

**Nurturing students' 21st century
skills through integrating
English into STEM Education**

Tak Sun Secondary School

School's background

Tak Sun Secondary School

Support level

S2

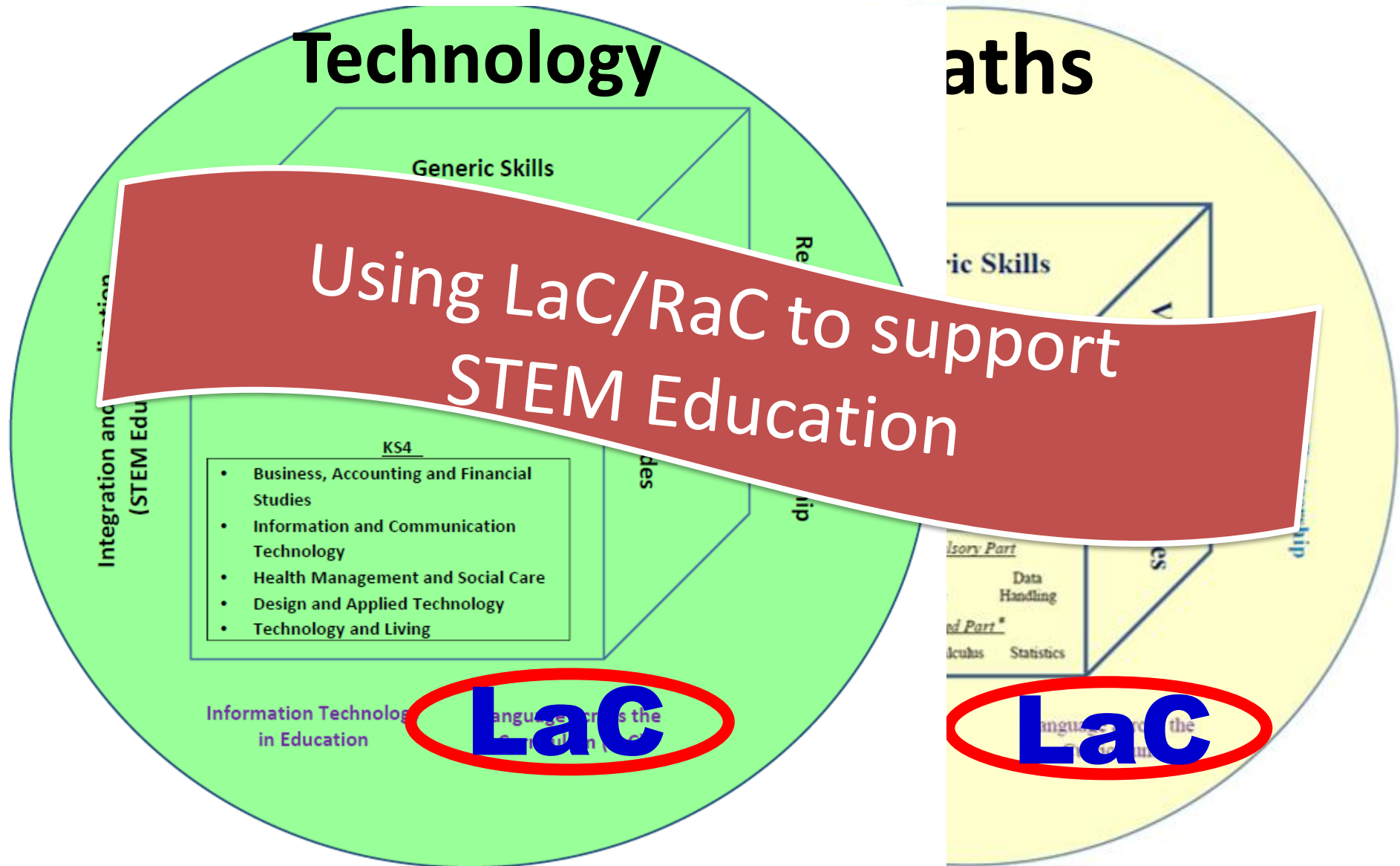
School concerns

1. How to support students in **using English** in **different KLAs**?
2. How to nurture students' **essential skills** (e.g. critical thinking, creativity, collaboration) in their learning?

School development goals

1. To increase students' language exposure through **cross-curricular planning** (e.g. LaC, RaC in support of STEM)
2. To provide students **with experiential learning** opportunities (e.g. STEM projects)

WHY integrating English into STEM Education



Relationship between STEM Education and 21st century skills

STEM curriculum incorporates the “four C’s” of 21st century skills: creativity, critical thinking, collaboration & communication. Students work together to create innovative solutions to real-world problems and communicate their solutions with others.

Sue Z, Beers. (2013) 21st century skills: Preparing students for their future.

STEM project

Product to be created	A solar water purifier
Aims	<ol style="list-style-type: none">1. To apply and integrate the knowledge & concepts learned in different KLAs through a cross-curricular project2. To solve some real-world problems (e.g. water pollution)

Criteria for making the purifier

Recyclable + low cost + easy to use

Content connections

Science:

Applying the concepts of evaporation and condensation

Technology:

Using 3D printing to create the water purifier



English

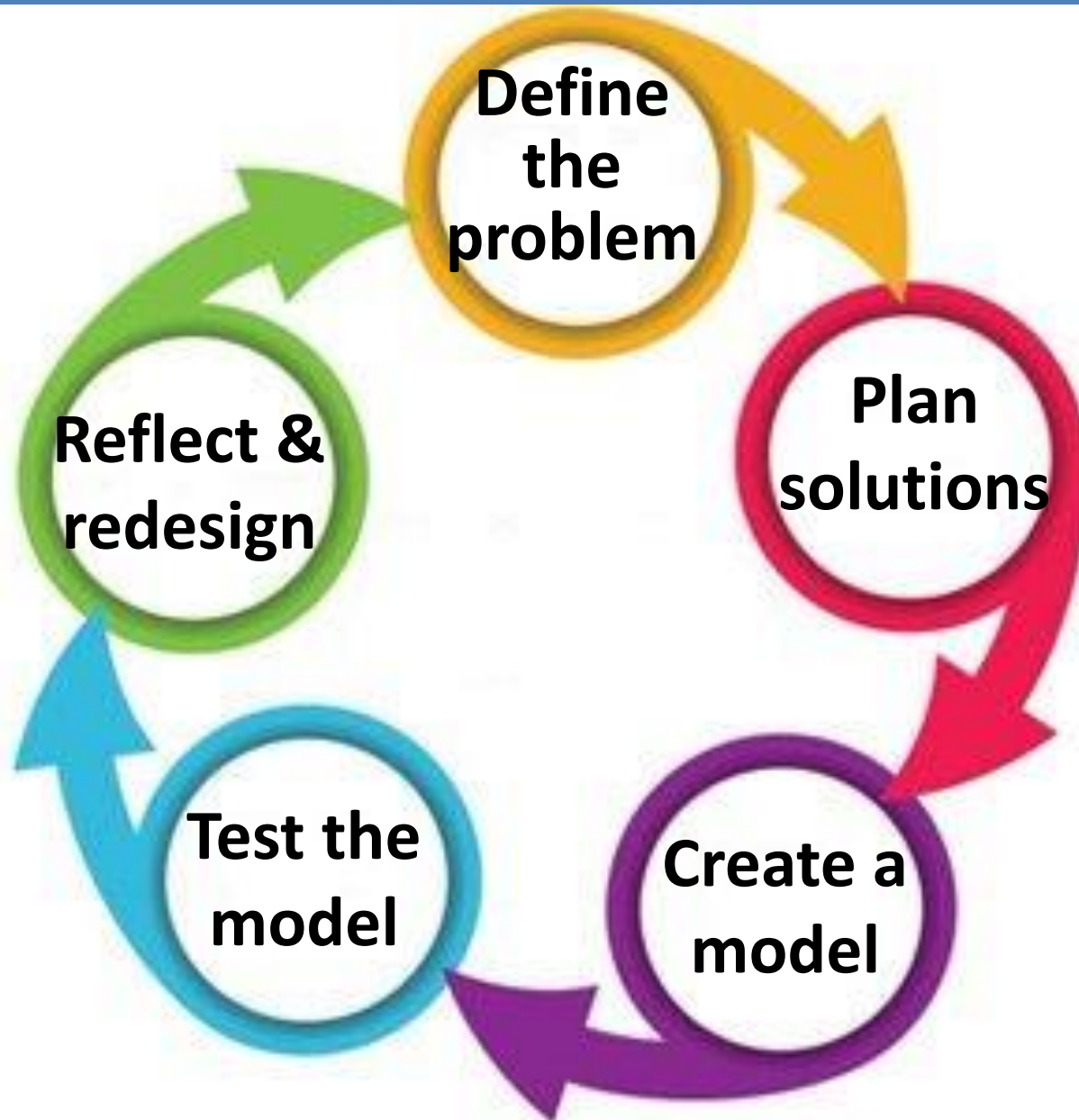
Engineering:

