Activating students' science process skills during the pandemic by home experiments through planning, implementation, and evaluation (PIE) iterative learning cycle

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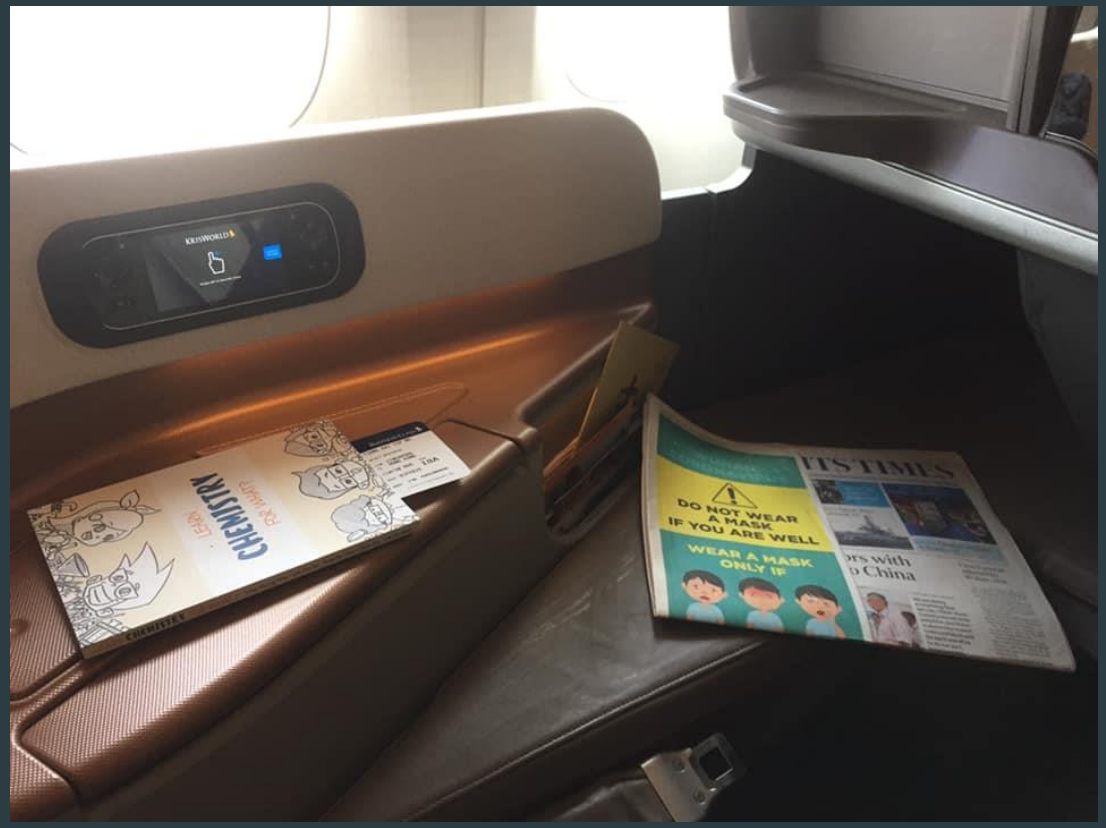
Outline

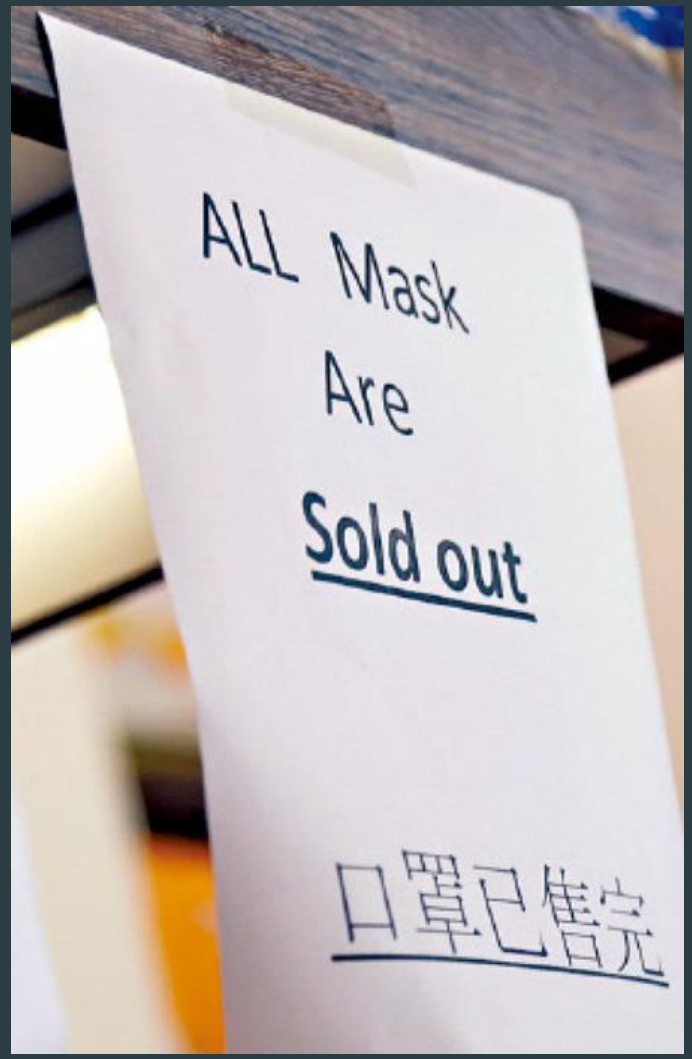
1. Background
2. Literature Review
3. Research Questions
4. Research Methodology
5. Findings
6. Discussions
7. Limitations
8. Conclusion

