Enriching Scientific Literacy in the school-based STEM curriculum

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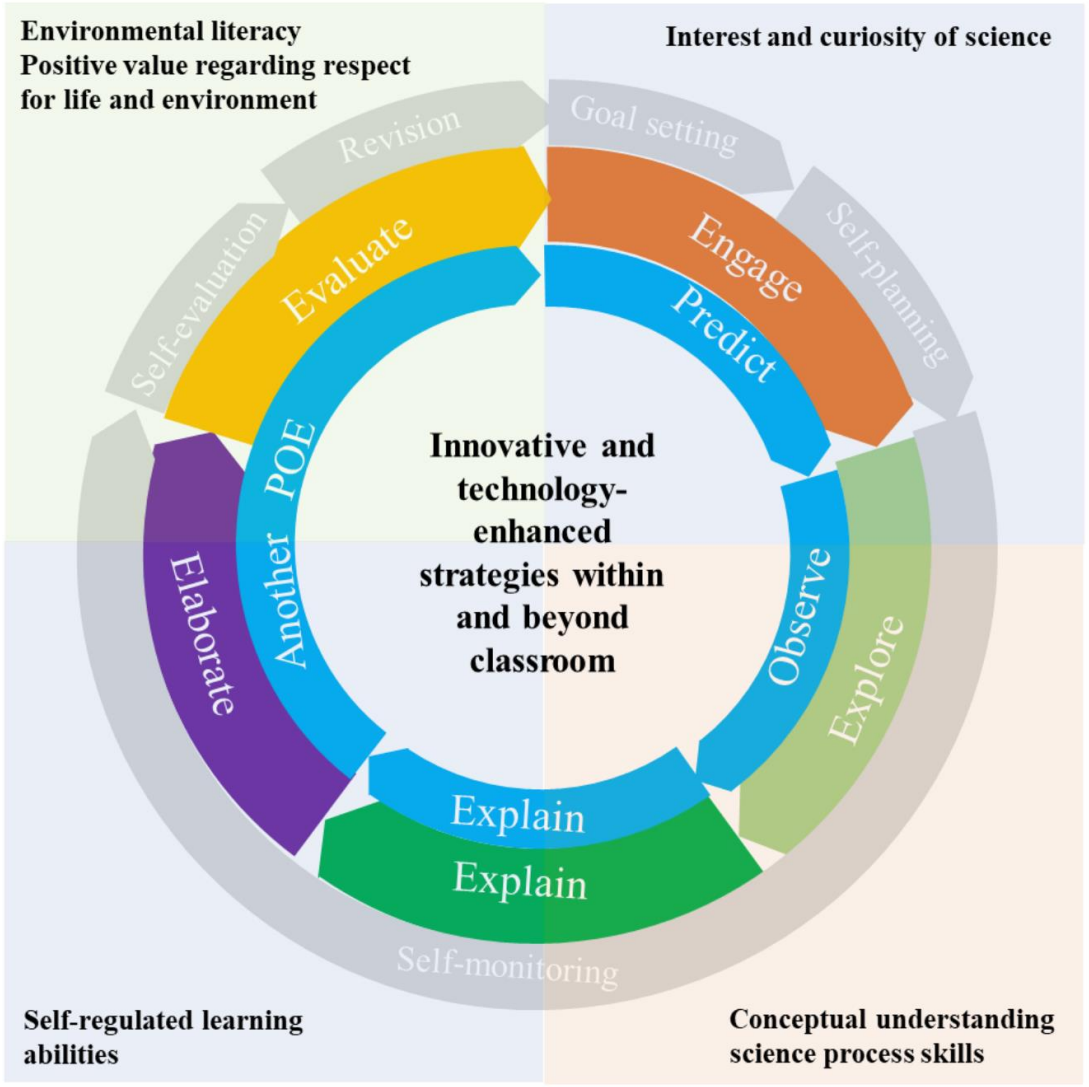
School-based Science Curriculum

- **Objectives:**
  - Enhancing students' **scientific literacy** and self-regulated learning ability by using innovative and technology-enhanced strategies
  - Nurturing students' positive values regarding the respect for life and environment through learning science
- **Pedagogical strategies**
  - Predict-Observe-Explain (POE)
  - 5E instructional strategy
  - **Self-directed learning (SDL) strategy**
- As a **platform** for Scientific investigations and Engineering designs in **STEM**



e-Life@KYC

A school-based STEM curriculum

e-Life: raising enthusiasm for life and value education

e-Life: enhancing environment literacy for the good of our Earth

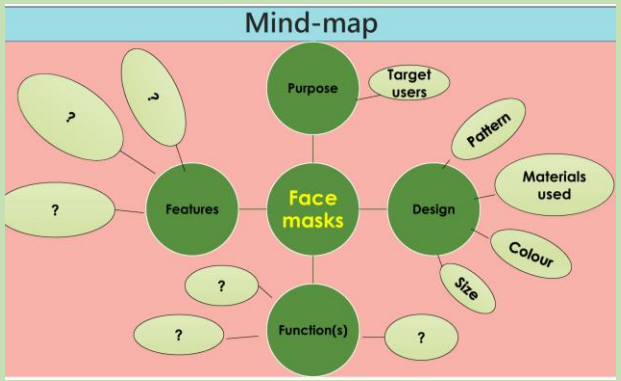
Level	S.1	S.2	S.3
Theme	**The Second Life of Plants**	**The Commitment of Green Pioneers**	**The Eco-city**
Topic	Design and tailor-make a good **microwavable heat bag** by using beans (*Vigna angularis* 紅豆) for the elderly	Design and make an environmental-friendly **drip irrigation device** for the growth of a pot of flowering plant (*Viola tricolor* 三色菫)*	Investigation on the effect of temperature on the change of vitamin C concentration using **self-made colorimeter** Investigation on the type of metal on heat conduction Design and make a good **solar cooker**
Subjects involved	Science, Home Economics, Mathematics, English	Science, Mathematics, Computer Literacy, Design and Technology	
Topic	Prepare saturated solution for competition, and design and make an effective **dehumidifier using dried leaves** (*Phyllanthus emblica* 油柑葉)	Competition of **gas powered jetboat** using vinegar and eggshell powder as environmental-friendly energy sources	
Subjects involved	Science, Mathematics, Computer Literacy, Design and Technology	Science, Mathematics, Design and Technology	Biology, Chemistry, Physics, Mathematics

