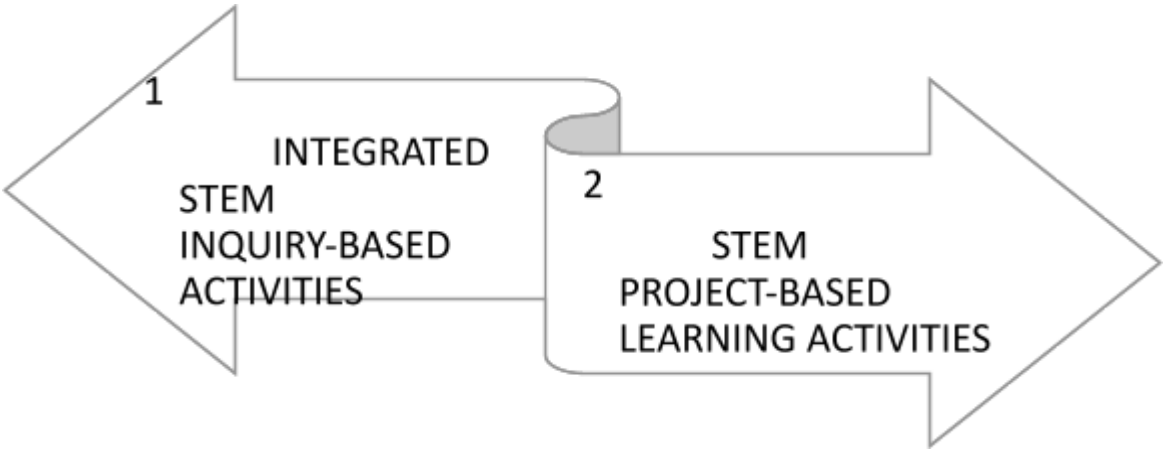
STEM INQUIRY-BASED

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)
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5. En. Byron MC Michael Kadum (Kolej Matrikulasi Labuan)

6. Pn. Tang Ee Yun (Kolej Matrikulasi Selangor)

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

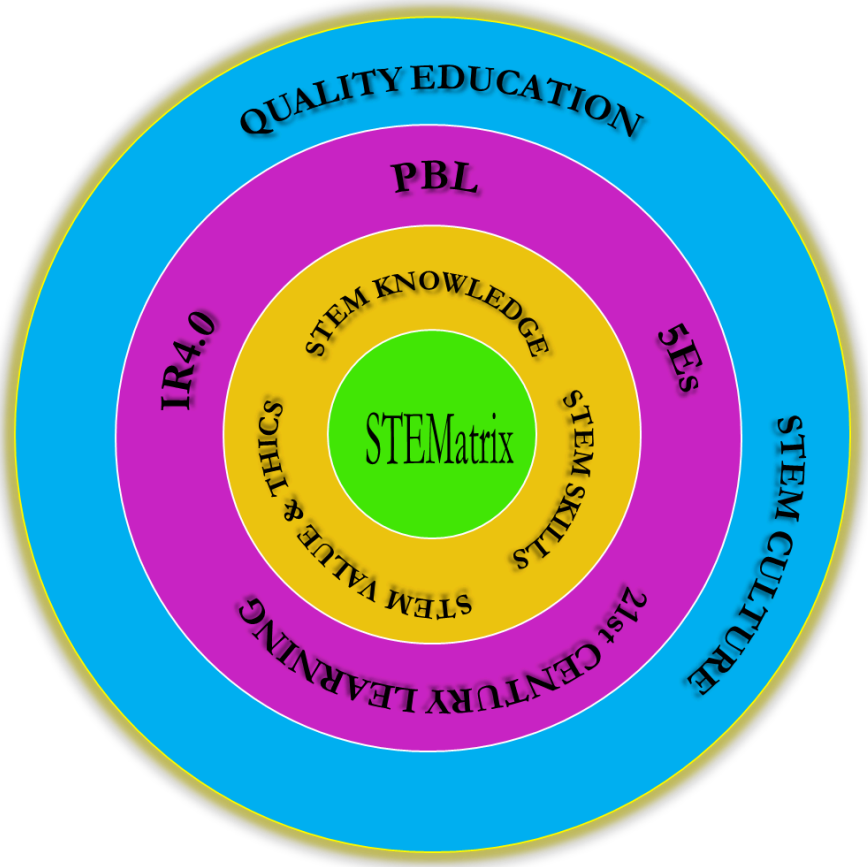
b. Inquiry-based learning
c. Project-Based learning

