STEM

Connecting the
English Language curriculum to
to motivate students
to learn and use English

Maker Education

Lok Sin Tong Yu Kan Hing Secondary School

School background

1. School development focus:
   - **Promoting STEM education to unleash students' potential and enhance their creativity**

2. Experience in implementing STEM education outside the classroom
   - **The project "Aquaponics" at whole-school level**
   - **Other STEM projects for competitions and exhibitions**

Stage 1   **Stage 2**   **Stage 3**

STEM → **Eng + STEM** → **Eng + STEM + Maker Education**

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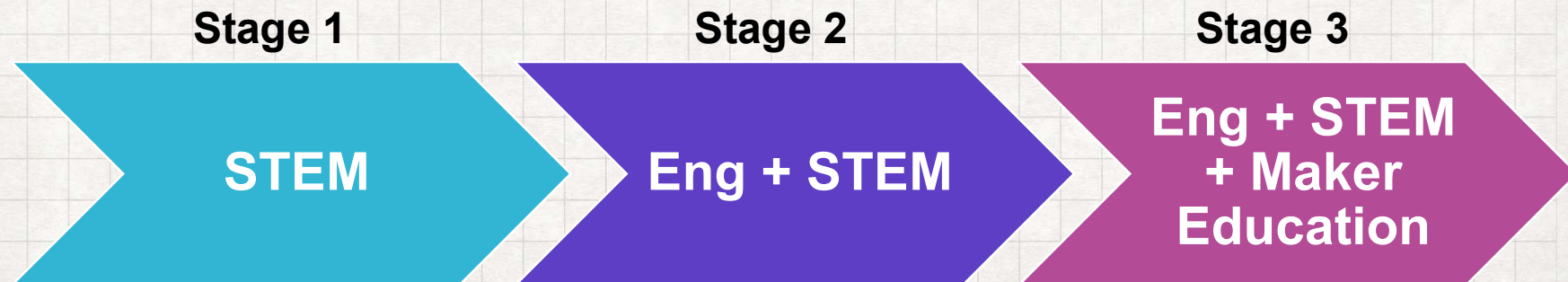
Stage 1

From 2014…

STEM

STEM project - Aquaponics

Constructing the manipulator

Robot coding & Realtime IP camera

A.   Operating the food separator: pellets for fish food
Daily Routine: Fish → Vegetables
Feeding (monitored by junior form students)
Water filtered (growing salad vegetables)

Eng + STEM

WHY integrating STEM Education into the school-based (SB) English Language curriculum?

To provide students with more chances to:
- ➢ **communicate** facts, ideas & hypotheses
- ➢ **present** information, findings & supporting evidence through **speaking**
- ➢ advance scientific inquiry through **reading & writing activities**

DeBoer, G, Carman, E, & Lazzaro, C. (2010.) The Role of Language Arts in a Successful STEM Education Program, *College Board.*

English teachers' contributions to promoting STEM education in school

- Introducing relevant **English reading materials** to support students in **discussing critically** the issues related to **mathematics, science and technology**

- **Designing tasks, activities and projects** to encourage students to work out **innovative solutions to problems** or **create new ideas** or things to enhance their creative capacity (e.g. designing a product, proposing the marketing strategy and writing a short story about a zany invention

The Curriculum Development Council. (2017). *English Language Education Key Learning Area Curriculum Guide (Primary 1 – Secondary 6)*. HKSARG: The Education Bureau.

Inside the classroom

Mapping some components of aquaponics with the SB English Language curriculum –
a unit on "**Growing Green**"

How can English teachers help promote STEM education in school?

Outside the classroom

Joining STEM competitions & exhibitions

Using English to introduce the inventions

Smart stove alert
to remind the elderly to switch off the stove

Eng + STEM + Maker Education

How to benefit MORE students inside the classroom?

1) Strengthen collaboration with teachers involved in Maker lessons

➔ provide opportunities for students to **present** their **Maker Class products** in **English**

2) Help students develop their **language skills** through the **STEM projects** & **promoting Reading across the Curriculum (RaC)**

➔ develop students' **presentation skills** in **English**

7

The Maker lessons

- For **S.1 & S.2**

- **4** lessons/week

- Projects related to **IoT** *(Internet of Things)* **Smart City:** solving urban problems using technology

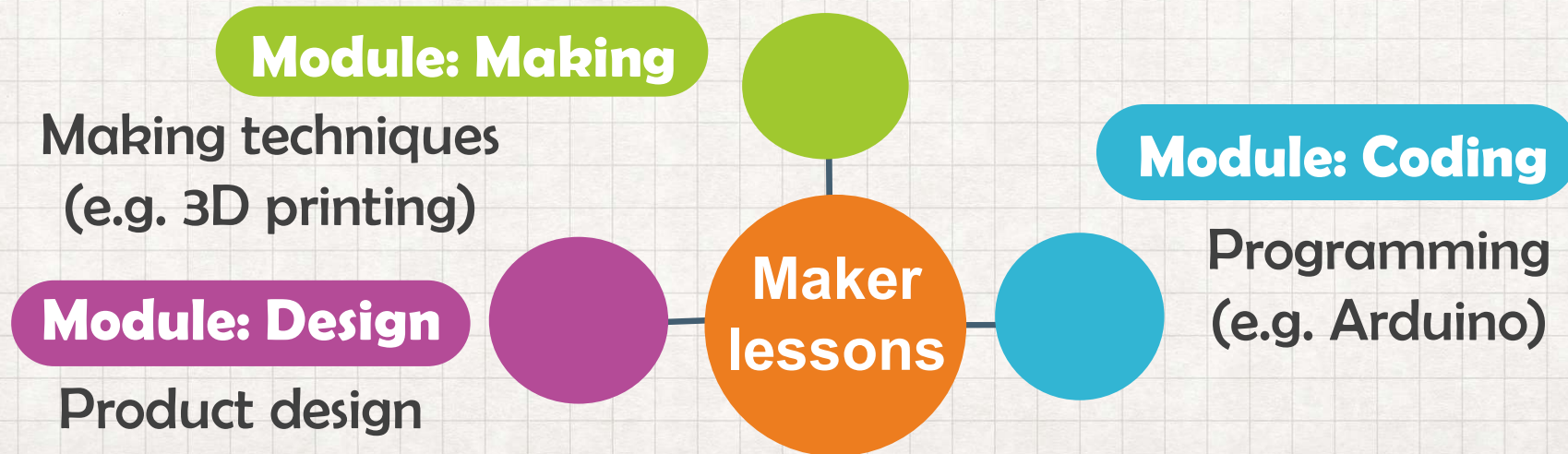| E-services	Cloud, Internet of Things Smart Devices, RFIDs and Sensors
Transport Systems	
Smart Traffic Management	
Health Cards	
Water Level Monitoring	IoT Applications for Smart City

The Maker lessons

Objective:

To provide students with opportunities to integrate and apply knowledge and skills they have learned from different subjects to solve real-life problems

Experiential learning

Module: Making

Making techniques (e.g. 3D printing)

Module: Design

Product design

Maker lessons

Module: Coding

Programming (e.g. Arduino)

Infusing STEM education into the English classroom:
Promoting a new product designed in Maker Class

1. Designing tasks, activities and projects to encourage students to work out innovative solutions to problems or create new ideas to enhance their creative capacity

Name: _____ (   )   Class: 2 C / D   Group: _____   Date: _____

A creative robot writes poems
(Taken from P4, Junior Standard, 1st September, 2017)

For some time, it was believed that rigid, predictable computer programs could not create art. But in May, a book that contained poetry composed by artificial intelligence (AI) was published.