Once upon a time…

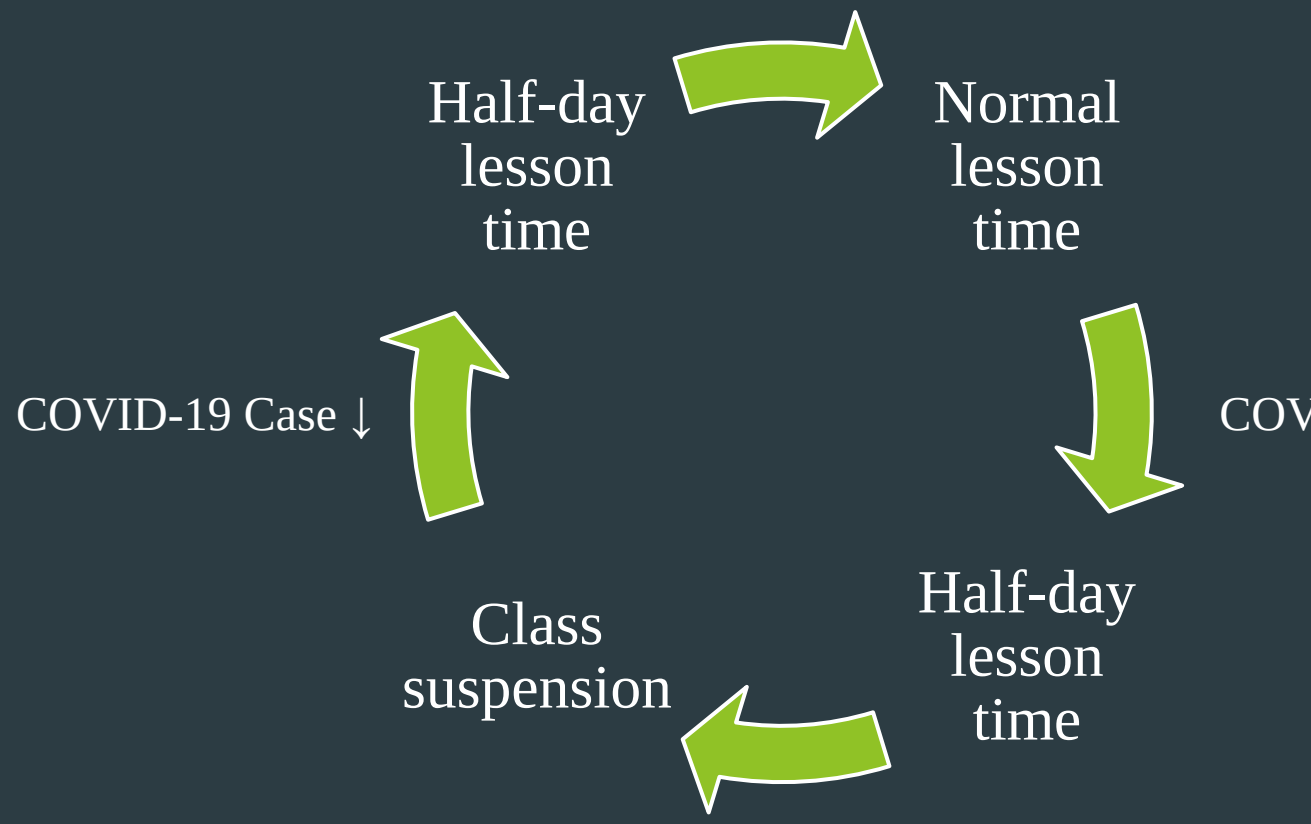
However…


CHEMISTRY
DO NOT WEAR A MASK IF YOU ARE WELL
WEAR A MASK ONLY IF

We have all experienced the downside…



We have all experienced the downside repeatedly…



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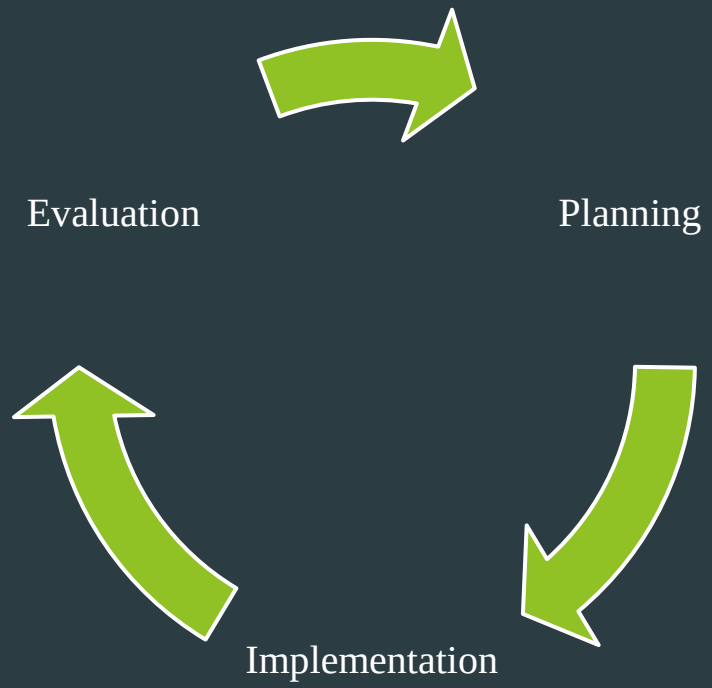