Applying the **Engineering design process**

Maths:

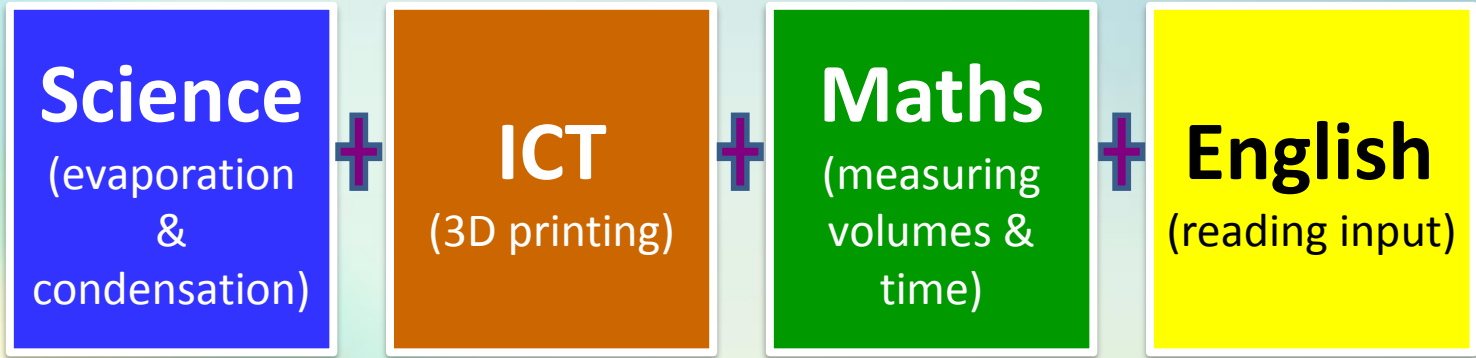
Measuring volumes and time

Engineering design process



Project design

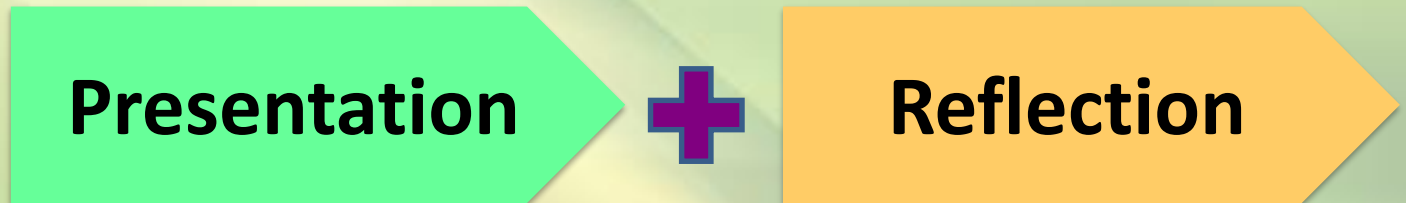
Pre-task
(input stage)