**Species of the flowering plant is subject to the "One person, one flower" scheme*

Microwavable heat bags for elderly

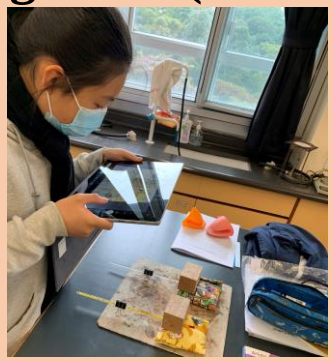
Overview

- **Making presentation of a STEM product – Face mask (English)**

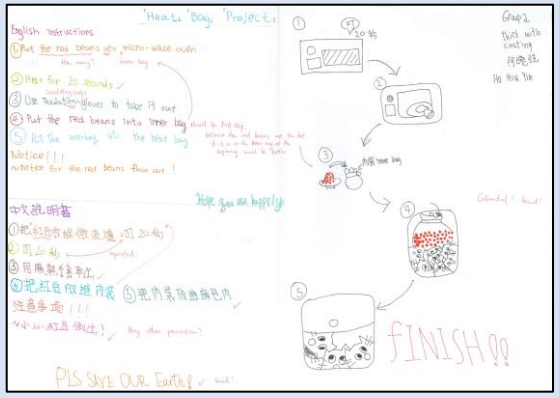


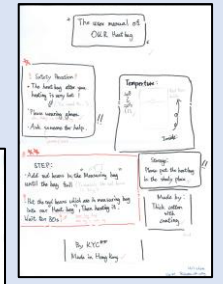
- **Engineering Design (Home Economics)**

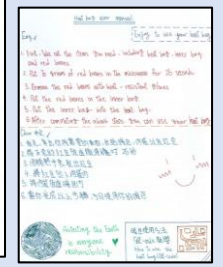
- **Scientific Investigations (Science)**



- **Revision of the microwavable heat bags**
- **User manual**







- **Making presentation of the microwavable heat bag and user manual in a 2-min video**
- **Parents' evaluation**

Enriching Scientific Literacy in STEM

- Identifying the needs for the scientific inquiry
  - **Pollution problems** of the disposal of traditional heat bags

【寒冬注意】暖包用完即棄唔環保　專家：內含鐵粉污染泥土和水質

撰文：黃桂桂
出版：2018-12-28 13:30　更新：2018-12-28 14:55

一到冬天，又是暖包總動員的時候，左右手各一個，肚及背脊又各一個，每日便產生四個用完即棄的暖包。暖包被丟到垃圾桶後，便會由垃圾車運至堆填區，然後呢？專家表示，暖包中的鐵粉會污染泥土及水質，如果暖包仍有餘溫便被丟去堆填區，更有可能引致火警，建議市民轉用暖水袋等替代品。

香港教育大學科學與環境學系副教授曾耀輝指，暖包、暖貼的主要成分有鐵粉、活性碳、蛭石和食鹽，打開塑膠包裝後，會氧化，繼而產生熱能，鹽有催化鐵的氧化作粉持續發熱。根據暖包的包裝標示，現時市面時發熱，而平均溫度亦達50度以上。

曾教授指暖包中的鐵粉是金屬，被棄置到堆填區後都會污染泥土及水質。而萬一暖包未經使用或未完全用盡就被棄至堆填區，有可能會繼續與空氣產生氧化作用，持續發熱，有潛在危險，可能會爆開。從環保角度來看，曾教授認為市民應使用一些可重用的保暖產品，例如暖水袋。

香港環保回收業總商會聯絡人鄭雲龍表示，暖包屬化學物品，不可以隨便運去堆填區棄置，萬一暖包在堆填區內發熱，有可能引發火警。根據《廢物處置（化學廢物）（一般）規條），化學廢物生產商如要棄置化學廢物，需先取得環保署的豁免批准。

他續指，其實暖包可以回收，而且工序並不複雜，回收商只需用磁鐵將鐵粉吸出，便可回收再用。「但是，若設回收箱收集市民棄置的暖包，當暖包大量堆積後，有可能發生火警，因此一直未有回收公司做暖包回收。」他強調，「暖包真的超級不環保，最好不要用。」

Enriching Scientific Literacy in STEM

- Identifying the needs for the scientific inquiry
  - **Pollution problems** of the disposal of traditional heat bags
  - Using **microwavable heat bag** as an alternative

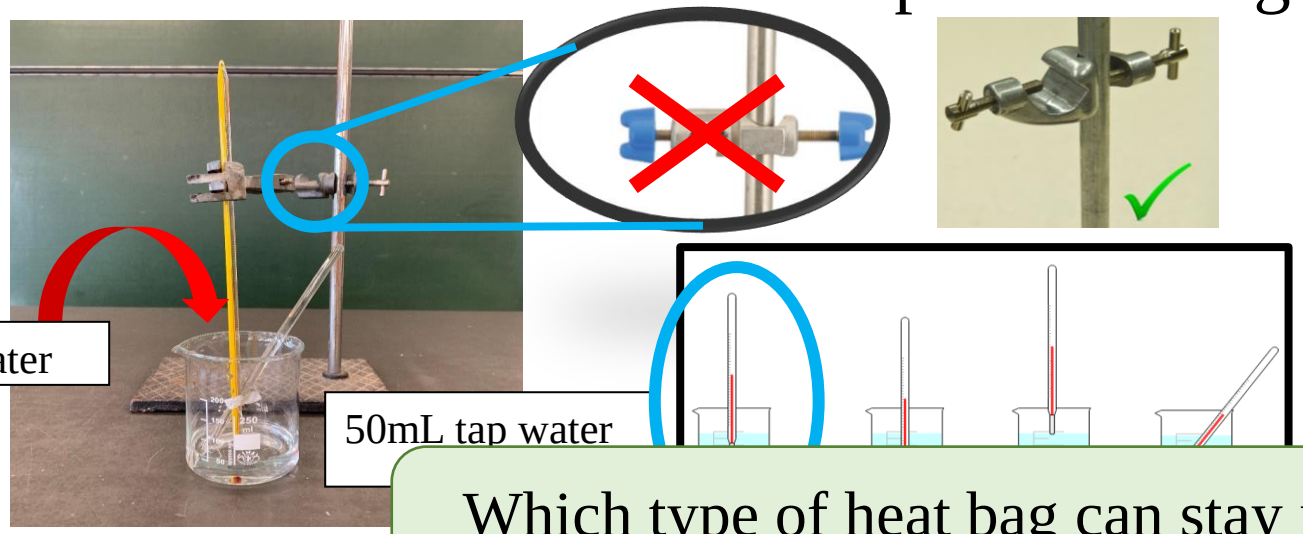
- **Engineering Design**: Tailor-made heat bags in HE with different size (small / medium / large) and material (thin cotton / thick cotton / thick cotton with polyester)
  - Comfortable
  - Easy for hand-holding
  - Easy for filling and replacing the beans

- **Scientific Investigation**
  - **Proposing hypothesis / research question**
  - **Identifying variables**
  - **Designing procedure / measuring method**
  - **Recording and analyzing data**

Science Process skills

Enriching Scientific Literacy in STEM

- Identifying **research question**
- Determination of a suitable temperature range for the heat bag



Which type of heat bag can stay in the suitable temperature range for the **longest period of time**?