5   A collection of Chinese poetry, titled The Sunlight That Lost the Glass Window (陽光失了玻璃窗), was written entirely by Microsoft's AI, Xiaoice (微軟小冰), which had studied the poetry of some 519 poets – a task that would take an ordinary human 100 years. It is also capable of being 'inspired' to write poetry after looking at pictures, and has already been publishing some of its
10   works on Chinese online forums since February. Few people realized they were written by a machine.

     Critics are divided on the idea of poetry written by a computer. Some critics accepted the AI-written poetry, and even thought it had a unique style. Other poets, however, rejected the work, saying that a computer program that has not experienced real life cannot create truly
15   emotional poetry. That could all change in the future.

3. Providing scaffolds to help students develop and apply knowledge and skills in an integrative manner
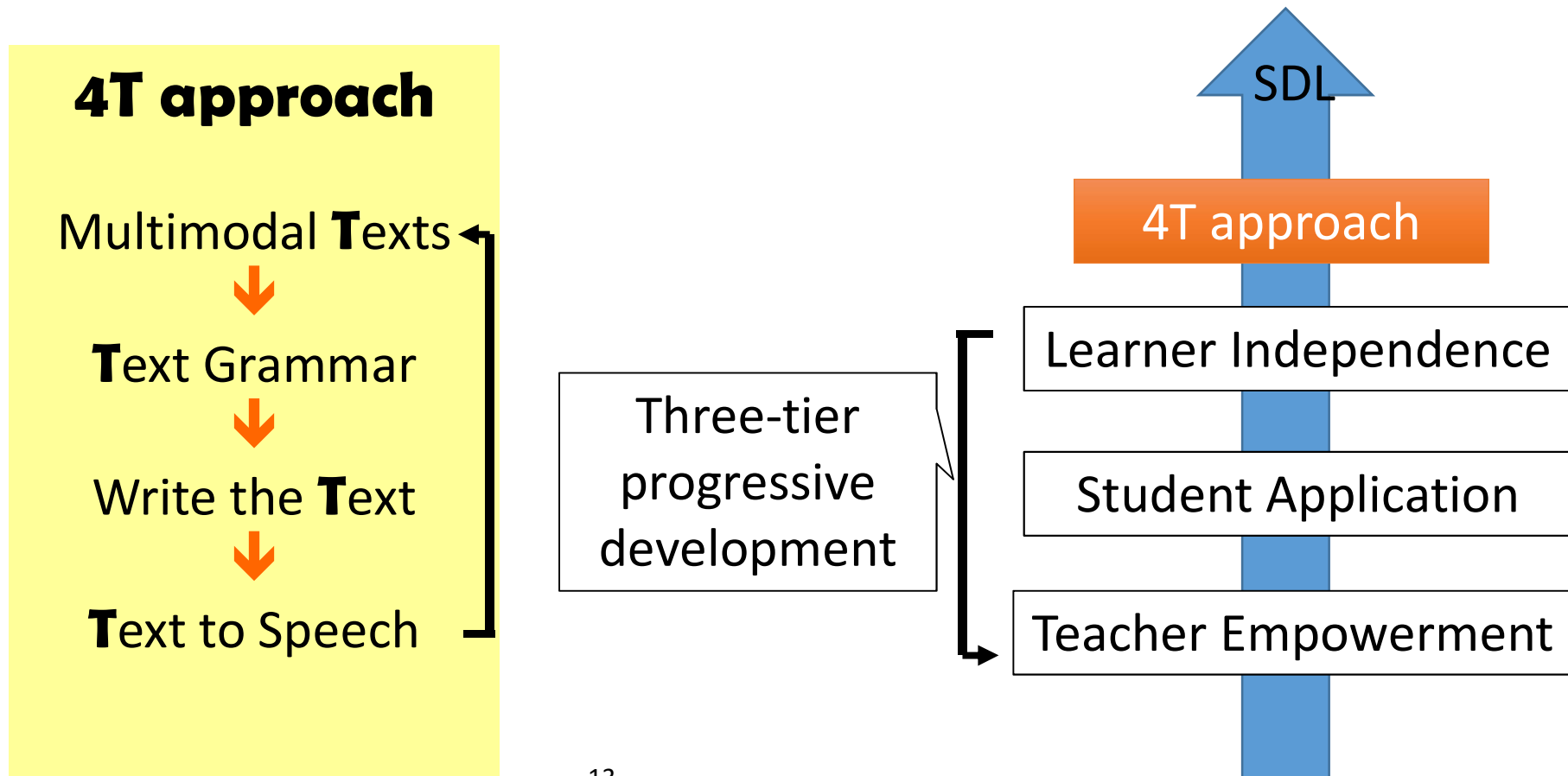
Using English to present the products during English lessons

Experiential learning task:

You work for one of the three technology companies. Being the marketing team of the company, your responsibility is **to convince the officers from different government departments to support installing your product in Hong Kong**.