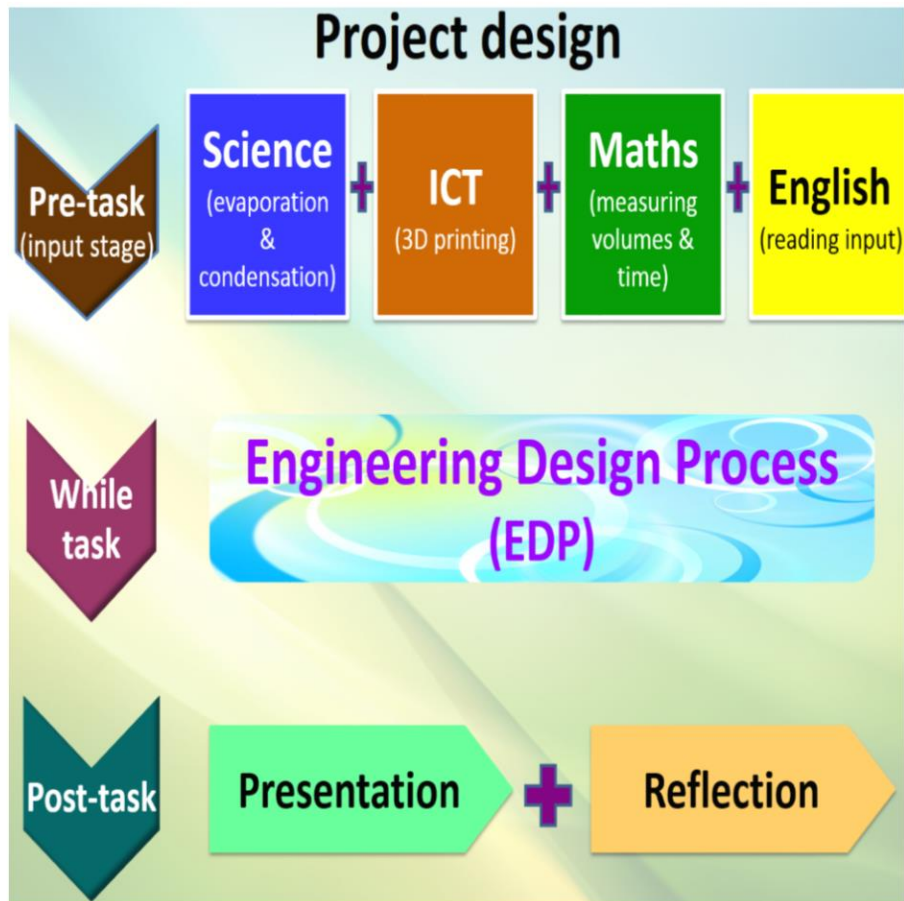
While task



Post-task



Role of the **English subject** in supporting the **STEM project**



Reading about some creative gadgets

Discussion skills for group interaction

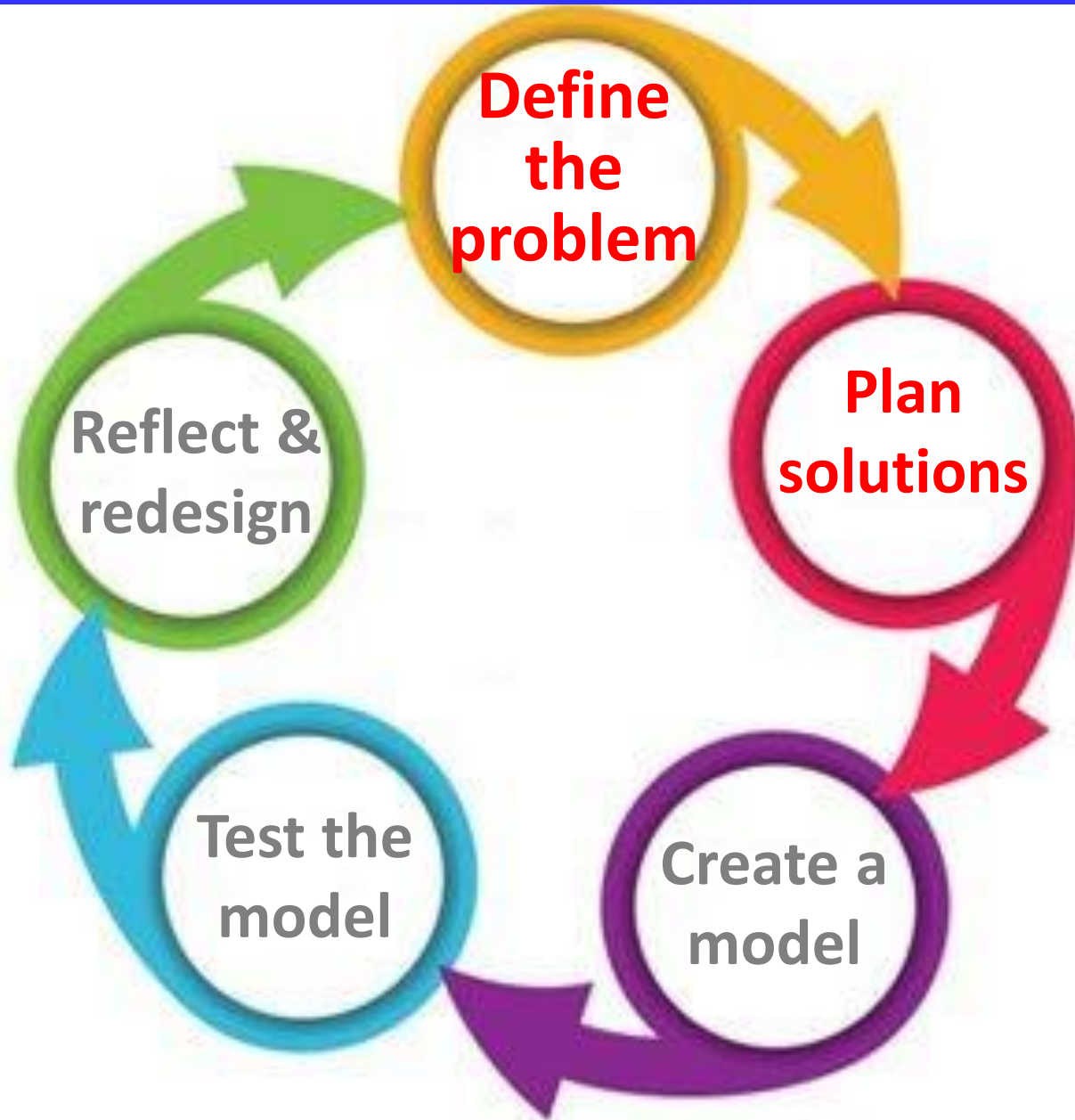
Speaking & writing for presentation & reflection

Holistic planning of the S2 STEM project

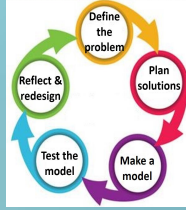
Subjects involved	Knowledge input	Tasks to do	Implementation schedule	
Science	Condensation & evaporation	<ul style="list-style-type: none"> - preparing the STEM booklet by setting questions at different stages of the EDP model with ICT teacher - introducing the EDP model to students - supporting students in identifying the problems and thinking of possible solutions when designing the prototype - helping students create and design a prototype and go through two trial tests - asking students to reflect on the prototype and redesign it after testing - helping students present their final product and evaluate their classmates' work 	-STEM project introduction	11/05/18
ICT	3D printing & drawing	<ul style="list-style-type: none"> - introducing 3D printing and drawing to students - setting questions to help students identify the problem and thinking of possible solutions when using 3D printing - using 3D printing to create the prototype 	-Knowledge input & planning	14/05/18
English	Reading, speaking & writing	<ul style="list-style-type: none"> - reading information texts about creative inventions - teaching the discussion skills to facilitate group discussions - teaching the writing and presentation skills for presenting the final product 	-1 st trial	21/5/18 and 25/05/18
				26/05/18 and 29/05/18
				23/05/18
			- Creating the prototype	28/05/18
			-reading input	04/06/18
			-discussing skills	18/05/18
			-presentation skills	06/06/18



Engineering design process



Define & Plan



Science & ICT	To support students in identifying the knowledge needed and the problems encountered when designing the purifier & using 3D printing	<ul style="list-style-type: none">➤ Problem-solving➤ Critical thinking
English	To arouse students' interest in creative inventions through reading some non-fiction texts	<ul style="list-style-type: none">➤ Application of reading strategies

Define & Plan

(2 marks)

b. Please write down the steps of making the purifier.

oded

(4 marks)

(+1 bonus: correct se

1) Pill a hole in each plastic screw top. Then, fasten them together using some hot glu.

2) Press-fit the screw tops onto the straw and screw on the bottle.

3) Wrap the aluminium paper around

4) Make sure the bottle with the lower bottle with the water need to be filtered.

Listing the steps of making the water purifier

- _____
- aluminium paper x _____
- Hot glu gun x _____

Define & Plan

(c) By searching the Internet, describe how 3D printing technology is used to solve

ICT

Problem-solving & critical thinking

Suggesting how 3D printing technology helps solve problems in industries and daily life

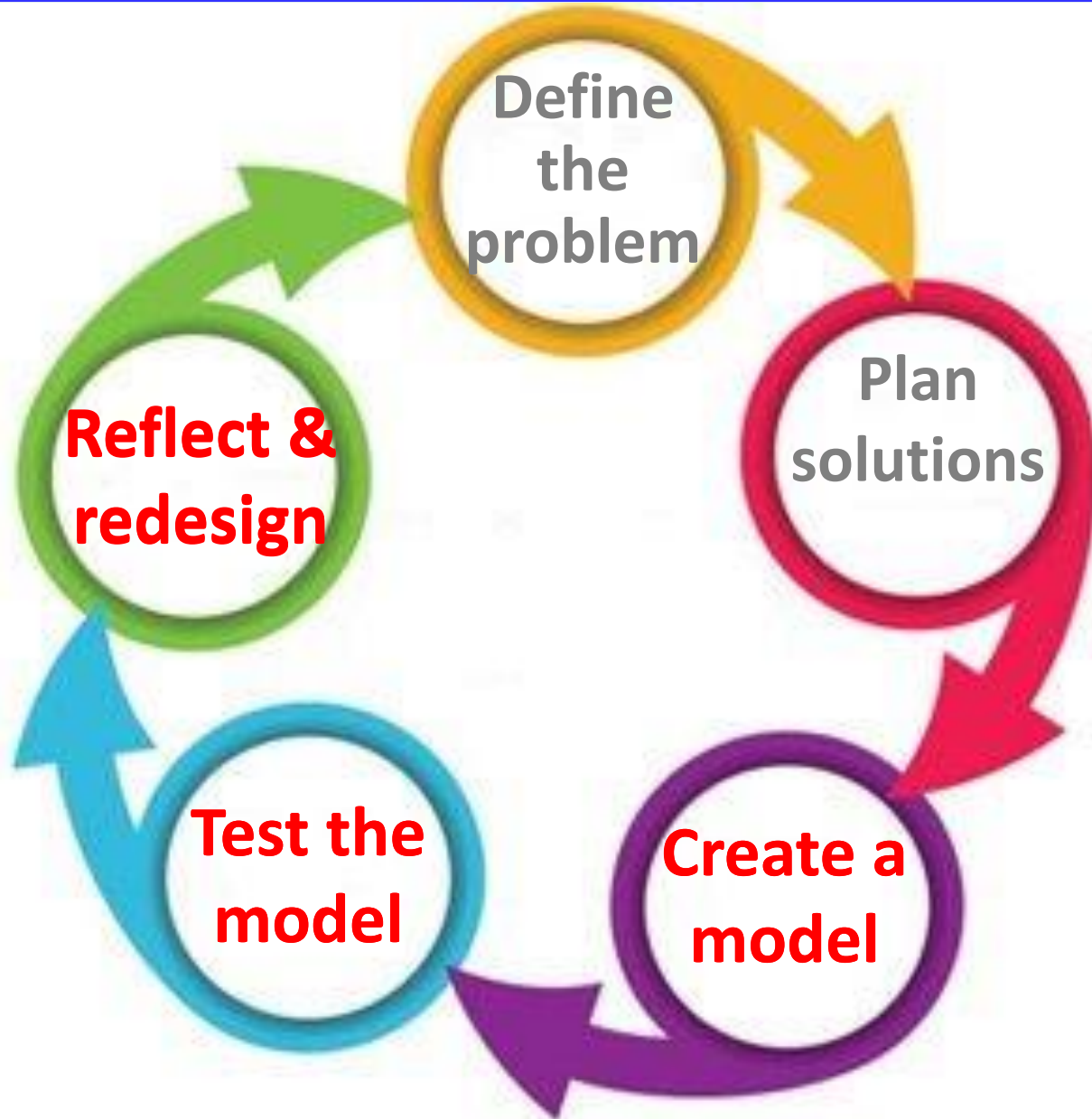
...as examining the stability of bridges and
... can be assisted with 3D printing. Printed scale models can be
used to put students' ...
understand their engine ...
tool to support a comprehensive STEAM-based makerspace. (2 marks)