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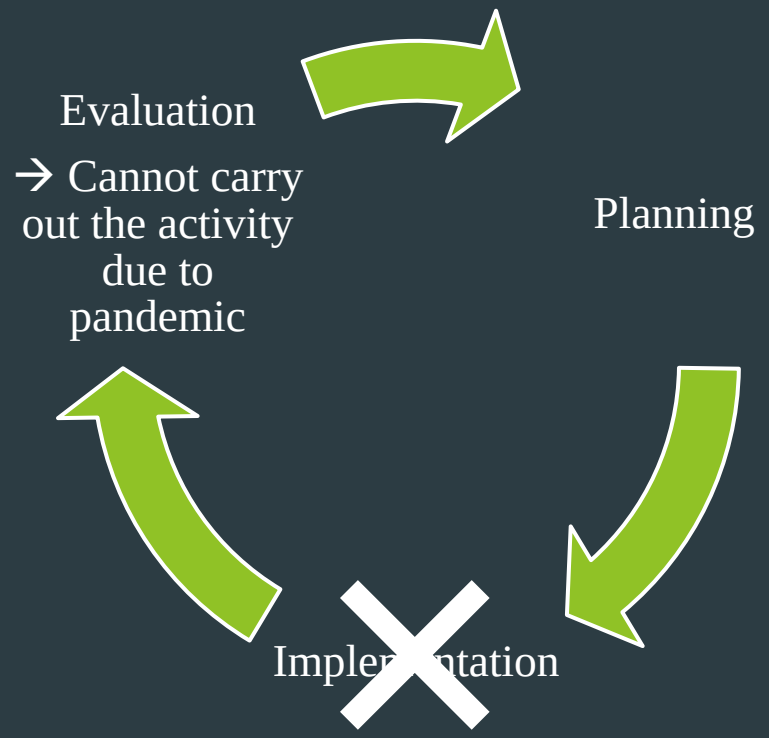
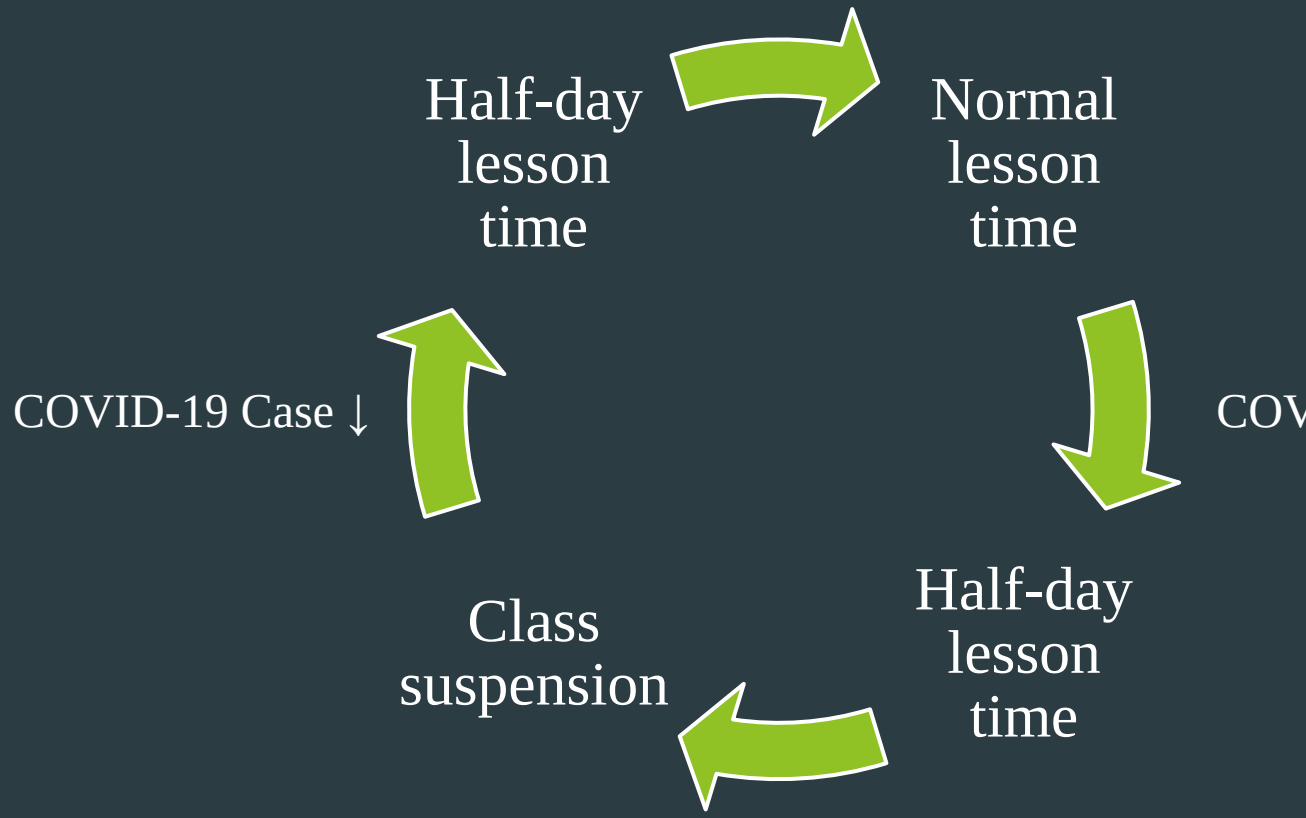


Can we bring our students out of the cycle?