How English teachers help their students develop grammar knowledge and language skills

A three-tier progressive development of self-directed learning (SDL) through the 4T approach

4T approach

Multimodal **T**exts

⬇

Text Grammar

⬇

Write the **T**ext

⬇

Text to Speech

Three-tier progressive development

SDL

4T approach

Learner Independence

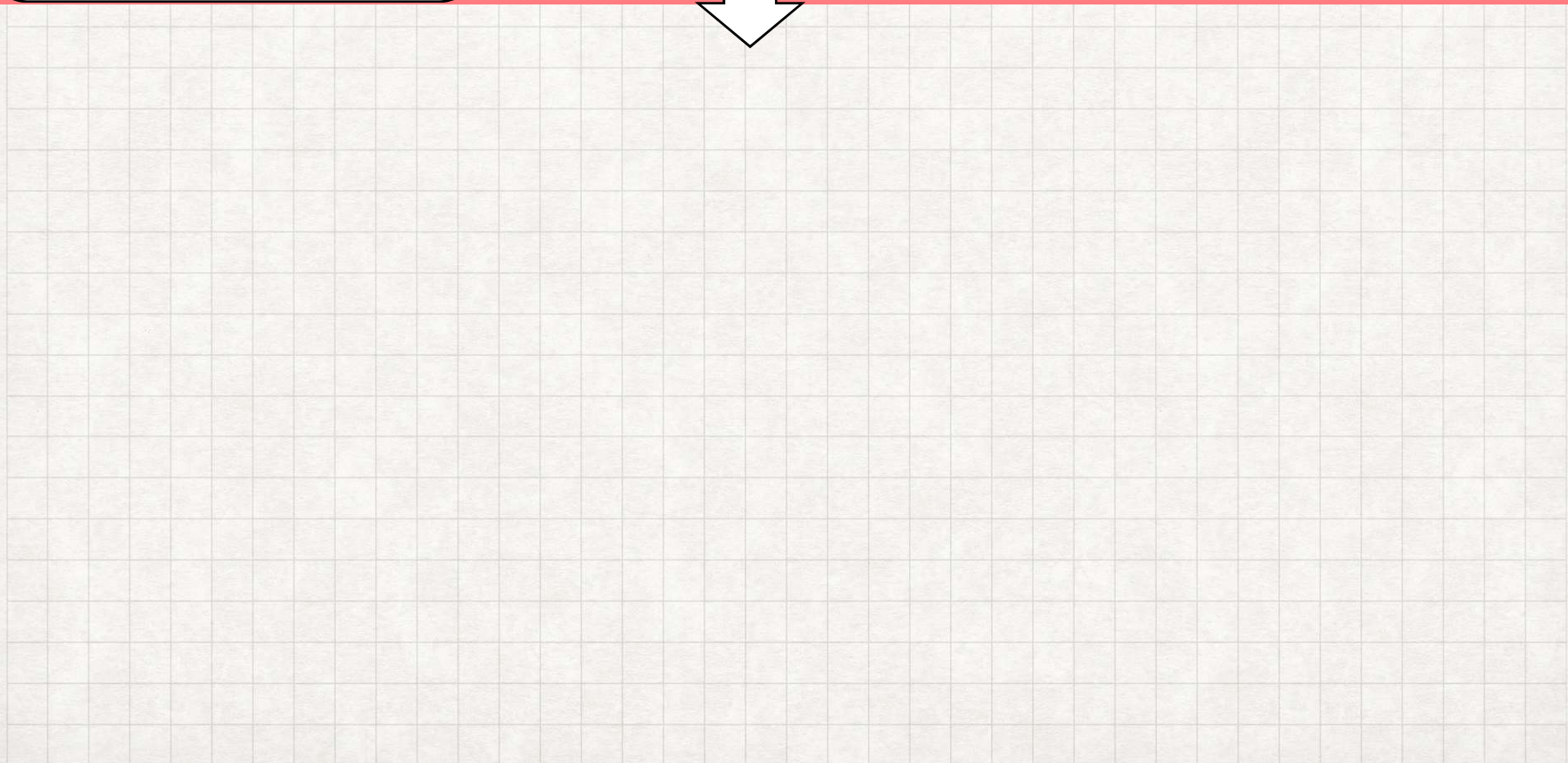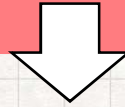Student Application

Teacher Empowerment

How English teachers help their students develop grammar knowledge and language skills

Sample Texts
- Use promotional materials (e.g. posters, leaflets, presentation speeches) about two smart products

Text structure

Text grammar

S.2 English Group D

STEM in English 2018-19

Name: _____

Class: _____ ( )

How to Explain How a Product Works

introduce your product in a video, how are you going to do so? Here are examples for you! Learn from them and write your own scri

The Aquaponics

1 This is our aquaponic system.

2 At the moment, we have sensors to detect the pH value and the temperature of the water. These sensors are connected to the microcomputer control board, which will sync the data collected to a cloud server, and the cloud server will store the data.

3 We have also designed an app to monitor all the data. It is very user-friendly. On the screen of the program, we use a clownfish to indicate the water quality. The temperature and the pH value are shown on the screen. When the water temperature is 26 degrees, the fish will turn orange to indicate that the water temperature is acceptable. As you can see, if the water temperature is 39 degrees, the clownfish becomes red. It is too hot for the fish in the tank. In our app, we use the clownfish. It is red, orange and white. We choose it because it is the most favourite fish in our school. We think that it can represent our aquaponics system.

4 This device is super-useful. It can make our life easier and more convenient. In the past, you might probably need to check the water temperature and pH value at the fish tank. However, if you use this device, you can check the data anytime and anywhere. You can read the data when you are shopping, working or having a party. As you can constantly control the water quality, your fish will grow faster and live more happily.

Smart Stove Alert

1 This is called Smart Stove Alert. It is used for minimizing the chance of leaving stovetop fire unattended.

2 The way it works is very simple. Once the stove is lit, it will be detected by the fire detector connected to the mini processing unit. Then, the indicator light will go on and the system will start playing voice reminders through the loudspeakers.

3 There are two types of voice reminders. The first type is a basic reminder that plays regularly once a lit stove top is detected. The second type is linked to the front door of the household – whenever the system detects that the front door is opened while a stovetop is lit, it immediately alerts the elderly that he/she shouldn't leave the house without turning off the stove.

4 We also added a human touch to the system by using human voice recordings that address the elderly directly.

5 The time intervals for the regular reminders are customizable. There is also a range of human voice reminders to choose from in order to cater for different users.

6 One more good thing about this Smart Stove is that it was made by widely available materials such as infrared sensors and alarm sirens, at a cost of just HK$150.

Name

Name

How it works

How it works

What happens in different situations

The selling points

Other features /selling points

Making use of students' writing and presentation scripts (for competitions) to develop the sample promotional texts