Suitable range of temp

檔案 編輯 查看 插入 格

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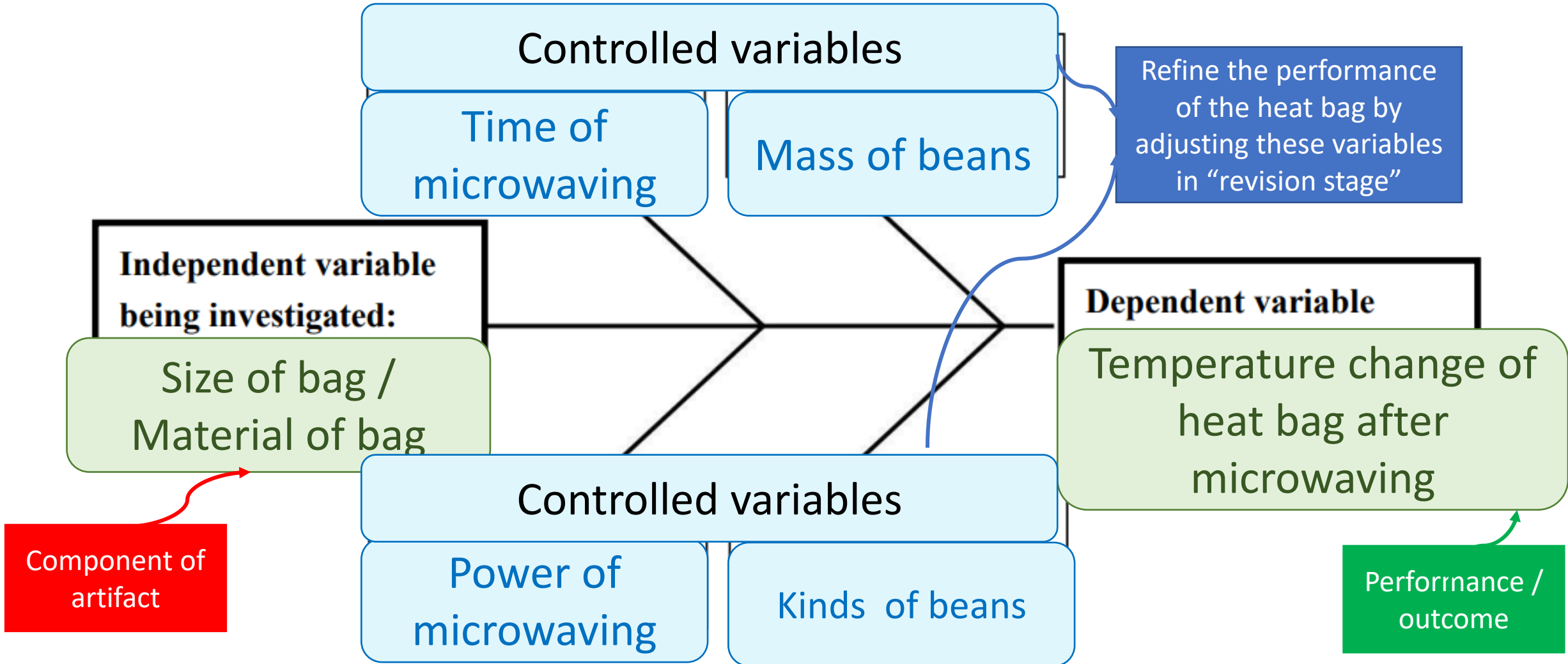
A2 fx 1B

	A	B	C	D	E	F	AG	AH
1								
2	1B							
3	Class number	1	2	3	4	5	2	Average
4	highest temperature that is comfortable	49	45	51		42	4	50
5	lowest temperature that is warm enough	23	39	46		27	5	35

1B	
Class number	Average
highest temperature that is comfortable	50
lowest temperature that is warm enough	35

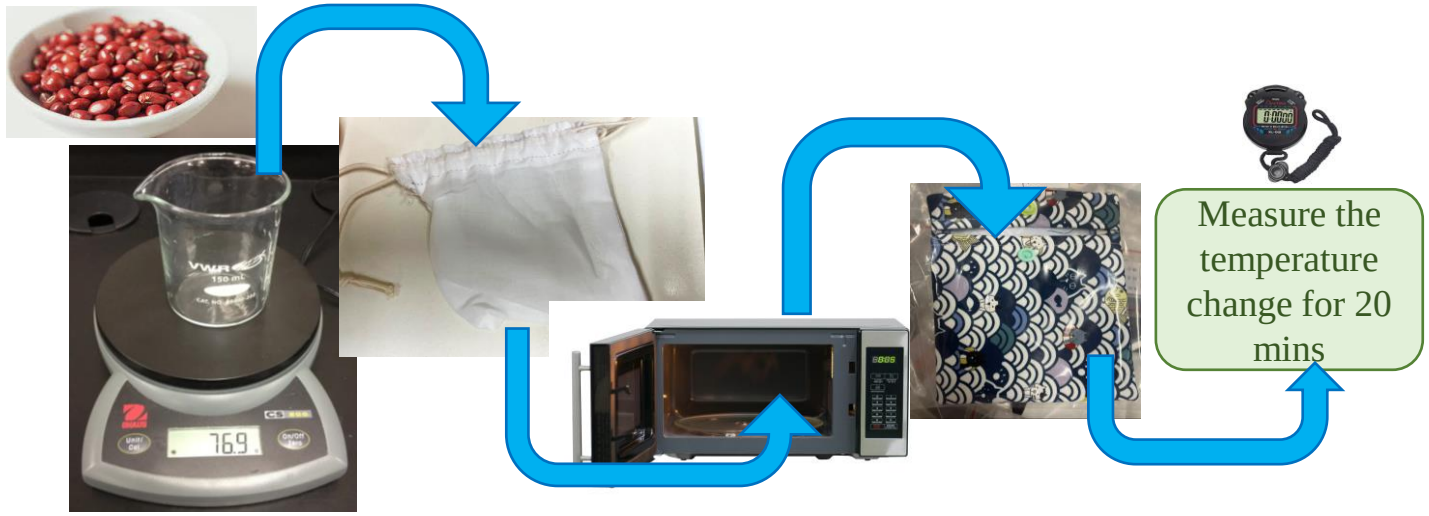
Enriching Scientific Literacy in STEM

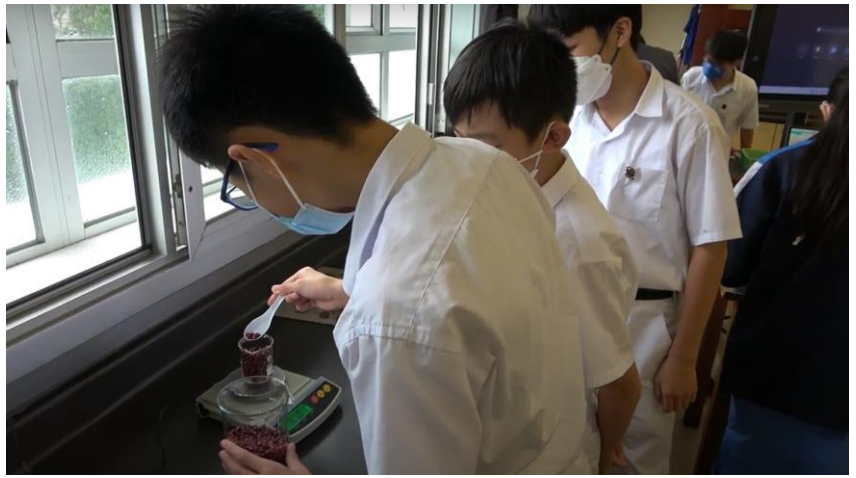
- Identifying **variables** with the use of fishbone conceptual organizer