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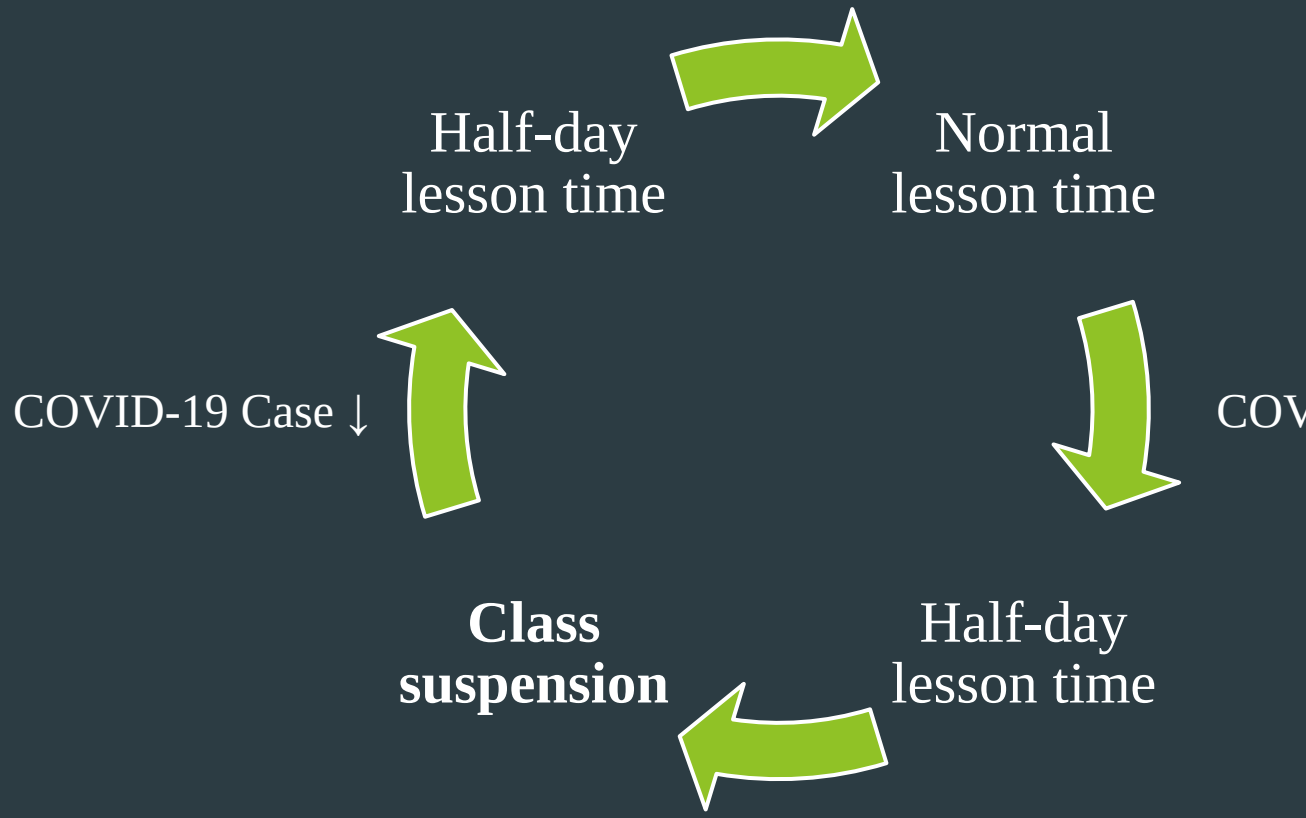
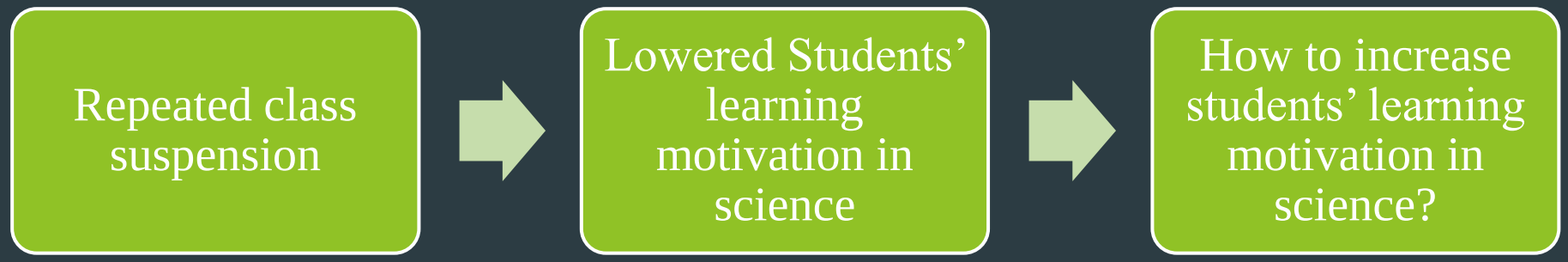


Background

Repeated class suspension

Lowered students' learning motivation in science

Background


Repeated class suspension
Lowered Students' learning motivation in science
How to increase students' learning motivation in science?

Background

What make students love science? / What is the uniqueness of science lessons?

Repeated class suspension → Lowered Students' learning motivation in science → How to increase students' learning motivation in science?

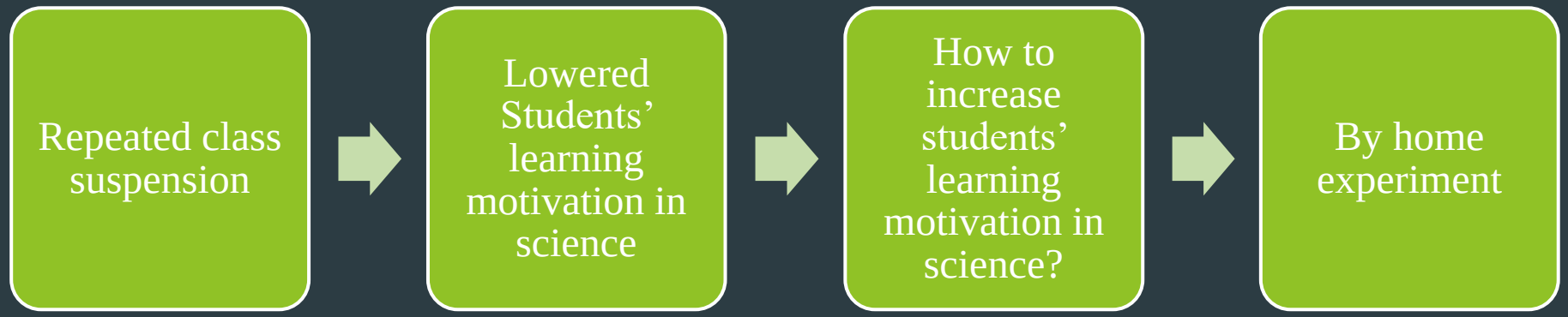
Background

Repeated class suspension

Lowered Students' learning motivation in science

How to increase students' learning motivation in science?