Reading input

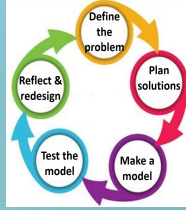
Preparing students for working out the features & design of their STEM products

Name of the product	
Country of origin, year of creation & inventor	
Product description: <ul style="list-style-type: none">- its design- its purpose- how it works- any special features	
Benefits	
Suggestion(s) that can improve the product	

Engineering design process



Create-Test-Reflect



Science, ICT & Maths

To give input to students to **create & design a 3D prototype** of the water purifier with the given criteria

- Creativity
- Problem-solving

English

To teach students the **discussion skills** for group discussion

- Communication
- Collaboration

Creating a prototype

a. Please write down the materials needed in the purifier. (2 marks)

<input type="checkbox"/> Water bottle	x 2	<input type="checkbox"/> Plastic wrap	x
<input type="checkbox"/> Long tube	x 3	<input type="checkbox"/>	x
<input type="checkbox"/> Glue	x	<input type="checkbox"/>	x
<input type="checkbox"/> CD		<input type="checkbox"/>	x

materials

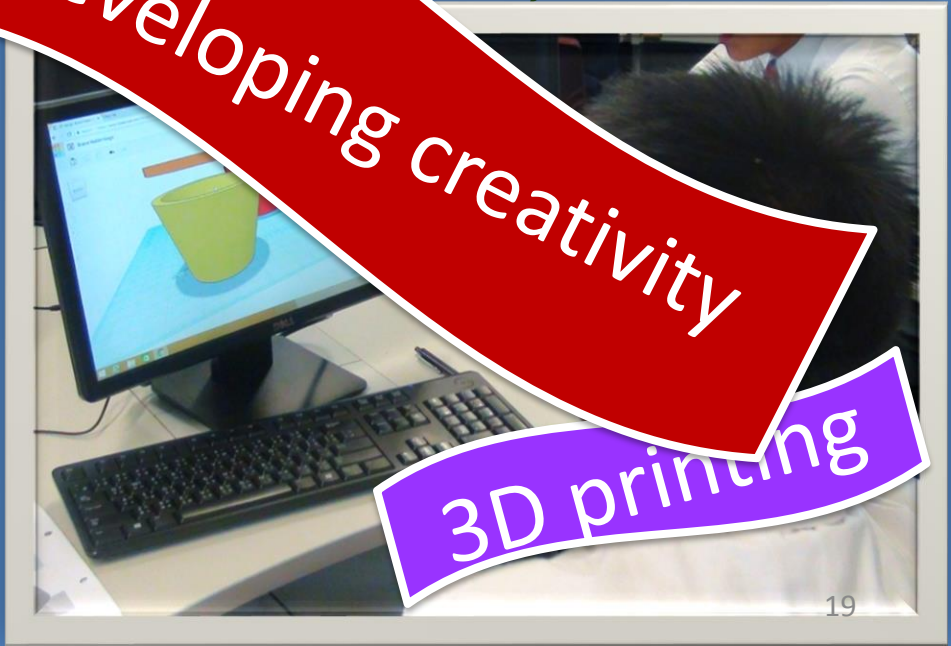
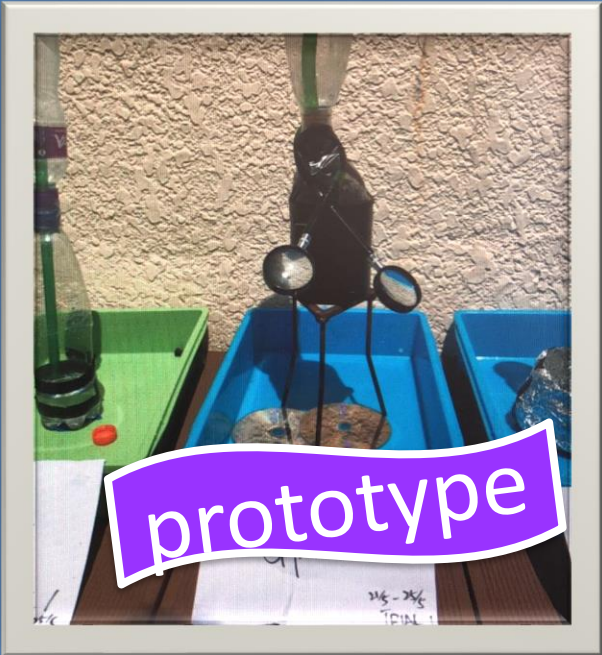
b. Please write down the steps of making the purifier. (4 marks)
(+1 bonus: correct sentence structure)

- 1) Put the mirror on the bottom of the tripod and the bowl
- 2) Insert both of the 3D printings over the bowl,
- 3) Insert two plastic cones into the 3D printing and put insert the end
- 4) set-up the magnifying glass and let the sun shine on the magnifying glasses

4 + 1

steps

Developing creativity



Creating a prototype

When comparing different kinds of water purifiers in the commercial market, in what ways do you think your product is better than others or more useful?

My water purifier can be use on camp . It

light & convenient

to bring while camping hiking and traveling . It is effective against many

can fight against many kinds of bacteria

I think it's not the worst, it is relatively low cost, basically

low cost

only 2 bottles of water is required. For balancing its

efficiency, no tubes are used or needed in making our

purifier. Ours is **small in size** it will be way better

if we enlarge it.

Given: 200 cm³

Create-Test-Reflect

Cycle 1



2T STEM project – Solar Water Purifier
Create-Test-Reflect (cycle 1): 21

Do these purifiers meet all the criteria?

Collect maximum amount of clean water in 5 days under same conditions.

Given: 200 cm³ ...

Create-Test-Reflect

Cycle 2



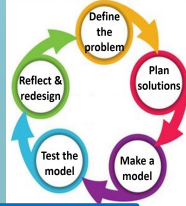
NEVER GIVE UP



2T STEM project
Solar Water Purifier
Create-Test-Reflect (cycle 2):
28/5 10:00am – 1/6 8:30am

Collect maximum amount of clean water in 5 days under same conditions.

Create-Test-Reflect



After testing, write down any **problems occurred** and the **improvement you've made** to make it better.

☠ The dirty water can get sun light, and then evaporate, but it stick between the pipe and the bot

✌ We cut the pipe to the suitable height, and the water being

☠ We use an other method +

✌ We cut the hole m

☠ The dirty water get eva water can't drop into the pipe accurate.

✌ We make cone and stick on the top of the bottle, and the not
can get into the pipe

Nurturing critical thinking and
problem-solving skills

Discussion skills

Getting everyone's attention to start

Getting started

Responding to others

Asking for an opinion

Responding to others

- What do you think of ...?
- What's your opinion of ...?
- In my opinion, ...
- Personally, I think that...
- It seems to me...
- As far as I'm concerned, ...

Giving an opinion

Agreeing

Keeping the discussion going

Encouraging everyone to participate

- So, what do you think?
- Does anyone have any ideas?
- John, what do you think?
- Mary, what do you think?