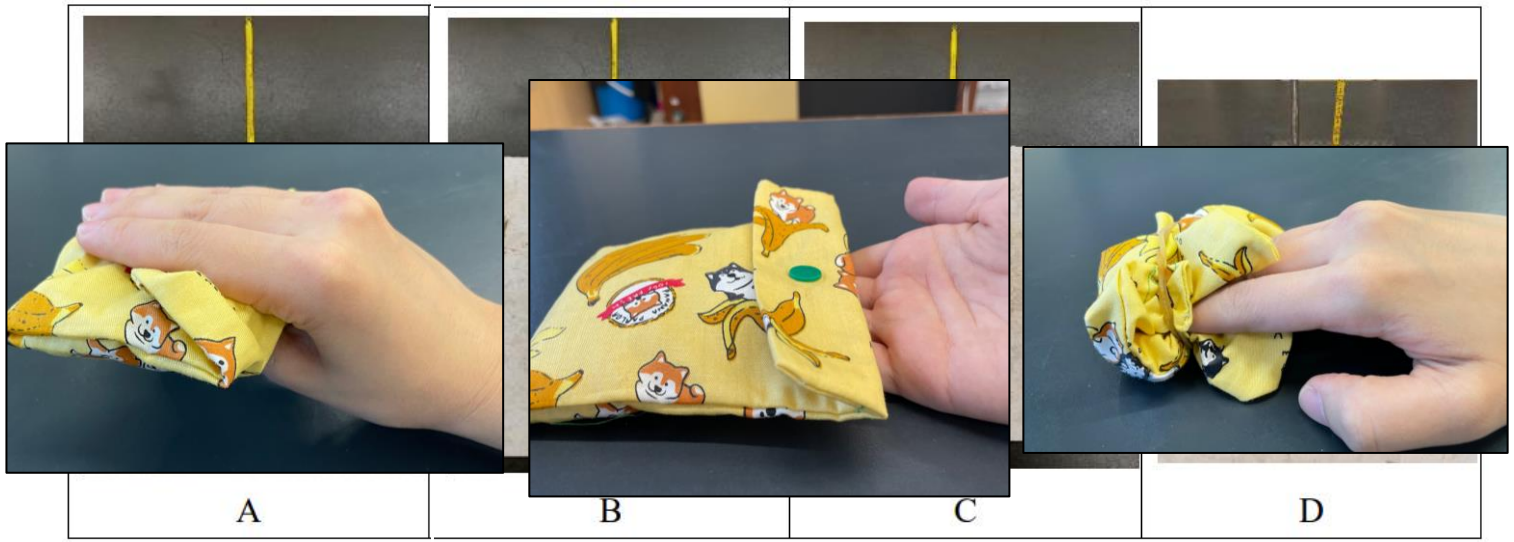


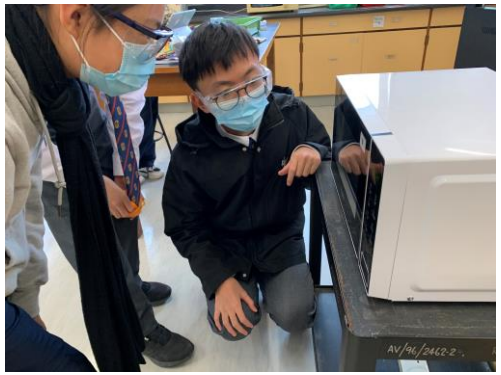
Enriching Scientific Literacy in STEM

- Designing **experimental procedure for scientific measurement**









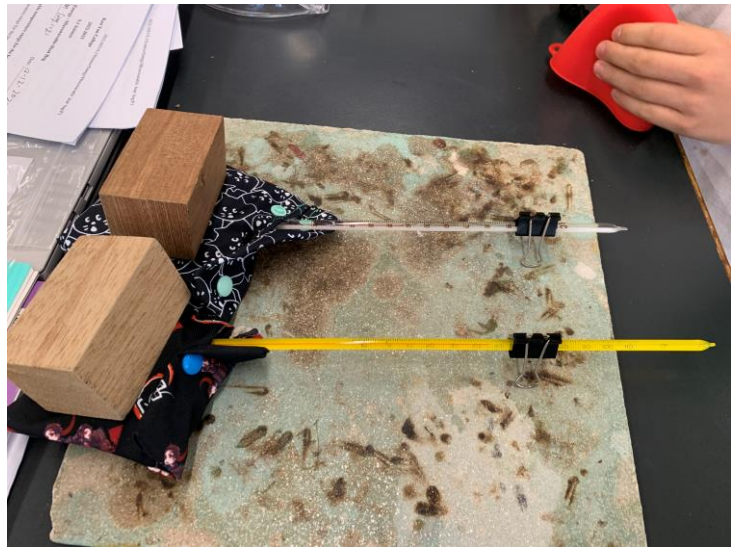
Enriching Scientific Literacy in STEM

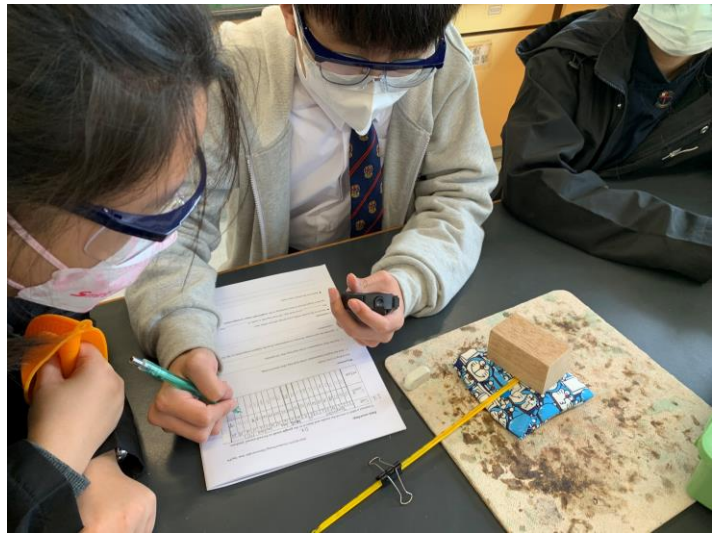
- Designing **experimental procedure for scientific measurement**

How can I make a long-lasting measurements?