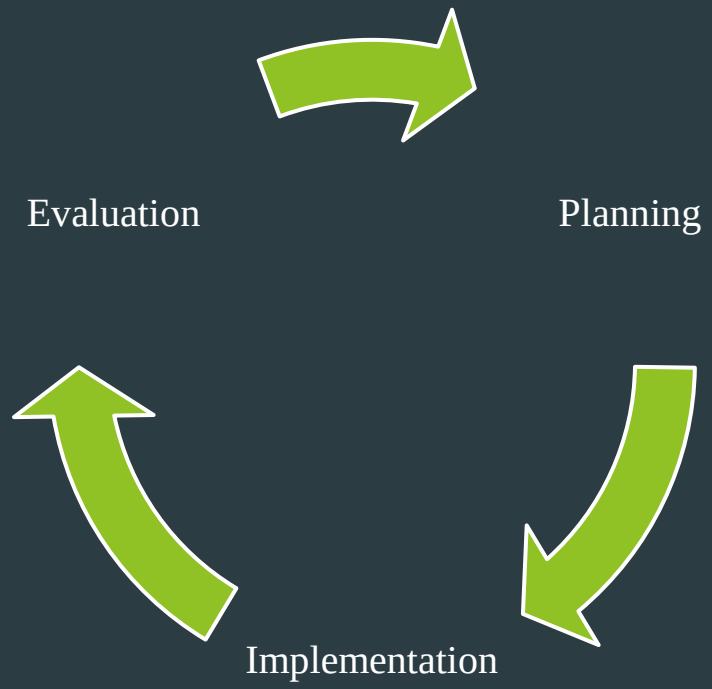
Background


Repeated class suspension
Lowered Students' learning motivation in science
How to increase students' learning motivation in science?
By home experiment

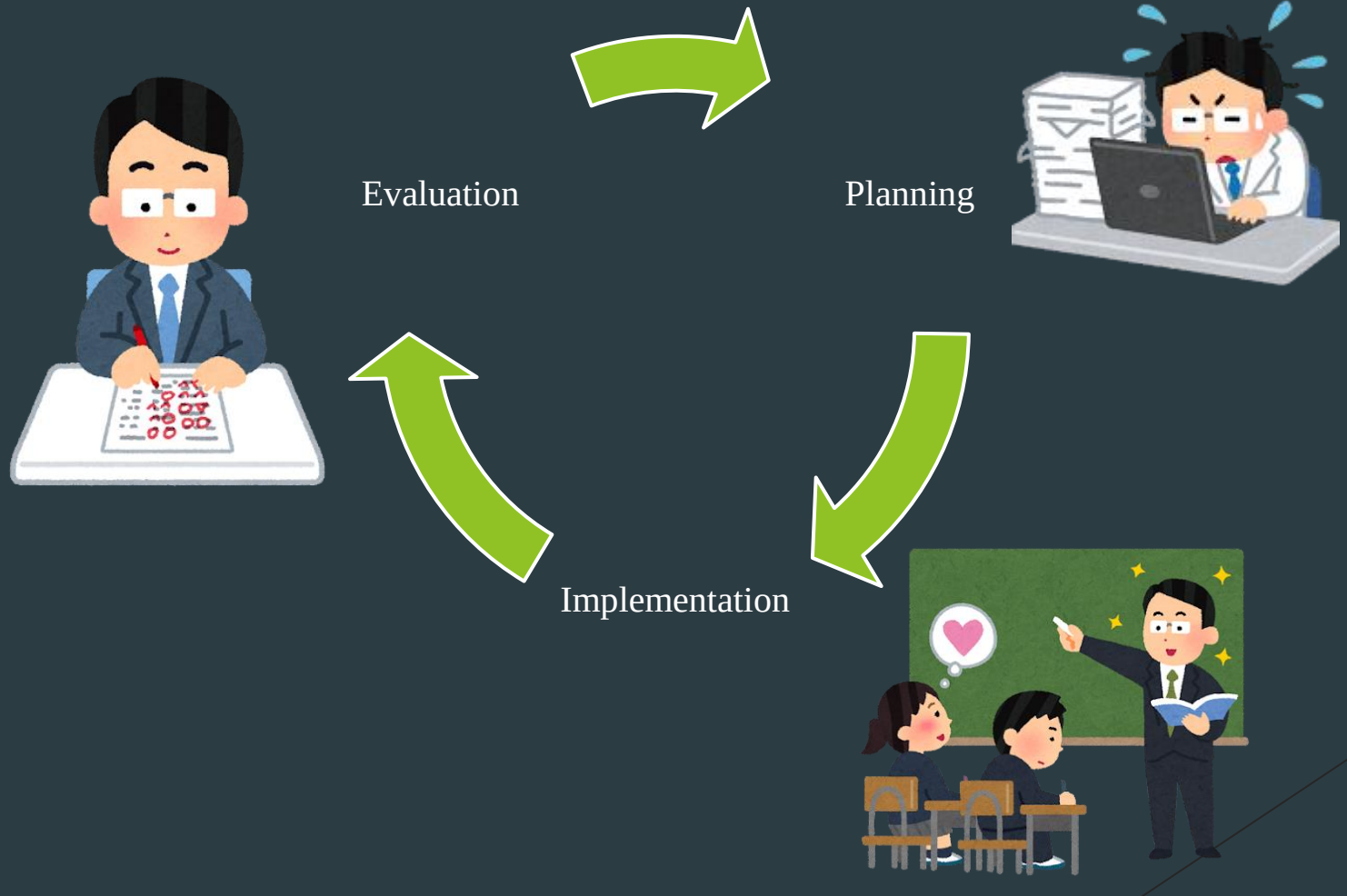
Literature Review (1)
Science Process Skills
(Curriculum Development Council, 2017)

Science process skills	Notes
Observing	1A Stating characteristics
	1B Measuring sensibly and accurately
	1C Recording data
Classifying	2A Comparing similarities and differences
	2B Grouping and ordering
	2C Constructing keys
	2D Stating relationship (includes identifying cause and effect)
Designing investigations	3A Asking questions
	3B Predicting results
	3C Making hypothesis
	3D Identifying variables
	3E Suggesting operational procedures with consideration of fair testing
Conducting practicals	Hands-on practice which includes:
	4A Choosing apparatus
	4B Handling apparatus
	4C Taking precautions
Inferring	5A Analysing and interpreting data
	5B Evaluating data
	5C Estimating errors
	5D Constructing explanations
	5E Drawing conclusion
Communicating	6A Using multiple representations to present information and ideas
	6B Putting forward logical scientific argument

Literature Review (2)
Planning, implementation, and evaluation (PIE) iterative learning cycle