Aquaponics

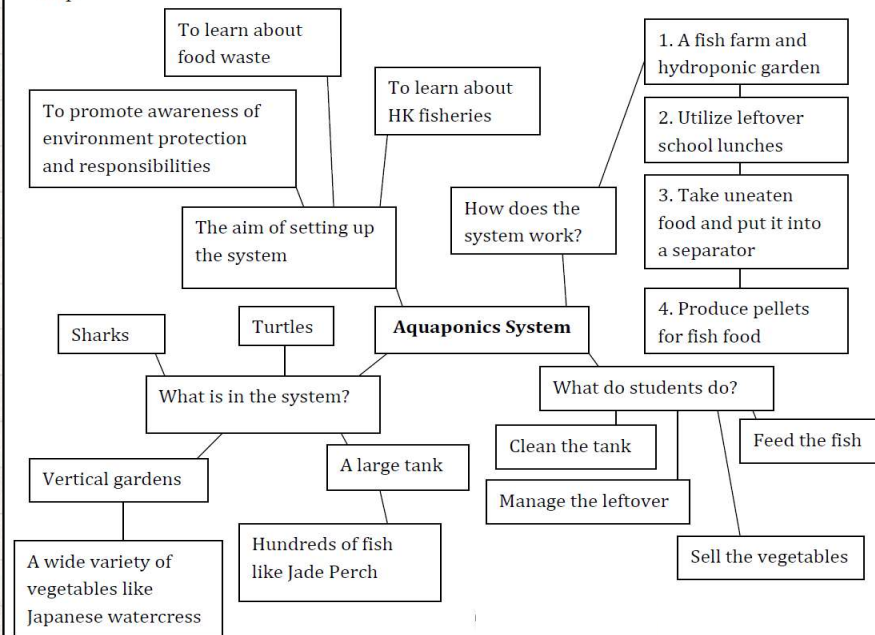S.2 English   Marks: _____/20

Name: _____ (   ) Class: _____   Date: _____

Writing Assessment 3 (Unit 8)- Writing an article

You are the editor of the school magazine. You are going to write an article to introduce the **Aquaponics System** in our school.

Brainstorming ideas
Look at the mind map below. Discuss with your classmates and try to add more ideas to the mind map.

- To learn about food waste
- To learn about HK fisheries
- To promote awareness of environment protection and responsibilities
- The aim of setting up the system
- How does the system work?
  - 1. A fish farm and hydroponic garden
  - 2. Utilize leftover school lunches
  - 3. Take uneaten food and put it into a separator
  - 4. Produce pellets for fish food
- Sharks
- Turtles
- **Aquaponics System**
- What is in the system?
  - Vertical gardens
    - A wide variety of vegetables like Japanese watercress
  - A large tank
    - Hundreds of fish like Jade Perch
- What do students do?
  - Clean the tank
  - Manage the leftover
  - Feed the fish
  - Sell the vegetables

Smart stove alert
to remind the elderly to switch off the stove

Product Name: Smart Stove Alert

Product-design Rationale

Product description

Product Components

The Working Process

Product Name: Smart Stove Alert

Product-design Rationale:

- According to the local fire brigade, most cases of kitchen fires are caused by unattended cooking.
- The elderly people are found to be the most vulnerable group when it comes to kitchen fires. They are likely to forget that they have left the stovetop on or have left food cooking on the stove unattended.
- Many elderly people in HK are living alone and they are especially prone to such home accidents as they have no one to remind them of lit stovetops.

> What would the elderly need to prevent such accidents?
> They need reminders!
> They need alerts!
> How could that be done without people by their sides?
> With the help of modern technology, I wish to create a safe cooking and living environment for the elderly.

Product Description:

- This is a smart kitchen alert system that detects stovetop fire and automatically plays voice alerts that remind users that the stovetop is turned on, and that they should not leave it unattended.

Product Components:

1) The fire detector
2) The mini processing unit
3) The indicator light
   (The indicator light goes on / will go on // ~~The~~ indicator lights up / will light up)
   (When the indicator is lit / ~~When~~ the indicator light is on)
4) Speakers/Loudspeakers: The speakers are embedded in the system.
   (The indicator light goes on/will go on // ~~The~~ indicator lights up/will light up)
   (When the indicator is lit/When the indicator light is on)

The Working Process

- Once the stove is lit, it will be detected by the fire detector connected to the mini processing unit. The indicator light will go on. And the system will start playing voice reminders through the loudspeakers.
- There are two types of voice reminders.
- The first type is a basic reminder that plays regularly once a lit stove top is detected.
- The second type is linked to the front door of the household – whenever the system detects that the front door is opened while a stovetop is lit, it immediately alerts the elderly that he/she shouldn't leave the house without turning off the stove.
- We also added a human touch to the system by using human voice recordings that address the elderly directly.

> For example, the system will play, "Granny, granny! You need to get back to the kitchen! The fire is on and the pot is boiling over!".
>
> And in cases when the elderly opens the front door to leave the house while the stove is on, the system will warn, "Grandpa! Do not leave the house! You need to turn the burner off!"
>
> What makes it even more human-like is that, once the alert system is set off, the 'intonation' and the amplitude of the voice warnings get stronger and stronger over time.

- The time intervals for the regular reminders are customizable. There is also a range of human voice reminders to choose from in order to cater for different users.

S.2 English Group D

Name: _____

Class: _____ ( )

STEM in English 2018-19

How to Explain How a Product Works (2)

Text Structure

Read the examples given to you yesterday and fill in the following table.

Content	Paragraphs	
	The Aquaponics	Smart Stove Alert
• Introduce the ___name___ of the product • ___Define___ what it is used for	1	1
• How it ___works___ : Explain what parts are connected and how they work together (* ___Sequence___)	2	2
• What ___happens___ in different ___situations___ (* ___Situations___)	3	3
• Other ___features___	/	4, 5
• The ___selling___ point	4	6

Now, you know **what to write** in the script.

However, **how to write** it?

What **useful words/ phrases** can you use to write each part?

1

8

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Part 1: Introduction

To tell the **name**	
To define its **function**	

Part 2: How it works (Procedures)
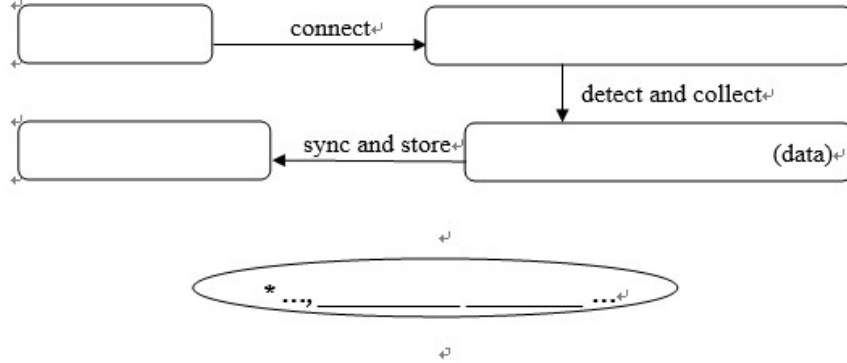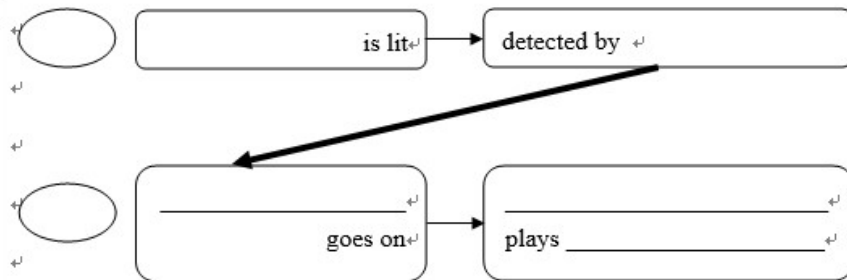
The Aquaponics	
Smart Stove Alert	
Other useful words for writing about procedures	

Diagram: [ ] → connect → [ ] → detect and collect → [ ] (data) ← sync and store ← [ ]

* ...,_____...