Wooden block

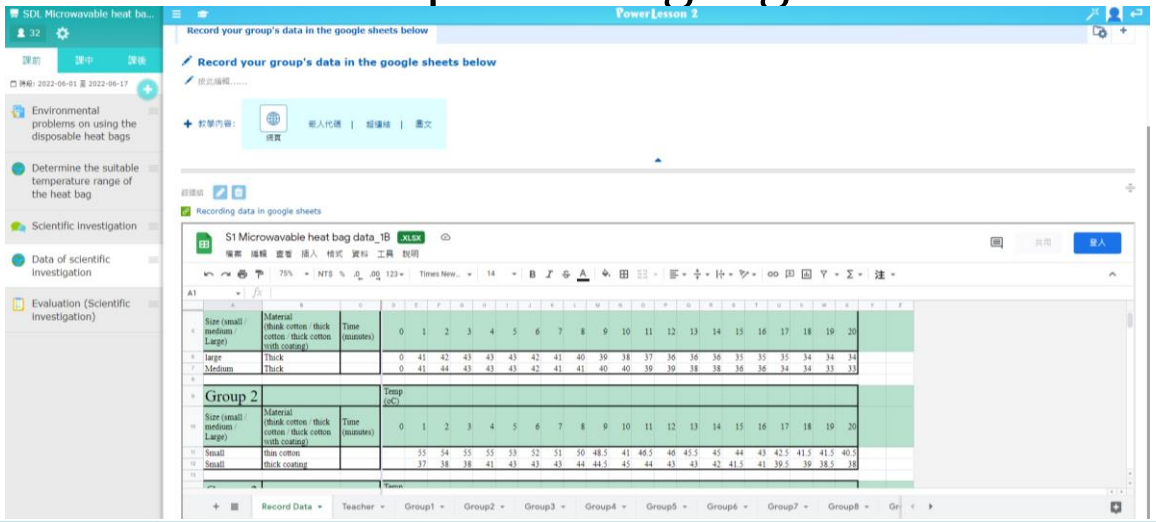
clip

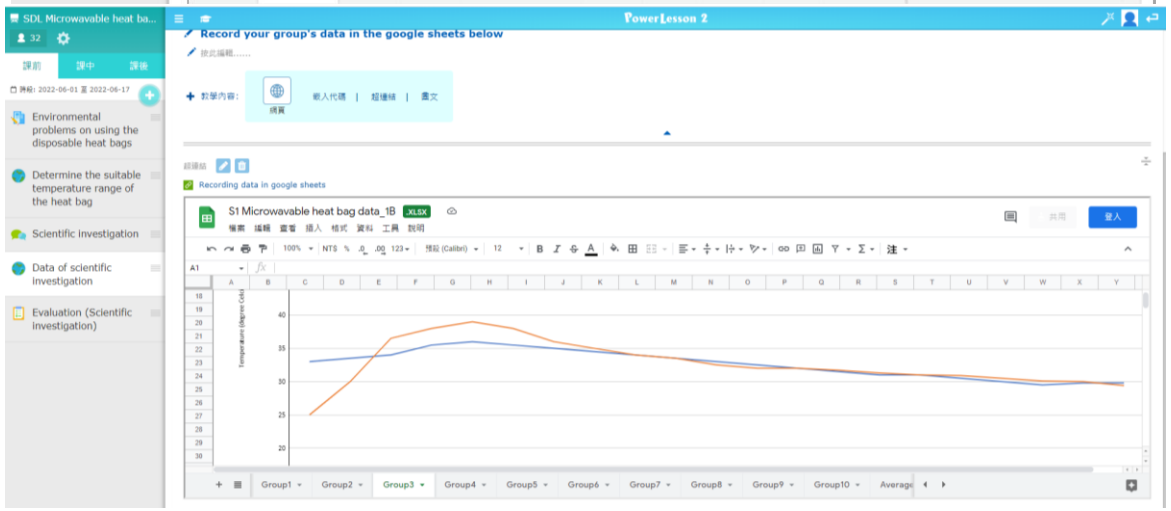


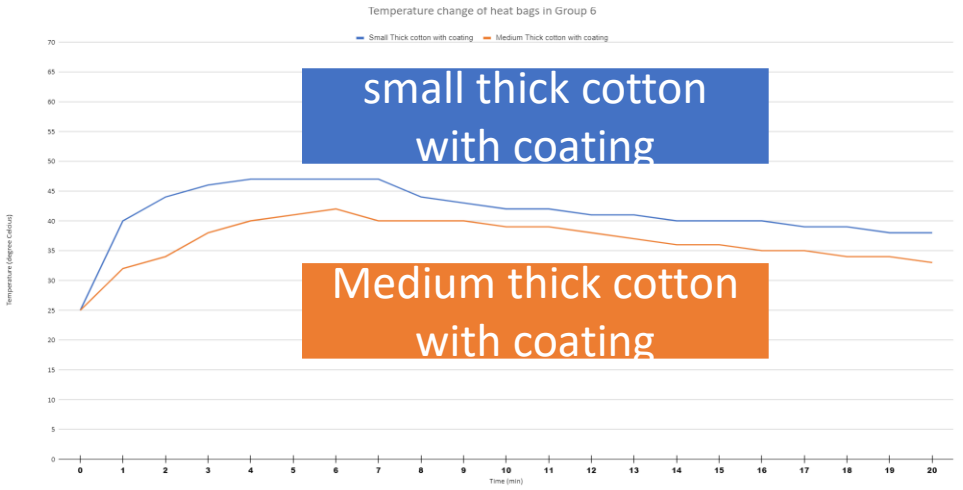


Enriching Scientific Literacy in STEM

- **Data collection and analysis**
  - Group data in google sheet → visualize group data into graphs automatically