Disagreeing

- You're right.
- I think so, too.
- I (completely) agree with you.
- I don't really agree with you.
- I'm afraid I don't agree with you because...
- Well, I can see your point, but...
- I see what you mean, but...

Bringing people into the discussion

Clarifying

Drawing conclusions

Starting a discussion

- I'm not sure we all understand what you mean. Could you explain that again?
- That's an interesting idea. Perhaps let's finish this point first.
- Perhaps we should go on the next point..
- Are there any more comments before we move on to the next point?

Starting point

Adding other main points

Providing support

Getting attention

Interrupting

Reaching agreement and summing up

Drawing conclusions

- Excuse me, but...
- Sorry to interrupt, but...
- So, to sum up, we've decided...
- In conclusion,...

Project design

Pre-task
(input stage)

Science
(evaporation
&
condensation)



ICT
(3D printing)



Maths
(measuring
volumes &
time)



English
(reading input)

**While
task**

**Engineering Design Process
(EDP)**

Post-task

Presentation



Reflection

Presentation & reflection

Science & ICT

- To ask students to
 - **present** their final product & **evaluate** their classmates' work
 - **reflect** on the areas for improvement

English

- To teach students **how to present** their products in class
- To **give** students **instant feedback** on their presentations

- Presentation
- Collaboration
- Communication

Presentation skills

Language patterns
required

Group	<p>morning/afternoon, (<u>Teacher's name</u>)</p> <p>Benefits:</p> <ul style="list-style-type: none">- So what are the benefits? It can- In addition,- Finally,
	<p>Suggestion(s) that can improve the product:</p> <ul style="list-style-type: none">- The (<u>name of product</u>) is (<u>a positive adjective</u>) invention. However, it could be even better!- To make it better, we could/should <p>OR</p> <ul style="list-style-type: none">- To improve this product, I would <p>OR</p> <ul style="list-style-type: none">- In order to make this product even better, I would ...
<ul style="list-style-type: none">- its price- how it works- any special features	<p>Closing:</p> <ul style="list-style-type: none">- (<u>encourage your listeners to buy this product</u>)- This is the end of- We hope you enjoyed- Thank you for listening. You have been a great audience! <ul style="list-style-type: none">- All you have to do is ...- Also,

handouts

Presentation & reflection

Name of the product

Function

Special features

Instructions for use

Problems encountered & solutions

Areas to be improved

Things I've learned

c) Write the script for your presentation. Take a picture of your final product and stick it here.

Good morning. We are glad to have to present our purifier. It

Function

We It can let more people drink in Africa can drink clean water. It have to put

How to use

Some dirty bottom bottle, then put it under the sun it will condense the

Problems encountered

3.- drinkable water by the bottle. If it have problem

the drinkable water flow back to the dirty water. The solution is use glue

Solutions

to block those space between that the solution is use glue to block those space between that

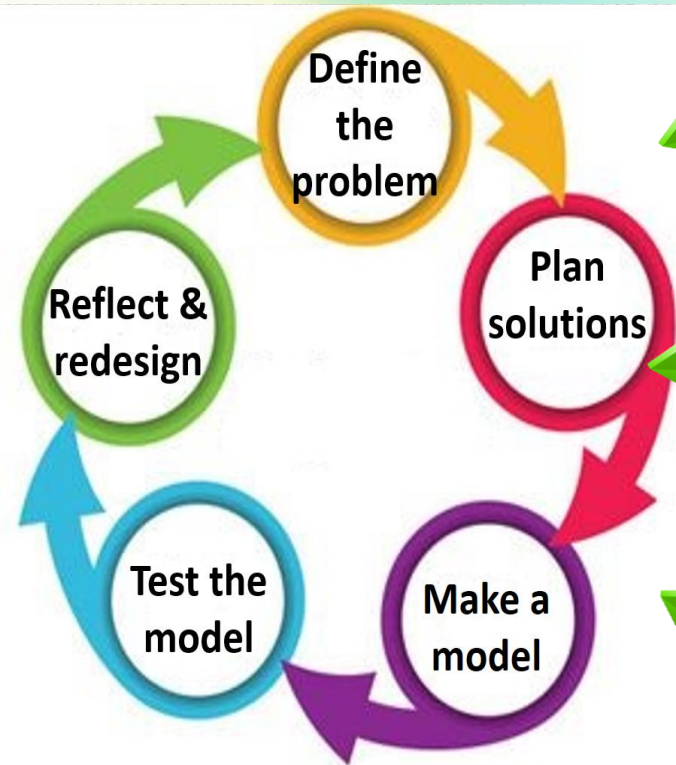
the solution is use glue to block those space between that the solution is use glue to block those space between that

Project design

EDP model

Language elements

Skills & values



Reading about some creative gadgets

Discussion skills for group interaction

Speaking & writing for presentation & reflection

Problem-solving

- Critical thinking
- Creativity
- Collaboration
- Communication
- Respect for others
- Perseverance

Problems

Having difficulty in organising a project which involves different KLAs

Not knowing how to infuse English elements into the project

Solutions

- Forming a STEM group to initiate the project and invite different parties to participate
- Working closely through cross-curricular planning
- Identifying feasible entry points (e.g. reading and discussion skills)

Impact on Teaching and Learning



Students' work

Impact on
learning

Questionnaires

Interview

Impact on learning

Part I

After participating in this STEM project,

Generic skills and values and attitudes

Application of knowledge

Questionnaires

Interest level

Use of English

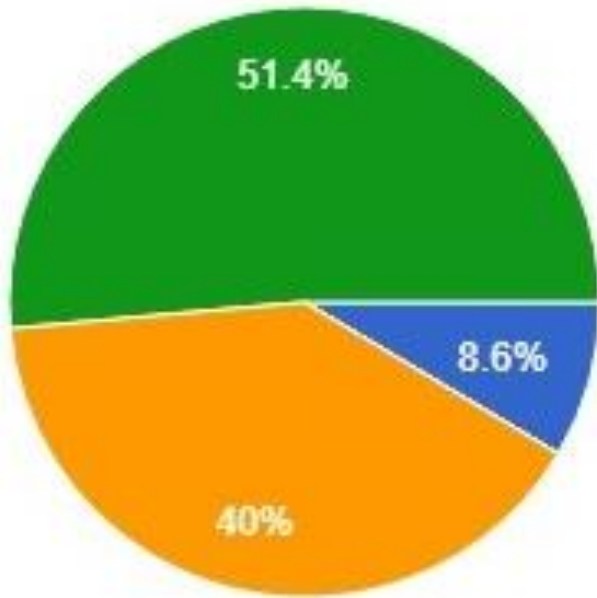
		Strongly disagree	Disagree	Agree	Strongly agree
1.	I can use Science knowledge from IS on water to create the water purifier.				
2.	I can apply the knowledge from ICT on 3D printing to design my 3D water purifier.				
3.	I can use Maths knowledge to do simple calculation when designing the water purifier.				
4.	I know how to use the EDP (Engineering Design Process) model to create the water purifier with my groupmates.				
5.	I can discuss in my group.				
6.	I can use English to write the steps of making the water purifier.				
7.	I could use English to present my final product systematically.				

Application of knowledge

- Strongly disagree
- Disagree
- Agree
- Strongly agree

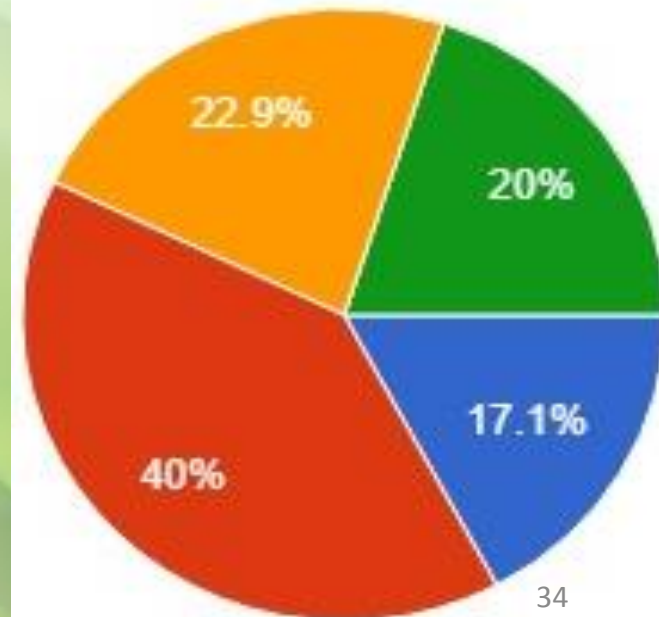
(1) I can apply the knowledge from IS on water purification to create the water purifier.