Smart Stove Alert: ( ) [is lit] → detected by → [___ goes on] → plays ___

- This is called…
- It is used for…
- We have… to …
- … are connected to… (passive voice)
- Once …
- Then, …
- …will...

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Part 3: What happens in different situations (Situations)

The Aquaponics	( ) Water temperature = ____ °C → The fish turns _____
	( ) Water temperature = ____ °C → The fish turns _____
Smart Stove Alert	( ) _____ is lit → plays _____
	( ) the system detects _____ + _____ → _____ the elderly
Other useful words	

Part 4: Other features

When you write about the other features, you write about their functions/ purposes.

Smart Stove Alert	We also added a human touch to the system by using human voice recordings ( ) address the elderly directly.
	There is also a range of human voice reminders to choose from ( ) cater for different users.
Other useful words	

Part 5: Selling points

We use a lot of comparatives and superlatives and positive adjectives to persuade audience to believe us.

	Comparatives and Superlatives	Positive adjectives
The Aquaponics	a. The clownfish is _____ _____ _____ fish. b. It can make our life _____ and _____ _____ . c. Your fish will grow _____ and live _____ _____ .	user-friendly, easier, super-useful, more convenient, etc.
Smart Stove Alert	/	Customizable, good, available

- When…
- If…
- There are two types of…
- As you can see, …
- We think that it can…
- Whenever…
- …that…
- in order to …
- Adjectives
- Comparatives/ superlatives

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How English teachers help their students develop grammar knowledge and language skills

Sample Texts
- Use promotional materials (e.g. posters, leaflets, presentation speeches) about two smart products

Text structure

Text grammar

Multimodal Texts
- Watch videos about how to introduce a product

Write the text
- Introduce the product

Speak the text
- Produce a video → Upload to Schoology → Give comments

How to Explain How a Product Works (4)

|	
(1) Name & Function	
(2) How it works (Procedures) - First, - Then, - After that, - Once	
(3) What happens (Situations) - When - While - Once - Whenever	
(4) Other features (If any) - in order to - so that	
(5) Selling points - Comparatives & superlatives - Positive adjectives	

Catering for learner diversity

How English teachers help their students develop grammar knowledge and language skills

Sample Texts
- Use promotional materials (e.g. posters, leaflets, presentation speeches) about two smart products

Text structure

Text grammar

Multimodal Texts
- Watch videos about how to introduce a product

Write the text
- Introduce the product

Speak the text
- Produce a video → Upload to Schoology → Give comments

Sample Texts
- Debate scripts

Text structure

Text grammar

Write the text
- Write a debate speech
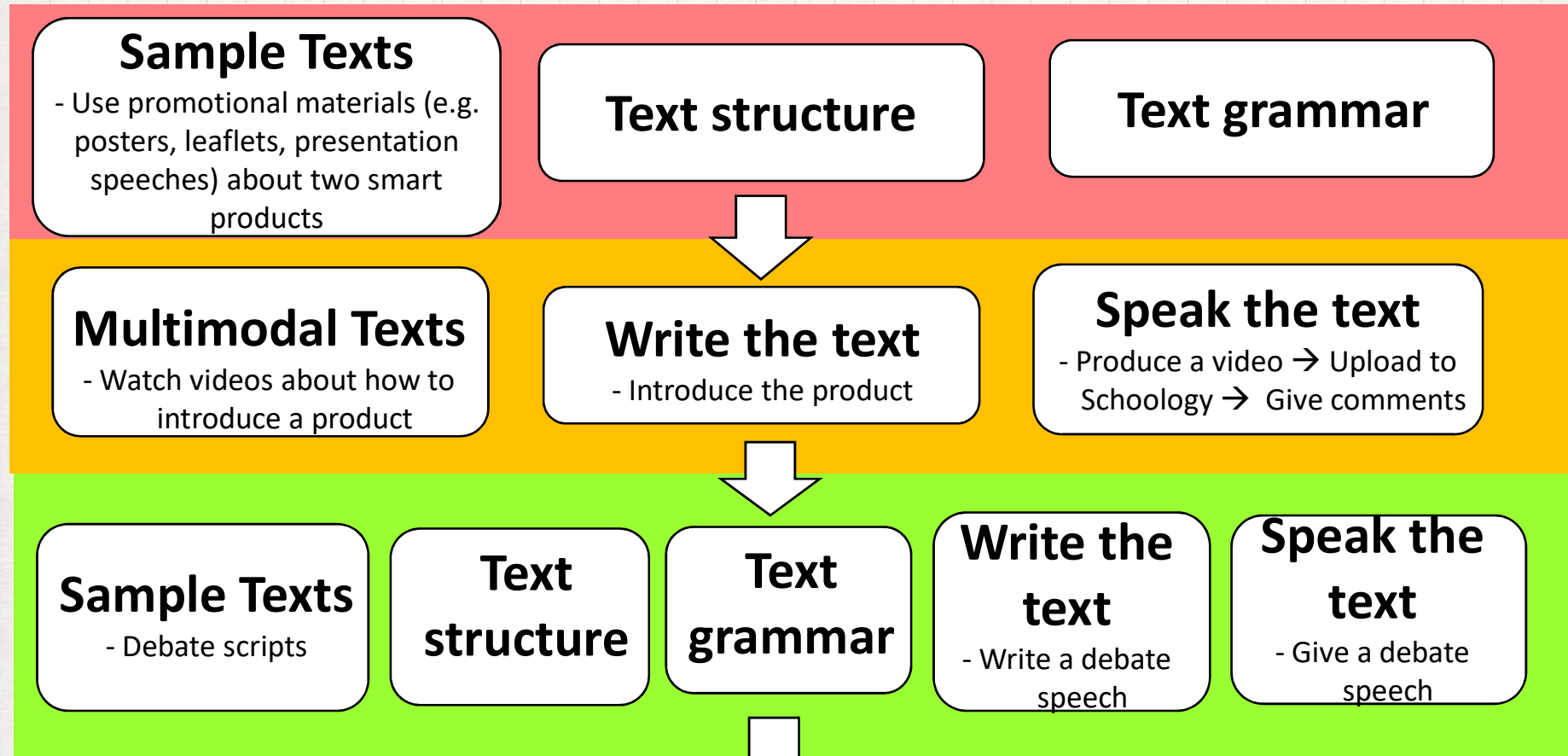
Speak the text
- Give a debate speech

Speaker 1
(define the motion, address the problem(s) and quote figures)

Speaker 1: Cue card # 1

Good morning officers, teachers and fellow students

Polite opening- address the audience

Speaker 1: Cue card #1

Good morning officers, teachers and fellow students,

The motion for today is 'The government should install Smart Escalators in Hong Kong'. I am speaking for the motion. I do agree with installing Smart Escalators here. In fact, I believe that escalators are necessary items in our daily life. As the 1st speaker of the affirmative side, I wish to look at the importance of escalators from the perspectives of the community and the problems with the present escalators.