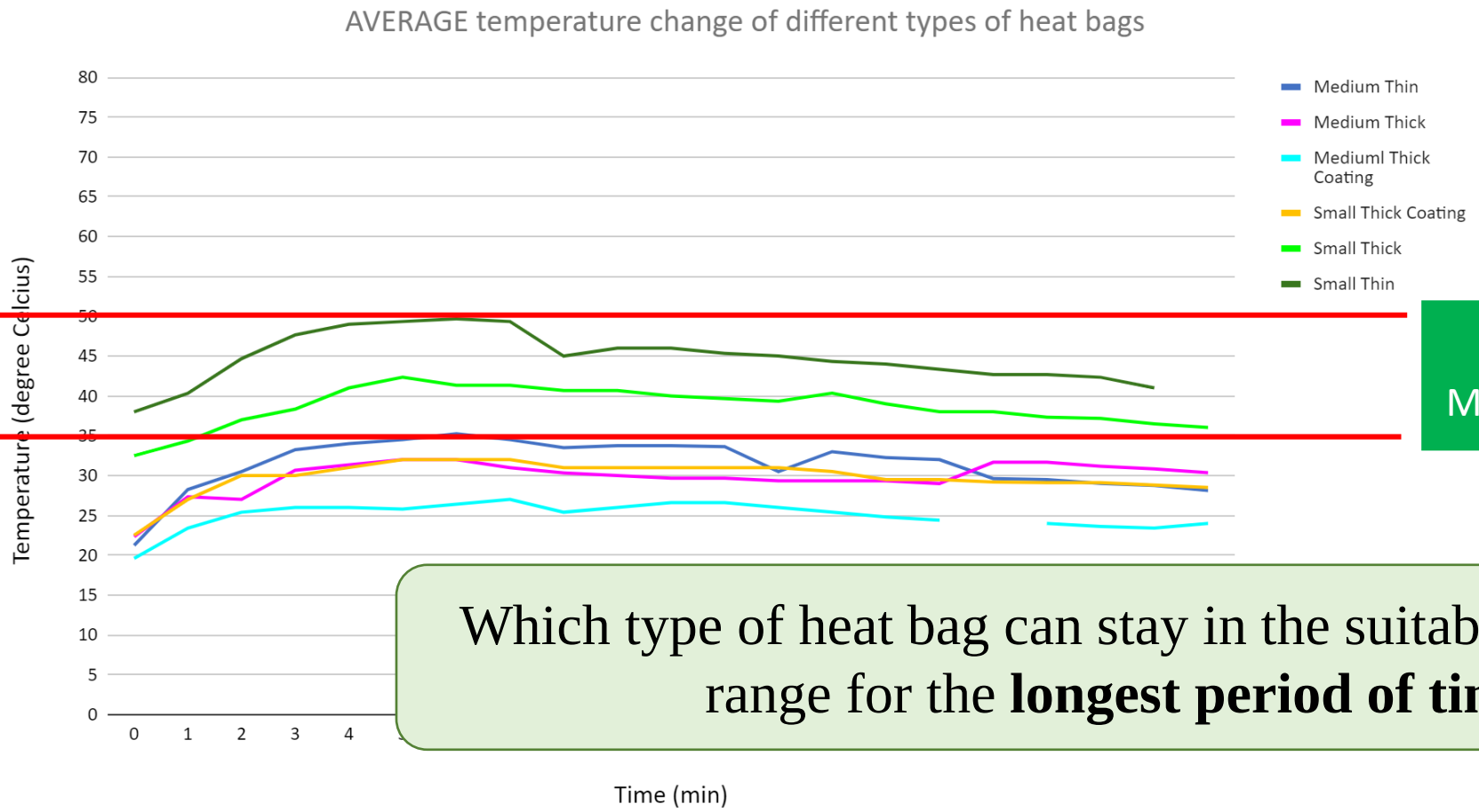






Enriching Scientific Literacy in STEM

- **Data collection and analysis**
  - comparing group data with the aid of graph in a whole-class manner



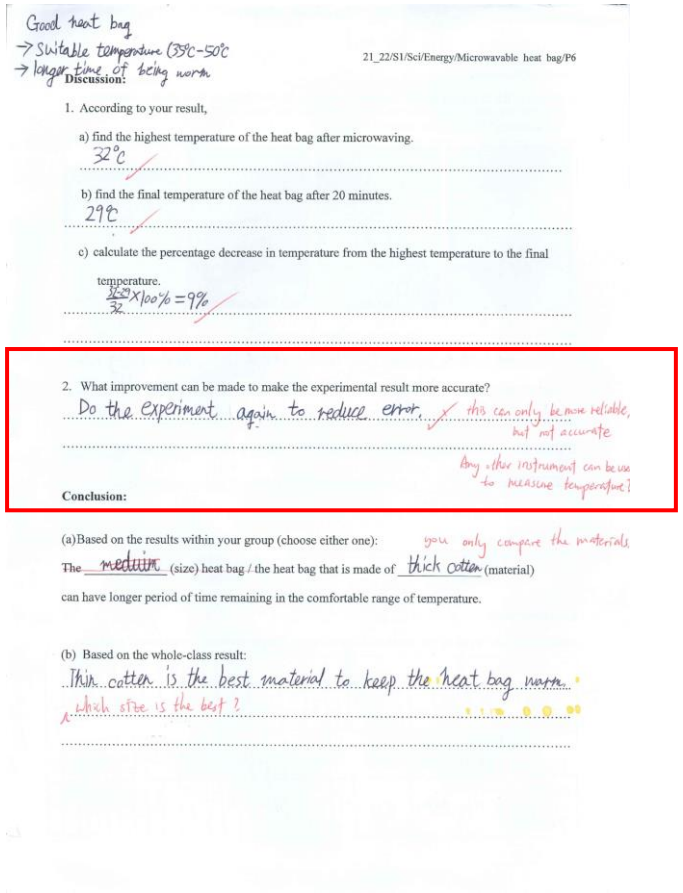
Suitable temperature range determined by the class

Size: small
Material: Thin cotton

Which type of heat bag can stay in the suitable temperature range for the **longest period of time**?

Enriching Scientific Literacy in STEM

- Improvement of the measurement with technology
  - Accuracy vs precision


Good heat bag
→ Suitable temperature (39°C-50°C
→ longer time of being warm

21_22/S1/Sci/Energy/Microwavable heat bag/P6

Discussion:

1. According to your result,

a) find the highest temperature of the heat bag after microwaving.
32°C

b) find the final temperature of the heat bag after 20 minutes.
29°C

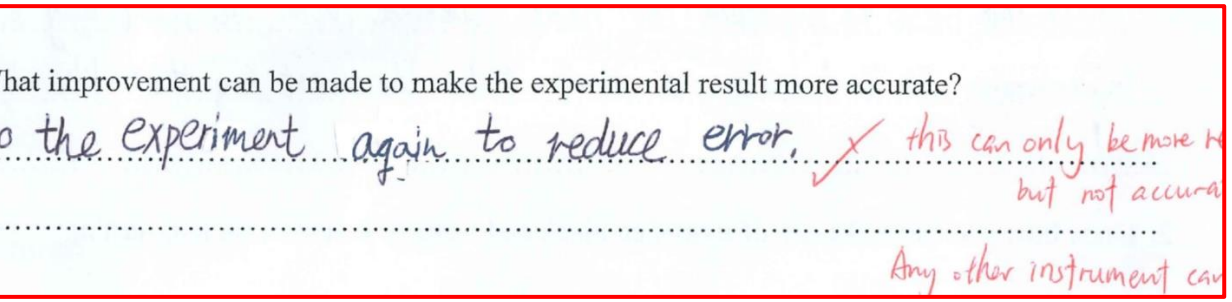
c) calculate the percentage decrease in temperature from the highest temperature to the final temperature.
$\frac{32-29}{32} \times 100\% = 9\%$

2. What improvement can be made to make the experimental result more accurate?
Do the experiment again to reduce error. ✓ this can only be more reliable, but not accurate
Any other instrument can be use to measure temperature

Conclusion:

(a) Based on the results within your group (choose either one): you only compare the materials
The medium (size) heat bag / the heat bag that is made of thick cotton (material)
can have longer period of time remaining in the comfortable range of temperature.

(b) Based on the whole-class result:
This cotton is the best material to keep the heat bag warm.
which size is the best ?