IS



(2) I can apply the knowledge from ICT on 3D printing to design my 3D water purifier.

ICT

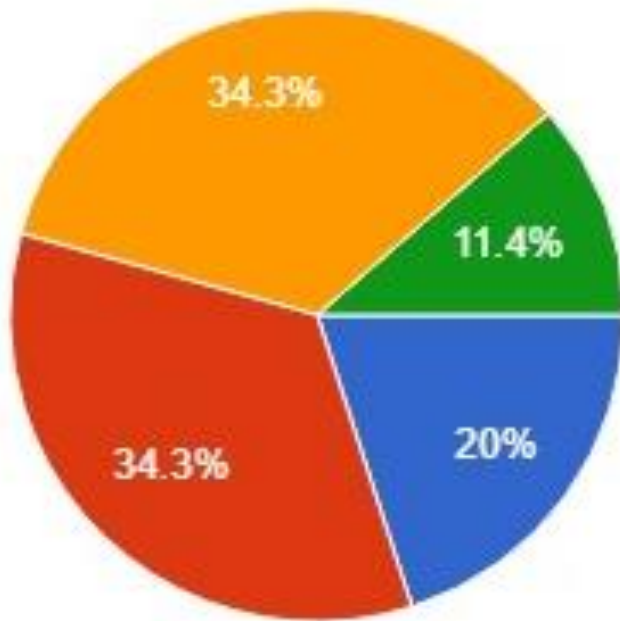


Application of knowledge

- Strongly disagree
- Disagree
- Agree
- Strongly agree

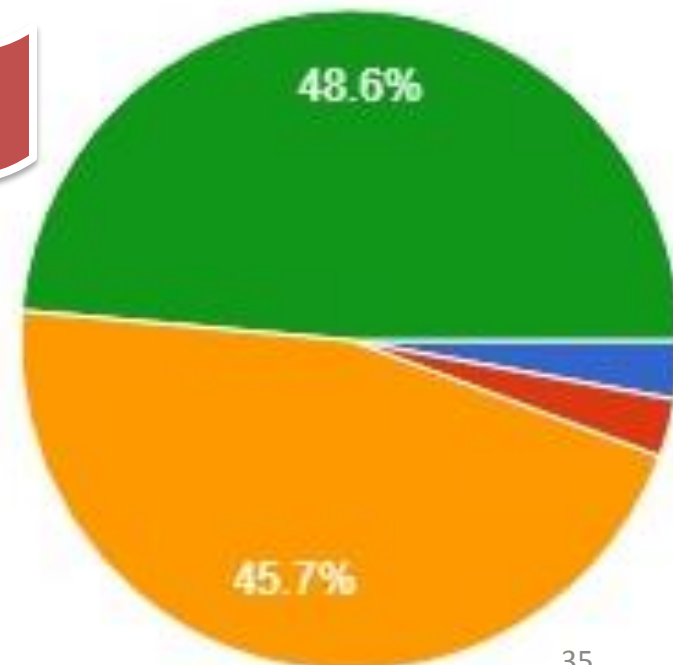
(3) I can use Maths knowledge to do simple calculation when designing the water purifier.

Maths



(4) I know how to use the EDP (Engineering Design Process) model to create the water purifier..

EDP

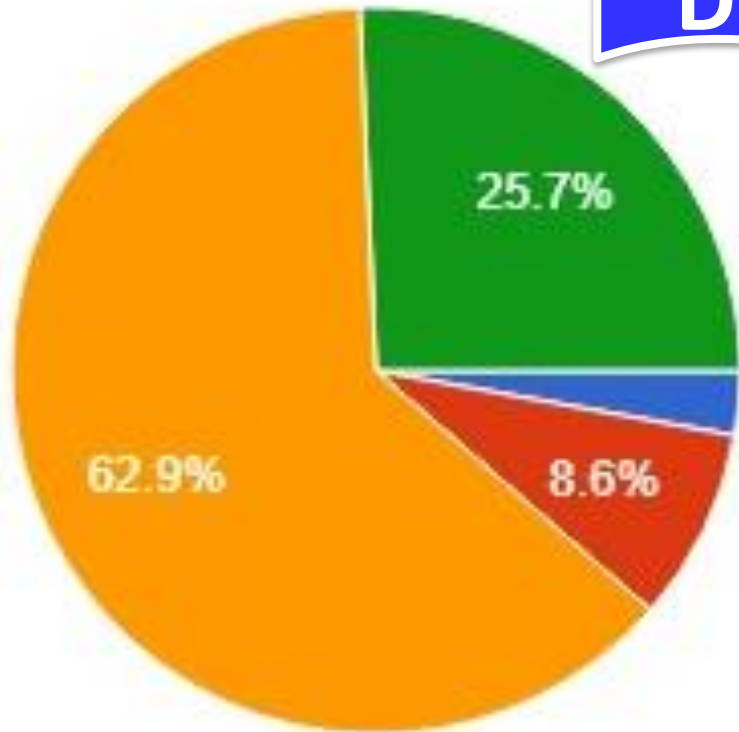


Use of English

- Strongly disagree
- Disagree
- Agree
- Strongly agree

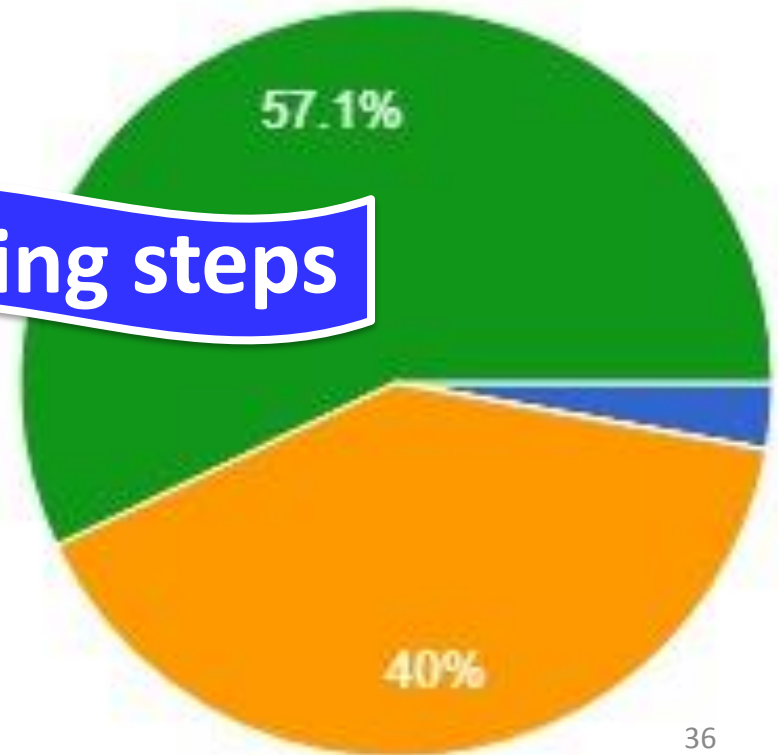
(5) I could use English to discuss in my group.

Discussion



(6) I could use English to write the steps of making the water purifier.