Expressions commonly used in debating

- addressing the audience politely
- stating the motion
- stating your stance clearly & powerfully
- using linking words to build coherence
- presenting the focus/ intention of the speech

Speaker 2
(describe the product and give details of how to solve the problem)

Speaker 2: Cue card #1

Good morning, everyone. Let me carry on by explaining our design.

First of all, our handrails are very special. We added light indicators and little speakers. **Why? This is because** they would be very useful in reminding particular passengers on different things. **For example**, if someone has not held the handrail, a light will go on and a voice reminder will be played to remind him or her.

Moreover, due to the fact that many accidents involved passengers wearing sandals while standing too close to the edges of escalators, we added a detector to the edge as well. **Once** there are objects getting too close to the edge, there will be voice reminders and light indicators.

Persuading the audience their design is the best:

- using questions
- giving reasons & examples
- using positive adjectives

today must be carried.

Speaker 3 (refute and summarise)

Speaker 3: Cue Card # 1

Good morning, everyone. After listening to all the three sides, you may wonder, 'Why should the government install Smart	-using repeated rhetorical questions to give a summary of arguments to appeal

Speaker 3: Cue card #1

<u>Good morning, everyone</u>. After listening to all the three sides, you may wonder, 'Why should the government install Smart Escalators but not the other two?' The answer is simple – This is about safety. There are more than 65, 000 escalators in Hong Kong. Just imagine **if** one person gets hurt when he uses an escalator, there will be 65, 000 people getting hurt! That's a lot! Also, **as you know**, very often, there is more than one victim in each accident. Clearly, the safety of escalators is **more vital than** we can imagine. **In addition**, escalators are things **which** tourists must come across in Hong Kong. **If** they get hurt, the reputation of Hong Kong and the tourism will get **worse**. Does the government want to risk this by not installing Smart Escalators?	Intensifying the tone to persuade the audience their design is the best: • using repeated rhetorical questions to appeal to emotions • quoting facts/figures • using comparatives and superlatives

service and traffic time **more important** that we should sacrifice our safety for them?

S.2 English Group D

Name: _____

Class: _____( )

STEM in English 2018-19

Debate (3)

During the debate, jot down notes in the table below. They will be useful for your writing. Also, choose the best debater and explain why he/she is the best.

	Smart Post Boxes	Smart Traffic Lights	Smart Rubbish Bins
Why created this? Any data/ facts to support it?			
How it solves the problem(s) - Special things			
Why better	Better than Smart Traffic Lights Better than Smart Rubbish Bins	Better than Smart Post Boxes Better than Smart Rubbish Bins	Better than Smart Traffic Lights Better than Smart Post Boxes

Best Debater: _____ [Refer to note Debate (2).]

Two stars	He/ She did well in (ing)_____ and (ing)_____
One wish	I wish he/ she can do better in (ing)_____ next time.

Delivering a persuasive speech

⊹ SCORE SHEET

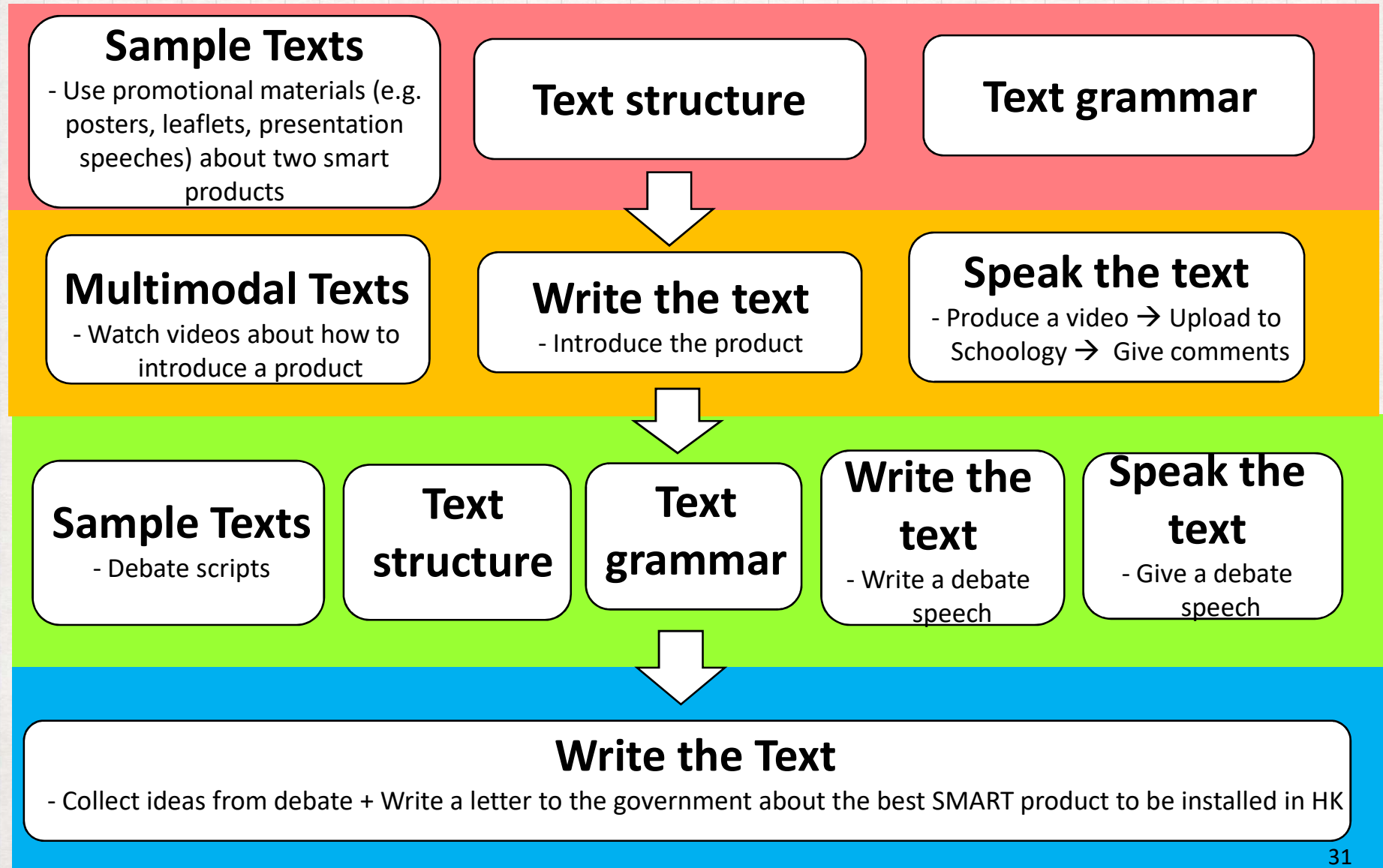| Content	• Have clear logical flow of ideas • Have relevant arguments • Have clear organisation • Support the ideas well by using examples & data	
Language	• Speak clearly and accurately • Use suitable words & expressions • Use appropriate linking words • Use persuasive language (e.g. rhetoric/ emotional appeal)	
Voice	• Speak loudly and forcefully • Enunciate words clearly	
Fluency	• Speak with confidence & energy • Show passion and conviction • Speak with a comfortable flow pausing when necessary • Stress important words and phrases when necessary	
Poise	• Stand up straight • Hold cue card down and look up when speaking • Refer to cue card only when necessary • Have eye-contact with audience • Use appropriate gestures • Have suitable facial expressions	