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)

a. Integrated STEM IBL Activities
b. 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

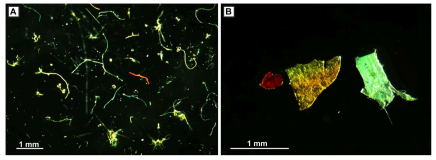
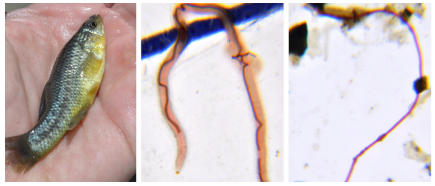
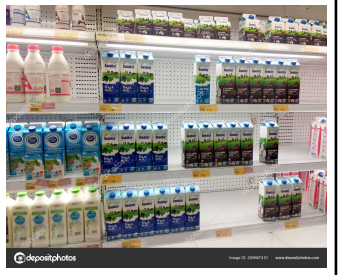
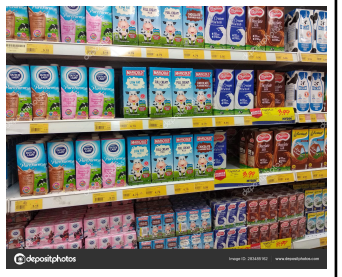
Note: This part will be discussed during the third and fourth series of the workshop (7-18 May 2022)

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	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).  Images of microplastics (Kane & Clare, 2019).  Images of microplastics found in fish guts (Talley et al., 2019). 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;	 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 Hydrogen gas has the potential for use as a clean fuel in reaction with oxygen. The relevant reaction is $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}$.	  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.	  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.

	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). Human consumption drives the production of these artificial polymers up to 2000 million tonnes by 2050 (Coyle et al., 2020). As a responsible citizen, how would you solve this problem?	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.	One of the biggest threats to drains and pipes, especially in the kitchen, is “FOG” FOG refers specifically to fats, oils and grease entering the sewer system when poured down drains in homes, apartments, restaurants, industry and public facilities. All the fats, oils and grease are disposed of improperly during food preparation and kitchen clean-up. 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. 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?	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 fruit juices for several days or weeks by destruction of spoilage microorganisms and/or enzyme inactivation. Today, pasteurization is an important food processing process in the food industry to ensure food preservation and food safety. In supermarkets, we can see some milk are kept in the refrigerator and some are kept unrefrigerated for a certain period of time. 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 ?

STEMATRICULATION INQUIRY-BASED LEARNING MODULE (STEMATRIC-IBL MODULE) _DRAFT V.1

SYLLABUS LINKS	**SK025** Benzene & Its Derivatives Haloalkanes	**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 ● 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 ● 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

				life of a pasteurised milk. ● determine the best milk pasteurisation method for room conditions storing. ● able to transfer the pasteurisation methods and storage conditions knowledge into fruit juice context.

INTEGRATED STEM IBL LESSON PLAN

Theme 1: Water & Pollution
Title of Integrated STEM Activity: What?! Microplastics Found in Human Blood?

Syllabus link:	**Topic:** SK025 1. Benzene & Its Derivatives 2. Haloalkanes	**STEM links:** S: Chemistry & Biology T: ICT & Multimedia E: Engineering Design Process M: Calculation involved in proposing a solution. Data management & representation (i.e., graphs and tables).	**Bloom's Taxonomy:** C3: Application C4: Analysis C5: Evaluation	**Estimated Duration (hours):** 2 hours
	Teaching methods and techniques: ● Inquiry-based learning ● Blended learning		**Tools and Materials:** <u>Tools:</u> Smartboard, Online board (e.g., Jamboard, Liveboard), Telegram/WhatsApp, Google Meet/Microsoft Teams/Zoom, Padlet, PowerPoint, Canva, YouTube, Google Scholar, Google Slides, Torchlight/Flashlight mobile app, gloves, scissors, bucket of water, and tongs.	**Assessment for learning (AFL)**

			Materials: "What Do You See?" photographs, "You're Breathing in Microplastics, But What Does That Mean for Your Health?" YouTube video, "Microplastics Found in Human Blood" YouTube video, "Plastic Types Labelling" diagram, "Plastic Materials Sorting Flowchart" diagram, "Identifying Plastic Materials Table", "Plastic Life Cycle Analysis" diagram, "Strategy Examples", SK025 Benzene and Its Derivatives notes, and SK025 Polymers notes.	