Writing steps

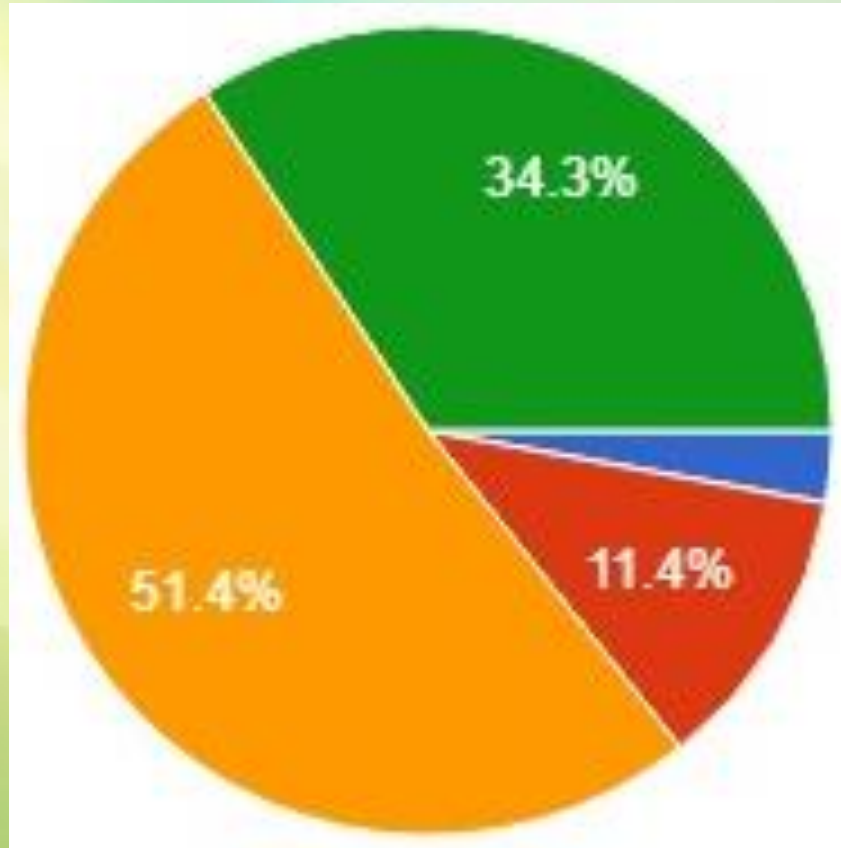


Use of English

- Strongly disagree
- Disagree
- Agree
- Strongly agree

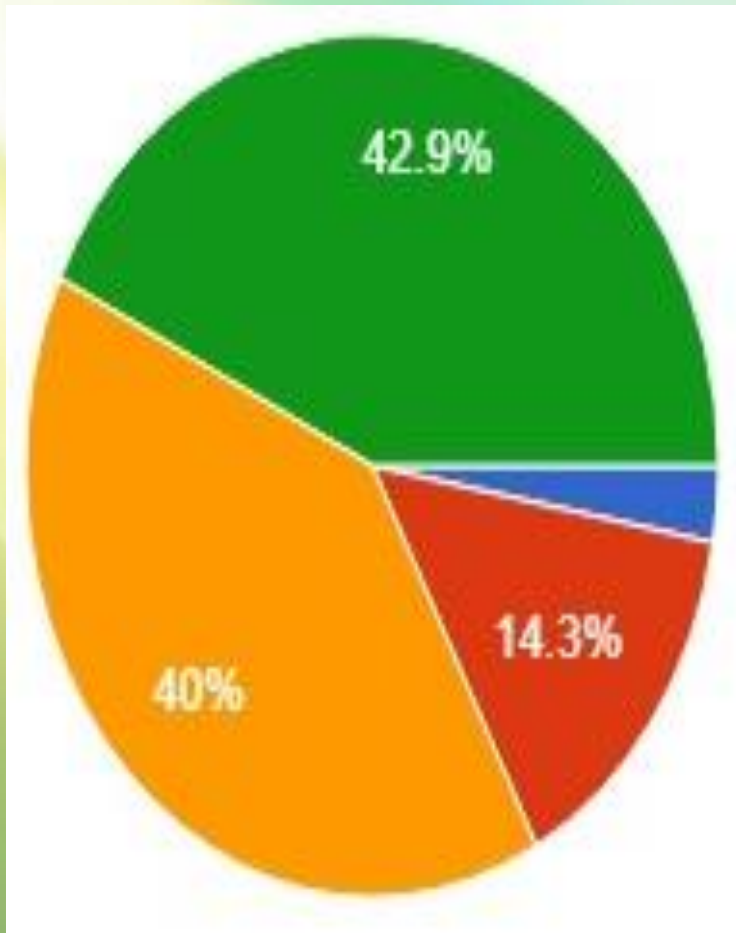
(7) I could use English to present my final product systematically.

Presentation



Interest of the project

(8) I liked and enjoyed the process of making the water purifier.



- Strongly disagree
- Disagree
- Agree
- Strongly agree

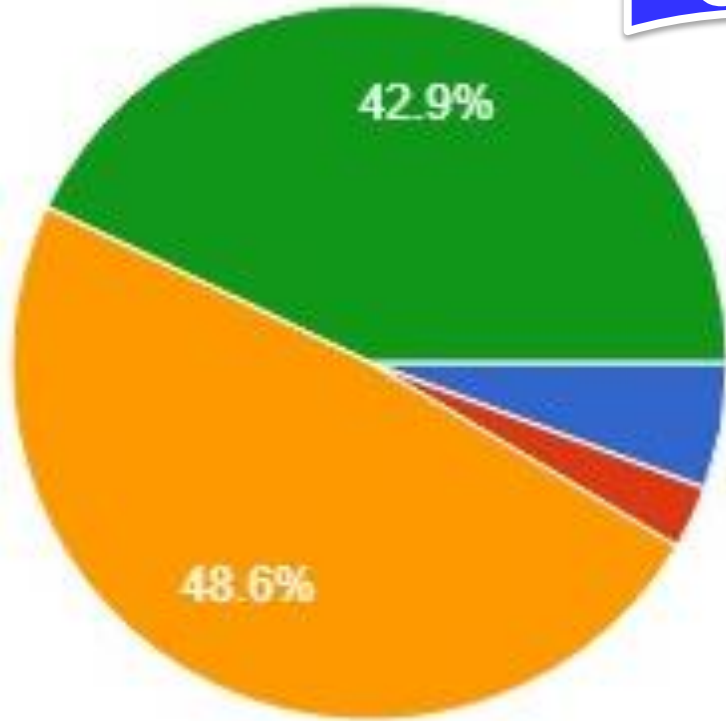
Developing a sense of ownership in learning

Generic skills

- Strongly disagree
- Disagree
- Agree
- Strongly agree

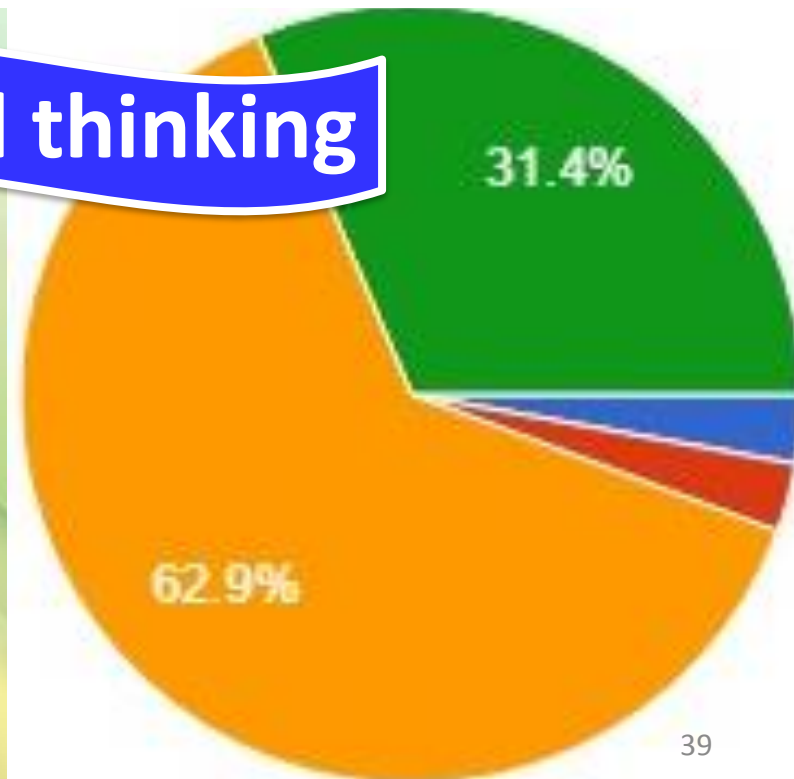
(9) I have learned how to collaborate with my classmates.