Rehearsals help!

Step 7: Showcasing the SMART products

Step 8: Convincing the government officers to support installing the SMART products in Hong Kong

How English teachers help their students develop grammar knowledge and language skills

Sample Texts
- Use promotional materials (e.g. posters, leaflets, presentation speeches) about two smart products

Text structure

Text grammar

Multimodal Texts
- Watch videos about how to introduce a product

Write the text
- Introduce the product

Speak the text
- Produce a video → Upload to Schoology → Give comments

Sample Texts
- Debate scripts

Text structure

Text grammar

Write the text
- Write a debate speech

Speak the text
- Give a debate speech

Write the Text
- Collect ideas from debate + Write a letter to the government about the best SMART product to be installed in HK

STEM in English 2018-19

Class: _____ ( )

Writing a Letter

Write a letter to the government to persuade it to install one of the following smart products. *(Please tick.)*

☐ Smart Rubbish Bins   ☐ Smart Post Boxes   ☐ Smart Traffic Lights

Why? *(In point forms. You may exact ideas from the debate materials in Schoology.)*

Reason 1	

Reason 2	

Reason 3	

What is your suggestion on how to make the smart product even better?

Suggestion	

Dear officers,

There are more and more smart products invented in the market these days. I believe that the government should install _____ because of the following reasons.

The first reason is that

_____

_____

_____

_____

_____

_____

The second reason is that

_____

_____

_____

Last but not least, _____ should be installed because

_____

_____

_____

_____

To make the smart products even better, I think

_____

_____

_____

_____

_____

Thank you very much for your attention. I hope you can install the smart products suggested to Hong Kong one day for our better future.

Yours sincerely,

_____

S.2 English Group D

STEM in English 2018-19

Writing a Letter

Name: _____

Class: _____ ( )

Write a letter to the government to persuade it to install one of the following smart products. *(Please tick.)*

☐ Smart Rubbish Bins ☐ Smart Post Boxes ☐ Smart Traffic Lights

Choose ONE

Why? *In point forms.* *You may extract ideas from the debate materials in Schoology.)*

Reason 1

THREE reasons

TREES

Topic sentence
Reasons
Examples
Effects
Summary/ **S**uggestions

33

What is your suggestion on how to make the smart product even better?

Suggestion	
TREE	**ONE** suggestion **ONLY**

Your turn!

Dear officers,

There are more and more smart products invented in the market these days. I believe that the government should install _____ because of the following reasons.

The first reason is that

The second reason is that

Last but not least, _____ should be installed because

To make the smart products even better, I think

Thank you very much for you attention. I hope you can install the smart products suggested in Hong Kong one day for our better future.

Yours faithfully,

_____

THREE reasons

ONE suggestion

Your **name**

Use Persuasive Language!

1) **Comparatives and superlatives**
   e.g. This is the best choice.
   e.g. It is better than other products.

2) **Positive adjectives**
   e.g. user-friendly, convenient, wonderful, beneficial, feasible

Use Linking Words!

3) **Procedures**
   e.g. first, next, then, after that

4) **Situations**
   e.g. when, if, whenever

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Impact of the project

Curriculum level

- collaborative problem-solving tasks → integration of knowledge and skills across disciplines

- use of technology (e-tools) → self-directed learning

- Students were given choices on what to create and how to present.

Impact of the project

Teacher level

- expertise in organising and implementing STEM-related English Language learning activities enhanced