2. What improvement can be made to make the experimental result more accurate?
Do the experiment again to reduce error. ✓ this can only be more reliable, but not accurate
Any other instrument can

Common students' misconception (even in textbook):

✖The result is more accurate if we measure again and take an average of the results

Result will be more accurate:	**Result will be more precise:**
Improved method	Repeated measurement and take an average
Better choice of instrument	

Literacy in STEM

2022-2023/S.1/Science/Energy/Microwavable heat bag/P.7

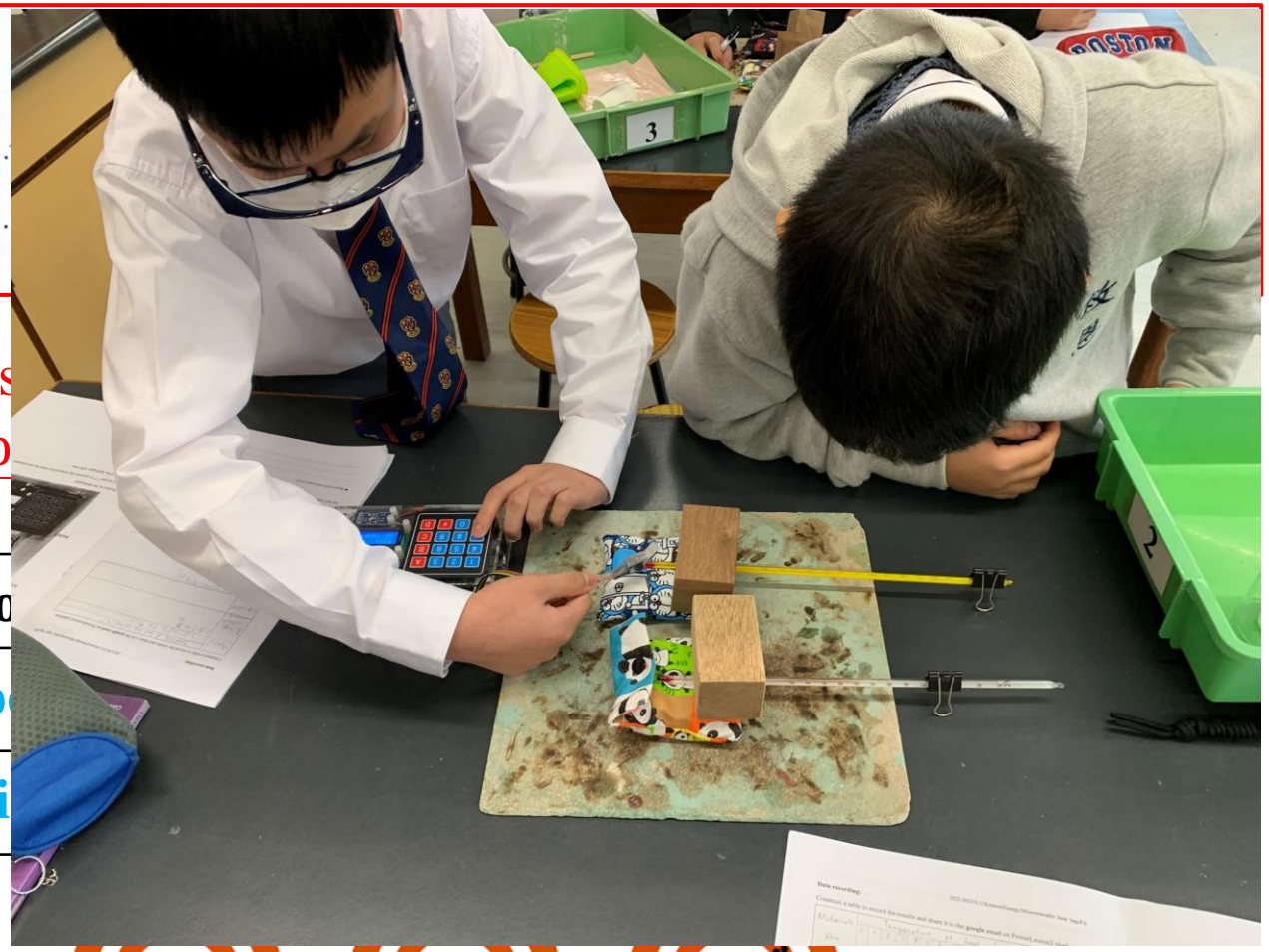
Guidelines on the use of mobile datalogger

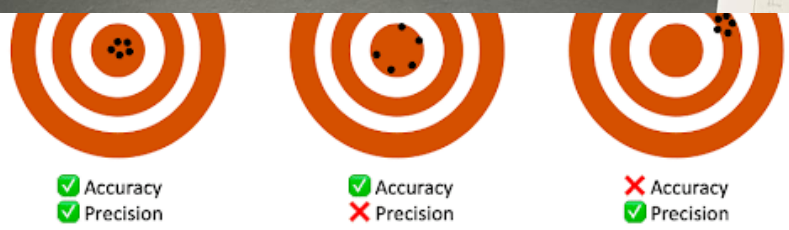
Measurement of temperature

1. Connect the infrared (IR) temperature sensor into the slot #6 of the datalogger as shown in the below diagram.

2. Switch on the datalogger.
3. Press keypad "6" to measure the temperature of the object.
4. Switch off the datalogger after use.

- Use of IR temperature sensor





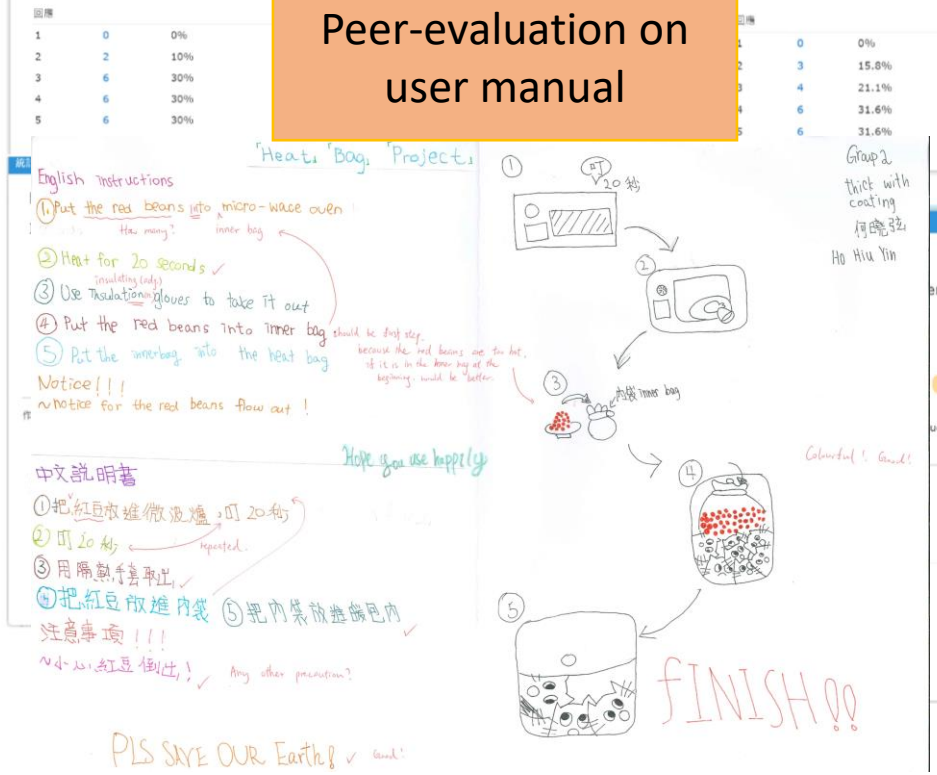
• Enriching Scientific Literacy in STEM

- **Evaluation** on scientific investigation and the microwavable heat bags as assessment for learning