Literature Review (2)
Planning, implementation, and evaluation (PIE) iterative learning cycle



Literature Review (2)
Planning, implementation, and evaluation (PIE) iterative learning cycle

Evaluation

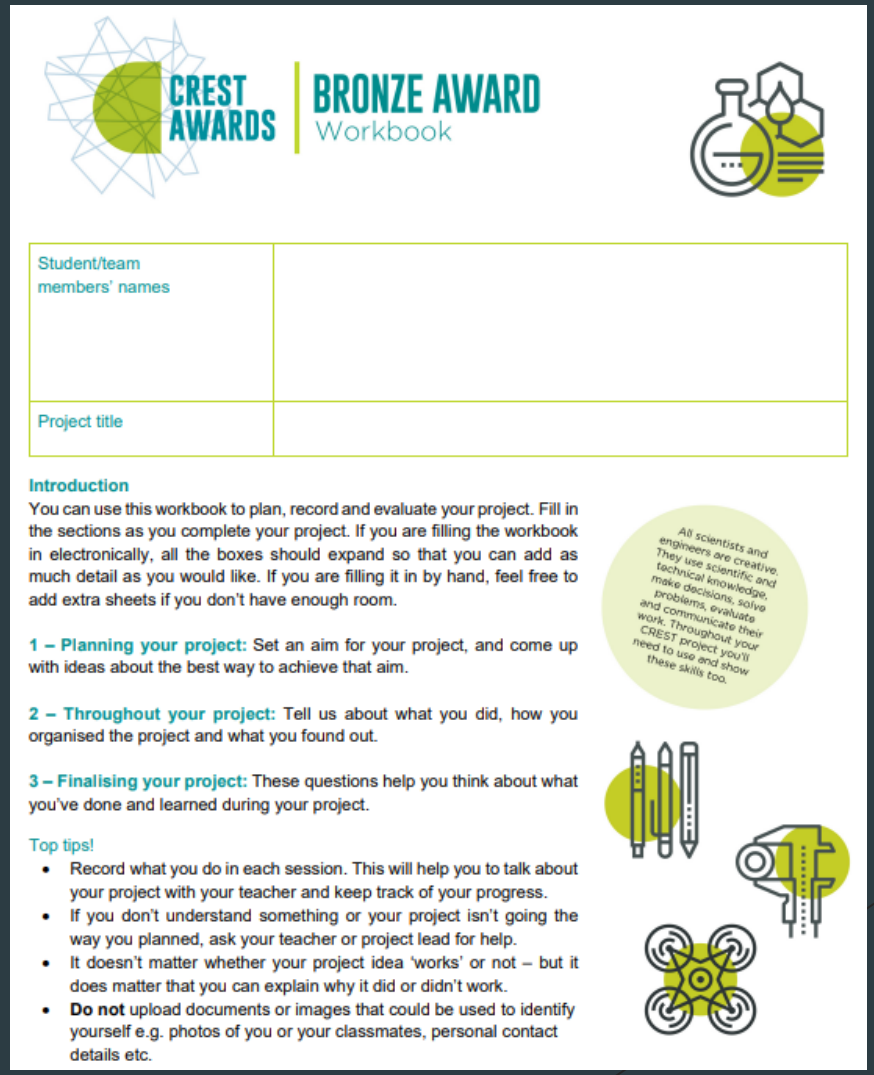
Planning

Implementation

Literature Review (2)
Planning, implementation, and evaluation (PIE) iterative learning cycle

Material used:

CREST bronze award secondary project brief from British Science Association



CREST AWARDS | BRONZE AWARD Workbook

Student/team members' names	
Project title	

Introduction

You can use this workbook to plan, record and evaluate your project. Fill in the sections as you complete your project. If you are filling the workbook in electronically, all the boxes should expand so that you can add as much detail as you would like. If you are filling it in by hand, feel free to add extra sheets if you don't have enough room.

1 – Planning your project: Set an aim for your project, and come up with ideas about the best way to achieve that aim.

2 – Throughout your project: Tell us about what you did, how you organised the project and what you found out.

3 – Finalising your project: These questions help you think about what you've done and learned during your project.

All scientists and engineers are creative. They use scientific and technical knowledge, make decisions, solve problems, evaluate and communicate their work. Throughout your CREST project you'll need to use and show these skills too.

Top tips!

- Record what you do in each session. This will help you to talk about your project with your teacher and keep track of your progress.
- If you don't understand something or your project isn't going the way you planned, ask your teacher or project lead for help.
- It doesn't matter whether your project idea 'works' or not – but it does matter that you can explain why it did or didn't work.
- **Do not** upload documents or images that could be used to identify yourself e.g. photos of you or your classmates, personal contact details etc.

Literature Review (2)
Planning, implementation, and evaluation (PIE) iterative learning cycle

Planning

6B Putting forward logical scientific argument

1.1 Set a clear aim for your project – What do you want to do/make/find out? Can you break this down into smaller steps or objectives which will help you to plan your project?

1.2 Why do you want to do your project? - How does it link to everyday life? Does it affect you or people you might know?

Literature Review (2)
Planning, implementation, and evaluation (PIE) iterative learning cycle

Planning

1.3 What are the different ways that you could complete your aim? – Write your aim in the centre below, and put your ideas around the outside. If you want to add extra drawings/diagrams then please include these at the end of the workbook or separately.

	write your aim here	

6A Using multiple representations to present information and ideas

Literature Review (2)
Planning, implementation, and evaluation (PIE) iterative learning cycle

