p>Actively brainstorming</p> <p>Actively communicating ideas</p> <p>Working collaboratively</p>	<p>YouTube (Hydrogen Fuel Cell tech. & green tech.), Google Scholar, Google search engine,</p>		<p>Brainstorming</p> <p>Collaborating</p> <p>Communicating</p> <p>Using digital tools</p>		
EVALUATE (10 MIN)	<p>i. Group presentations are implemented.</p> <p>ii. The lecturer conducts the assessment by observation based on the rubric provided.</p>	<p>Observing</p> <p>Reflecting on the whole class discussion</p> <p>Analysing students' feedback</p> <p>Giving feedback</p>	<p>Openly providing feedback to others</p> <p>Taking constructive criticisms positively</p> <p>Reflecting</p>	<p>Rubric</p> <p>-Idea/concept</p> <p>-Presentation</p> <p>-Communicating</p> <p>Develop new understanding</p> <p>-Relate with CS & daily life</p>		<p>Assessing</p> <p>Reflecting</p>		
CLOSURE (5 MIN)	<p>i. Debrief the lesson.</p> <p>ii. Connect the IBL with the corresponding PBL.</p>	<p>Explaining the tasks</p>	<p>Taking note</p>	<p>Whiteboard / Online board / Telegram / Google Meet / Microsoft Teams</p>	N/A	N/A	N/A	N/A

TEACHER'S SELF-REFLECTION:

Checklists		Self – evaluation	
		Achieved?	Not achieved? Why? How to solve it?
Learning outcomes	<p>i. Students will have a comprehensive discussion in solving the problems given.</p> <p>ii. Students will be able to explore and access the information as many as they can to come out with their own tentative proposal.</p> <p>iii. Students will be able to engage in determining whether the fuel cell method (using hydrogen) is more efficient than combustion method</p>		

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	(using petrol/diesel) using appropriate data / supported articles / reports.		
STEM Competency	<ul style="list-style-type: none"> i. Problem-Solving Competencies (Adaptability and flexibility) ii. Interpersonal Competencies (Awareness of Global Issues) 		
21st century skills	<ul style="list-style-type: none"> i. Critical Thinking ii. Problem Solving iii. Numeracy Skills 		
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