- **Aim(s)**

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

Learning outcomes	1. Recognise the link between curriculum specifications with everyday life scenarios. 2. Recognise ways plastics can impact the environment and human well-being. 3. Investigate and identify the plastics types exist around them. 4. Propose a strategy to mitigate plastics/microplastics pollution.
STEM Competency	5. Awareness of global issues. 6. Value creation. 7. Making observations. 8. Digital literacy.
21st- century skills	I. Collaboration II. Critical thinking III. Creativity
Scientific skills	I. Observing II. Classifying III. Communicating

- **Preparation notes**

Materials/ Apparatus	**Quantity**
● Gloves	25 - 30 pairs
● Tongs	5 - 6 pairs
● Torchlight/Flashlight mobile app	Student's mobile phone
● Scissors	5 - 6 pairs
● Bucket of water	5 - 6 sets

STEMATRICULATION INQUIRY-BASED LEARNING MODULE (STEMATRIC-IBL MODULE) _DRAFT V.1

NO.	STEP AND DURATION	TASK	TEACHER'S ROLE	STUDENTS' ROLE	TEACHING AIDS/ MEDIA/ SOURCES	QUESTIONS BY TEACHERS	LEARNING SKILLS	AFL
	INTRODUCTION (5 minutes)	1. Explain briefly the lesson's objectives. 2. Explain briefly the lesson's STEM 5E framework.	Explaining the tasks	Taking note	Smartboard / Online board (e.g., Jamboard) / Whiteboard / Telegram / Google Meet / Microsoft Teams / Zoom	N/A	N/A	N/A
	ENGAGE (10 minutes)	1. Split students into small groups of four (4) or five (5). **Preferably assign the groups before the lesson begins. *Preferably assign mixed ability groups.* 2. Provide each group with a set of "What Do You See?" photograph. Each group gets a different photograph. 3. Each group shares their thought(s) to the whole class via Telegram/Padlet/Jamboard. 4. Show students two (2) short YouTube videos on microplastics pollution. 5. Instruct students to discuss the videos based on the given question in their groups. 6. Each group shares their thought(s) to the whole class via Telegram/Padlet/Jamboard.	Assigning students into groups of mixed ability Conducting the whole class discussion Facilitating the group discussions	Getting to the assigned groups Working collaboratively Analysing contents Actively exchanging ideas & thoughts	**For Task 2:** "What Do You See?" Photographs **For Task 4:** You're Breathing in Microplastics. But What Does That Mean for Your Health? Microplastics Found in Human Blood.	**For Task 2:** What do you see? Does the photograph raise question(s) for you? What is/are your question(s)? What do you think the problem(s) the people and the environment are facing? **For Task 5:** What do you think is/are the cause(s) of microplastics pollution? Why is plastic litter harmful to humans and other animals?	Collaborating Analysing Communicating	N/A
	EXPLORE (30 minutes)	1. Initiate a whole class discussion on the prevalence of plastics in the campus. 2. Explain that plastics are labelled according to "Type of Plastic" and "Recycle Code". 3. Each group must gather four (4) or five (5) plastic materials that can be found within the campus. 4. Each group conducts four (4) tests on the plastic materials that they have gathered to identify their types.	Facilitating the whole class discussion Explaining the tasks	Actively communicating ideas & thoughts Working collaboratively	**For Task 2:** Plastic Types Labelling **For Task 3:** Gloves Tongs	**For Task 1:** Do you use plastics in your everyday life as a student in this college?	Analysing Observing Testing Classifying	