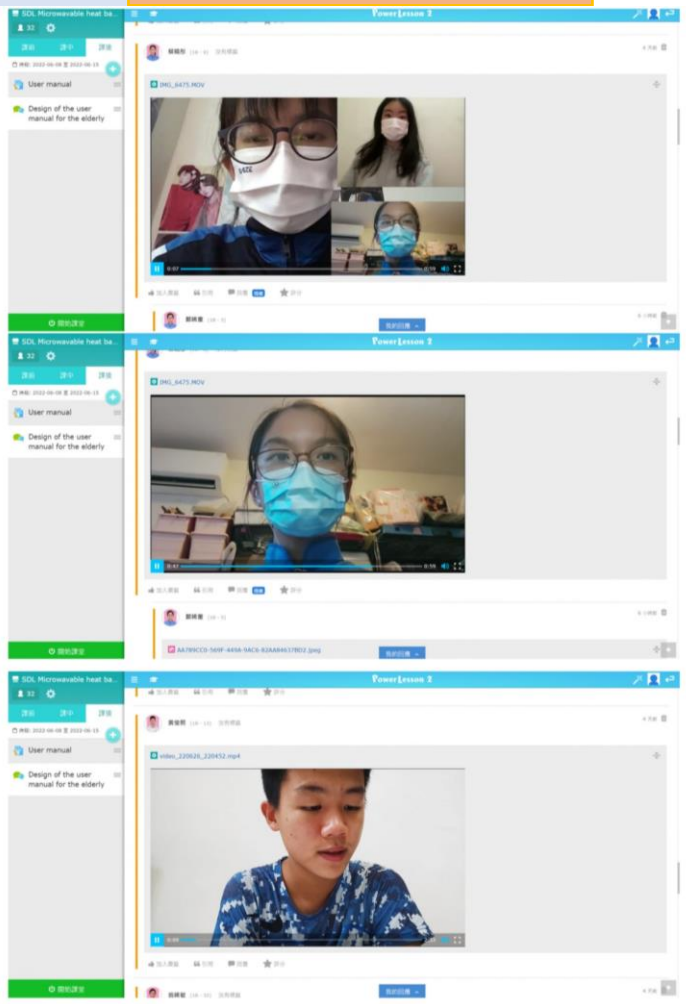
Self-evaluation on scientific investigations:

- Setting research question (Goal-setting)
- Designing investigation (self-planning)
- Measurement (self-monitoring)
- Data analysis and interpretation (self-evaluat

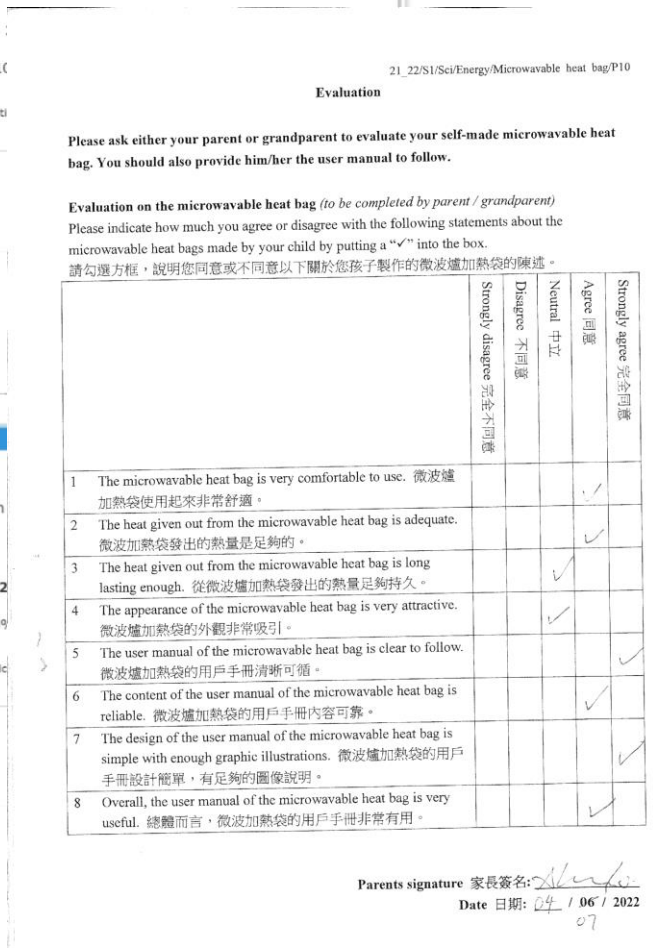
Peer-evaluation on user manual



Peer-evaluation on group presentation



Parent-evaluation on user manual and the microwavable heat bags



21_22/S1/Sci/Energy/Microwavable heat bag/P10

Evaluation

Please ask either your parent or grandparent to evaluate your self-made microwavable heat bag. You should also provide him/her the user manual to follow.

Evaluation on the microwavable heat bag *(to be completed by parent / grandparent)*

Please indicate how much you agree or disagree with the following statements about the microwavable heat bags made by your child by putting a "✓" into the box.
請勾選方框，說明您同意或不同意以下關於您孩子製作的微波爐加熱袋的陳述。

		Strongly disagree 完全不同意	Disagree 不同意	Neutral 中立	Agree 同意	Strongly agree 完全同意
1	The microwavable heat bag is very comfortable to use. 微波爐加熱袋使用起來非常舒適。				✓	
2	The heat given out from the microwavable heat bag is adequate. 微波加熱袋發出的熱量是足夠的。				✓	
3	The heat given out from the microwavable heat bag is long lasting enough. 從微波爐加熱袋發出的熱量足夠持久。			✓		
4	The appearance of the microwavable heat bag is very attractive. 微波爐加熱袋的外觀非常吸引。			✓		
5	The user manual of the microwavable heat bag is clear to follow. 微波爐加熱袋的用戶手冊清晰可循。					✓
6	The content of the user manual of the microwavable heat bag is reliable. 微波爐加熱袋的用戶手冊內容可靠。				✓	
7	The design of the user manual of the microwavable heat bag is simple with enough graphic illustrations. 微波爐加熱袋的用戶手冊設計簡單，有足夠的圖像說明。					✓
8	Overall, the user manual of the microwavable heat bag is very useful. 總體而言，微波加熱袋的用戶手冊非常有用。				✓	

Parents signature 家長簽名: [signature]
Date 日期: 04 / 06 / 2022
07

Enriching Scientific Literacy in STEM

- **Final remarks:**
  - Provide students opportunities to recognize the need and aim of integrating scientific investigation with engineering designs
  - Facilitate students to identify the research problem and variables of investigation
  - Allow students to self-plan the procedure
  - Facilitate group and whole class-data analysis
  - Provide chances for students to make revisions on their scientific investigations or artifacts
  - Encourage students to evaluate their investigations

Thank You