Collaboration



(10) I have learned how to think critically when making the product.

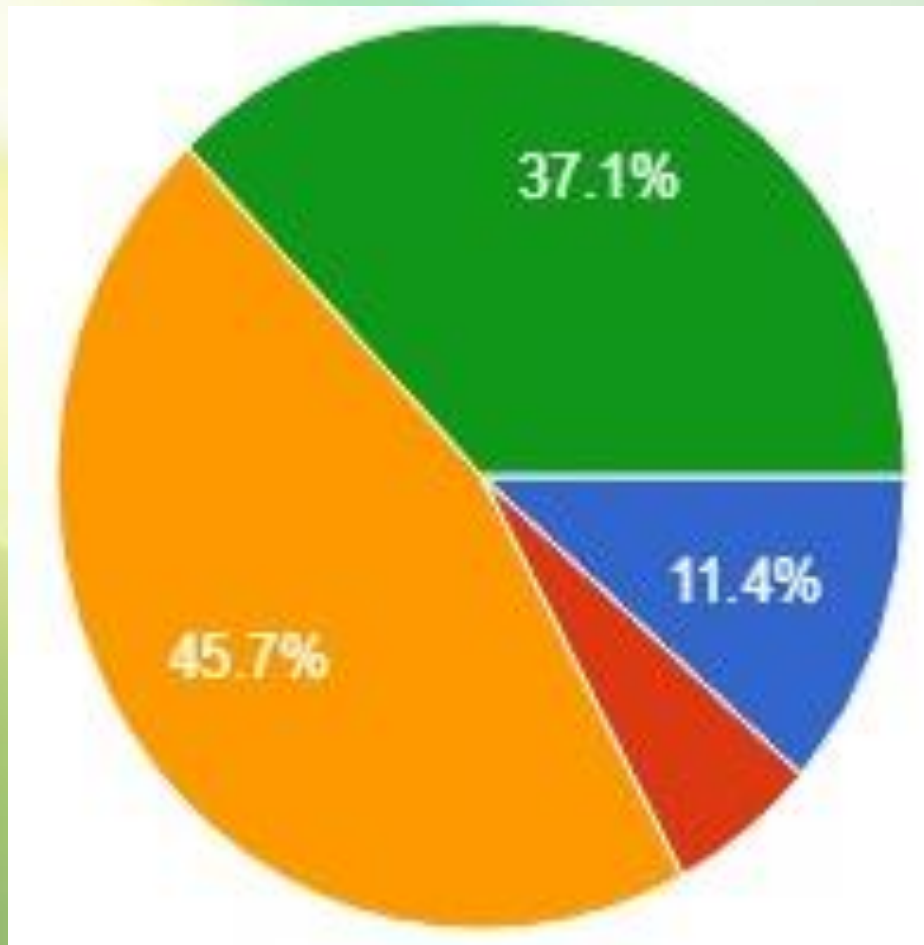
Critical thinking



Generic skills

(11) I was able to think creatively during the process of making the water purifier.

Creativity

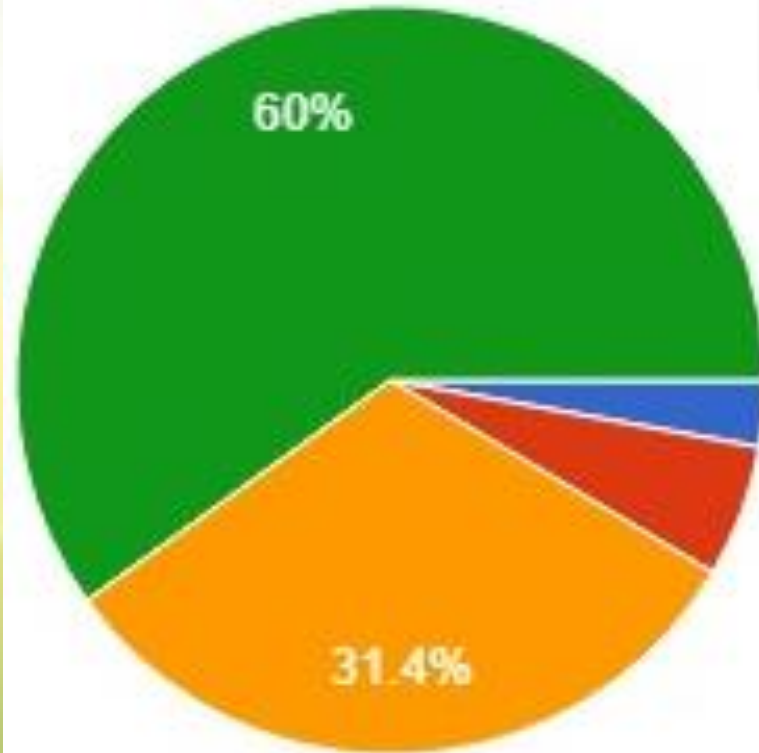


- Strongly disagree
- Disagree
- Agree
- Strongly agree

Positive values & attitudes

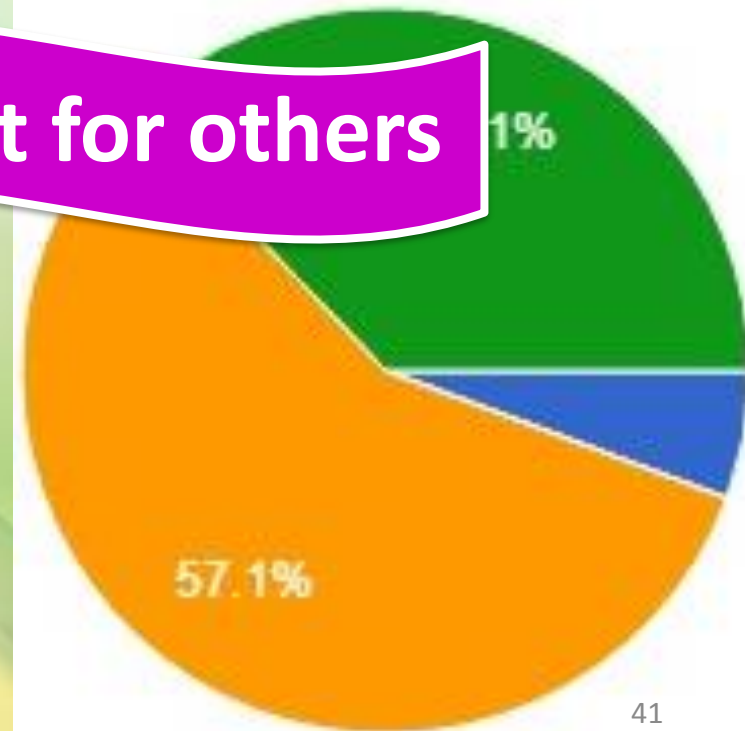
(13) I have learned to be persistent and not to give up easily when making the product.

Persistence



(12) I have learned how to respect other people when doing group work.

Respect for others



Impact on learning

Students' interview

Reflections on teaching

An authentic context was provided for students to **apply English** in content subjects.

Students developed **persistence, curiosity & a sense of ownership** through the Engineering Design Process (EDP).

Teachers played a **facilitating role** to support students' learning.

The lesson provided a **'risk-free environment'** where creativity & innovation can flourish.

Possible **entry points for** integrating **English** into **STEM education**

Getting together with **the STEM group/committee** to know more about the STEM projects the school is working on

Supporting students in conducting a **research topic** on a STEM project through finding related **reading materials** (e.g. magazine, etc.) newspaper,

Helping students **present** procedures for making the products, problems encountered and possible solutions through **speaking & writing activities**

Thank You