		a. **Opacity Test -** Identify whether the plastic materials are transparent, translucent or opaque by shining light through the materials. b. **Flexibility Test -** Identify whether the plastic materials are flexible by bending the materials. c. **Cut-Mark Test -** Cut the plastic materials and see whether they leave white marks. d. **Float Test -** Identify whether the plastic materials will sink when put in water. 5. Use the "Plastic Materials Sorting Flowchart" to record the observations from Task 4 into the "Identifying Plastic Materials Table".	Facilitating Task 4 & Task 5	Conducting tests on plastic materials Sorting plastic materials based on the sorting flowchart	**For Task 4:** Torchlight/flashlight mobile phone app Scissors Bucket of water **For Task 5:** Plastic Materials Sorting Flowchart Identifying Plastic Materials Table	Do other people in this college use plastics? How much plastics are being disposed of everyday?	Collaborating	
	EXPLAIN **(20 minutes)**	1. Students remain working in the assigned groups. 2. Select two (2) plastic materials (different types) in the ENGAGE phase to be used for the EXPLAIN phase. 3. Use the "Plastic Life Cycle Analysis" to analyse the selected plastic materials. 4. Encourage students to utilise Google, Google Scholar & YouTube to research for Task 2. 5. Discuss emerging concepts and misconceptions about plastics and their impacts to the environment and human well-being.	Facilitating group discussions Making connections between the curriculum specifications & the lesson Supervising students while they are using the internet for research	Working collaboratively Conducting research Realising connections between the curriculum specifications & the lesson	**For Task 2:** Plastic Life Cycle Analysis SK025 Polymers Notes SK025 Benzene & Its Derivatives Notes Google, Google Scholar, YouTube	**For Task 2:** What is/are the connection(s) between this lesson about plastics and microplastics with the organic chemistry curriculum specifications? What is/are new concept(s) that you have learned through the EXPLAIN phase? What is/are misconceptions that have been addressed through this session? How long does it take for the plastic materials to decompose? Where do you think the plastic	Using digital tools Analysing	

						materials are going to end up? How much do you care?		
	ELABORATE (40 minutes)	1. Provide examples of ways to mitigate plastics/microplastics pollution. 2. Instruct students to work collaboratively to design a strategy to reduce the impact of plastics/microplastics pollution. 3. Each group presents their ideas to the whole class.	Facilitating group discussions Facilitating group presentations	Actively brainstorming Actively communicating ideas Working collaboratively	**For Task 1:** Strategy Examples **For Task 2:** Google, Google Scholar, YouTube, Canva, PowerPoint, Google Slides & et cetera. **For Task 3:** Smartboard / Online board (e.g., Jamboard) / Whiteboard / Telegram / Google Meet / Microsoft Teams / Zoom	**For Task 2:** What strategy can be employed in mitigating plastics/microplastics pollution? What strategy can you employ in mitigating plastics/microplastics pollution?	Brainstorming Collaborating Communicating Using digital tools	
	EVALUATE (10 minutes)	1. Initiate peer-assessment. 2. Initiate whole class reflection on students' works. 3. Instruct students to write a personal reflection on the lesson.	Observing Reflecting on the whole class discussion Analysing students' feedback Giving feedback	Openly providing feedback to others Taking constructive criticisms positively Reflecting	Smartboard / Online board (e.g., Jamboard) / Whiteboard / Telegram / Google Meet / Microsoft Teams / Zoom	**For Task 1:** What feedback you can give to your peers' works? **For Task 3:** How does this lesson change the way you think about plastics and their impacts on the environment and human well-being?	Assessing Reflecting	
	CLOSURE (5 minutes)	1. Debrief the lesson. 2. Connect the IBL with the corresponding PBL.	Explaining the tasks	Taking note	Smartboard / Online board (e.g., Jamboard) / Whiteboard / Telegram / Google Meet / Microsoft Teams / Zoom	N/A	N/A	N/A

TEACHER'S SELF-REFLECTION:

STEMATRICULATION INQUIRY-BASED LEARNING MODULE (STEMATRIC-IBL MODULE) _DRAFT V.1

Checklists		**Self – evaluation**	
		Achieved?	**Not achieved? Why? How to solve it?**
Learning outcomes	I. Recognise the link between curriculum specifications with everyday life scenarios. II. Recognise ways plastics can impact the environment and human well-being. III. Investigate and identify the plastics types exist around them. IV. Propose a strategy to mitigate plastics/microplastics pollution.		
STEM Competency	I. Awareness of global issues. II. Value creation. III. Making observations. IV. Digital literacy		
21st- century skills	I. Collaboration II. Critical thinking III. Creativity		
Scientific skills	I. Observing II. Classifying III. Communicating		