Planning

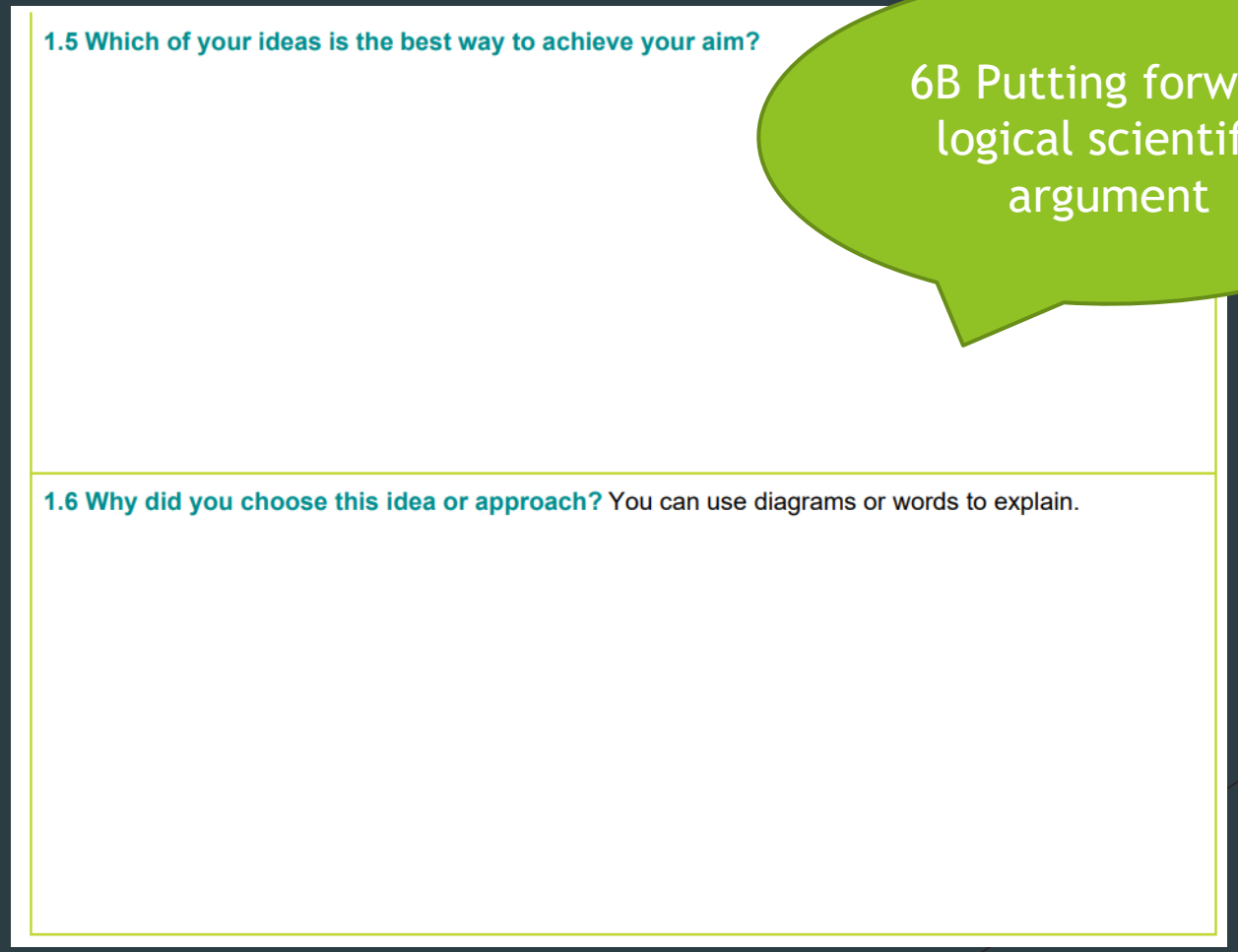
1.4 What can you find out about your project idea? – This will help you decide how to do your project. Has anyone else done a similar project before? If so, what did they do? Where did you find the information?

What I found out	Where I got the information from

Purpose:
Information search

Literature Review (2)
Planning, implementation, and evaluation (PIE) iterative learning cycle

Planning



6B Putting forward logical scientific argument

Literature Review (2)
Planning, implementation, and evaluation (PIE) iterative learning cycle

Planning

1.7 Whatever kind of project you decide to do, you need to carry out some kind of test or research – This might be a scientific investigation; testing out a design; testing whether a piece of communication works or testing how valid your research is.

Testing is an important part of the project process and you might decide to change or add to your ideas after you test them out. It's important that your tests are as fair as possible and that you have thought about all the possible variables.

What I will test	How I will test it	How I will control the variables
Example: How the amount of baking soda affects how long a bath bomb fizzes for	*Make bath bombs with different amounts of baking soda and put in water*	*Same size tub for water* *Same volume of water* *Same temperature water* *Same weight of other ingredients*

3D Identifying variables

Literature Review (2)
Planning, implementation, and evaluation (PIE) iterative learning cycle

Planning

4C Taking precautions

1.8 Stay safe! – Are there any health and safety risks in what you plan to do? What can you do to minimise the risks? Check your plans with your teacher.

Literature Review (2)
Planning, implementation, and evaluation (PIE) iterative learning cycle

Implementing

Purpose:
1. Division of labour
2. Effective time management

2 - Throughout your project

Now you have planned your project, it's a good idea to break the project into tasks that will need doing and organise:

- When each task needs to be completed by
- Who does each task (if working in a team) and if others may need to help you
- What resources you might need

If you have a final project deadline (e.g. to enter a competition) then keep this in mind.

2.1 The following table might be useful (the first row is filled in as an example) – You can add to it throughout the project and use it to track when things have been completed. It is a good way to decide if and when you might need help from other people (i.e. a technician, teacher or mentor) so that they can plan their time too.

Task	Who's responsible?	What help might I/we need?	What resources do I/we need?	Completed by when?	Finished?
Example: Decide what practical tests we want to perform on our product so we can set tests up	*Sarah*	*Teacher to show us what equipment is available*	*Access to the school labs to see equipment*	*Beginning of February*	*Feb 5th*

Literature Review (2)
Planning, implementation, and evaluation (PIE) iterative learning cycle

Implementing

2.2 Record what you do as you carry out your project - This might include records of more detailed research, diagrams, descriptions of methods used, photos/videos or even weblinks for blogs. Think about any decisions you had to make, maybe to overcome a problem, and record how you came to your decision.

2.3 Record what you find out – Record the results of your tests and think about what they tell you. Were the results what you expected? What have you learned from your tests? Also note down if you changed your plans or ideas based on your tests.