  → Maker class teachers: guiding the students through the making of STEM products

  → English Language teachers: developing students' language skills

- professional capacity and collaboration strengthened

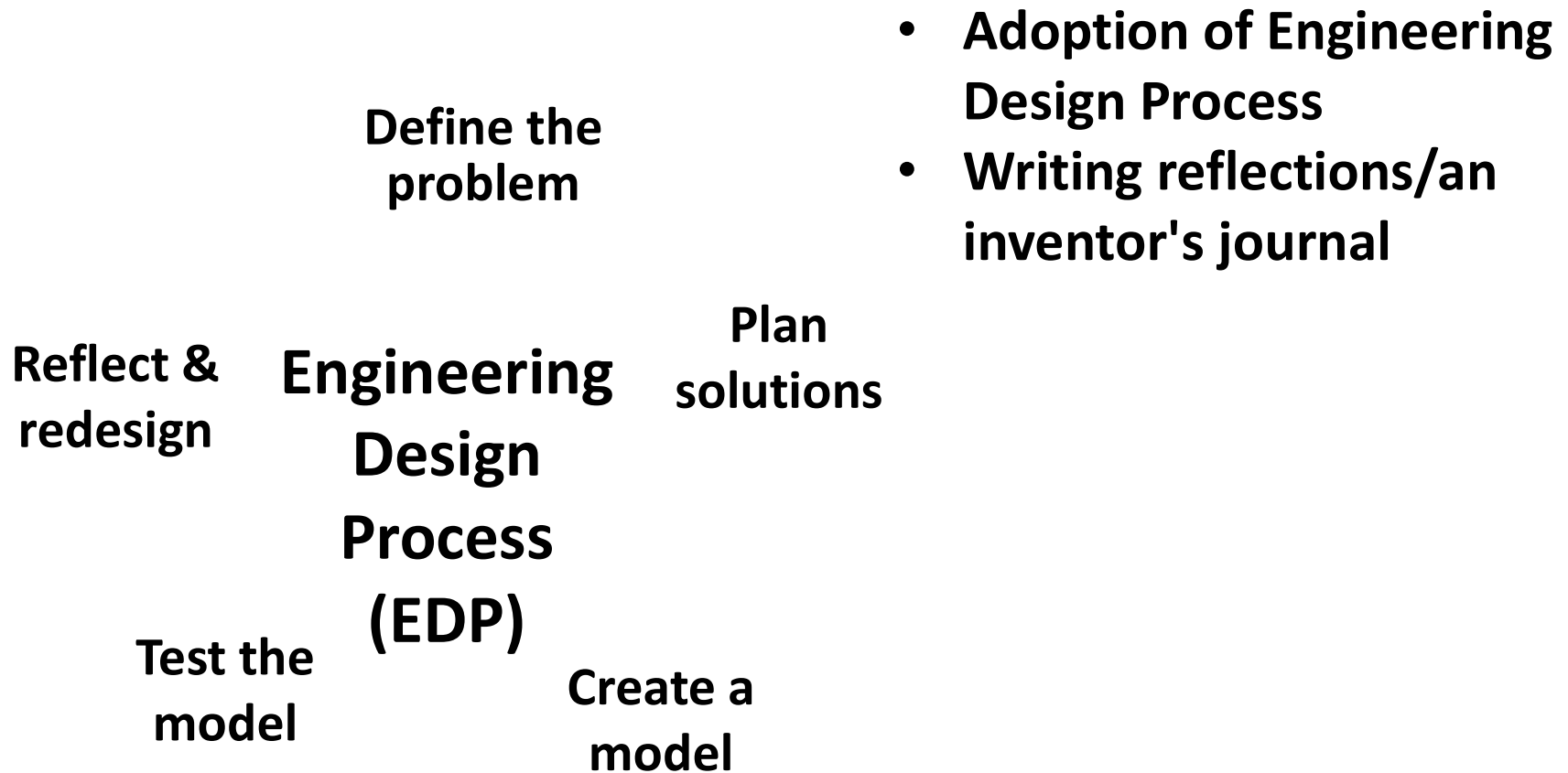## 4T approach

Impact of the project

Student level

- integrated and applied knowledge and skills across disciplines

- creativity, collaboration, problem-solving skills, innovation enhanced

- more motivated to learn and use English

- aspired to ever-improve their work

A video clip of students' revised video clips introducing their SMART products
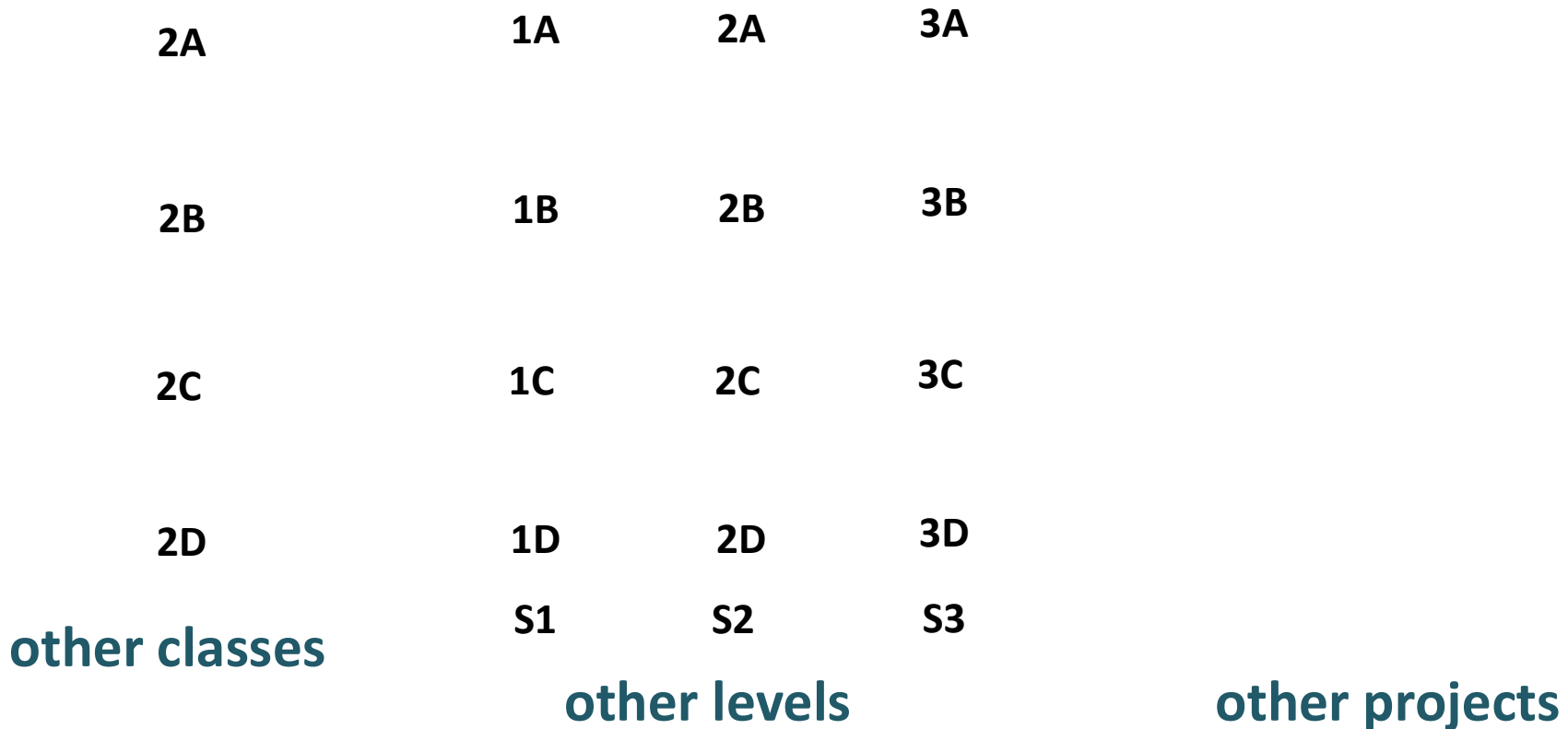
Way forward

Define the
problem

Reflect &
redesign

**Engineering
Design
Process
(EDP)**

Plan
solutions

Test the
model

Create a
model

- **Adoption of Engineering Design Process**
- **Writing reflections/an inventor's journal**

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Way forward

More collaboration between English teachers and Maker class teachers

Extending the practice to...

2A	1A	2A	3A
2B	1B	2B	3B
2C	1C	2C	3C
2D	1D	2D	3D
	S1	S2	S3
other classes			
	other levels		**other projects**

Thank You

Handouts

https://bit.ly/31Wuo55