3E Suggesting operational procedures with consideration of fair testing
1B Measuring sensibly and accurately
1C Recording data
2D Stating relationship (includes identifying cause and effect)
5A Analysing and interpreting data
6A Using multiple representations to present information and ideas

Literature Review (2)
Planning, implementation, and evaluation (PIE) iterative learning cycle

Evaluation

3.1 Was your project successful? Why? – What went well in your project? Did you meet the aim that you set at the start? How?

3.2 What impact could your project have on other people? For example, does it relate to environmental issues or provide a solution that may improve peoples' lives?

3.3 What would you do differently if you were doing this project again? Why? – What could you have done to make your project even better?

3.4 What do you think you have learned from doing this project? – What do you know at the end of your project that you didn't know at the start? What can you do now that you couldn't do before? How did learning these things help you with your project?

3.5 How will you communicate your project? Who to? – Who would be interested in the results of your project? What is the best way to share your work?

5B Evaluating data
5C Estimating errors
5D Constructing explanations
5E Drawing conclusion

Back to Literature Review (1)
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(Curriculum Development Council, 2017)

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Inferring	**5A Analysing and interpreting data**
	5B Evaluating data
	5C Estimating errors
	5D Constructing explanations
	5E Drawing conclusion
Communicating	**6A Using multiple representations to present information and ideas**
	6B Putting forward logical scientific argument

Research Question

To what extent is the implementation of PIE cycle effective to students' learning of science process skills?

Research Methodology

Participants: Grade 8 students (n = 35 in 11 groups)

Type of research: Action Research

Data collected: Students' Artefacts

Research Methodology

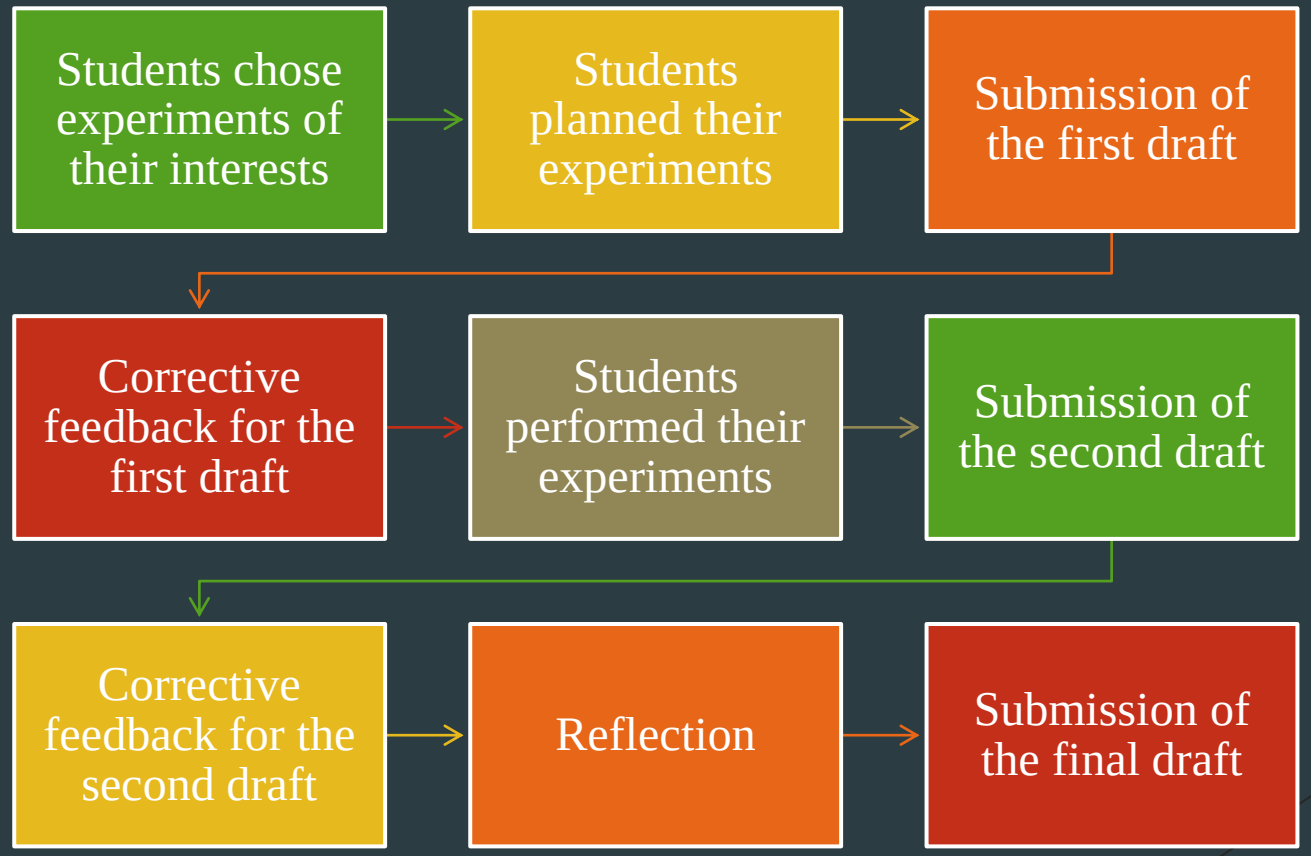
Method of Analysis:

Successful achievement of the criteria in the project brief

(Completely achieved / Partially achieved / Not achieved)

Research Methodology

Timeframe of the research:



Findings
First draft

Section	Criteria	% achieved
1.1	Clear aim	35%
1.2	Clear purpose to everyday life	65%
1.3	Various methods to achieve your aim	30%
1.4	Searching information	30%
1.5	Choosing the best way	40%
1.6	Justifying the best way	45%
1.7	Defining variables	70%
1.8	Safety	60%

Findings
First draft vs Final draft

Section	Criteria	% achieved	
		First	Final
1.1	Clear aim	35%	60%
1.2	Clear purpose to everyday life	65%	75%
1.3	Various methods to achieve your aim	30%	55%
1.4	Searching information	30%	40%
1.5	Choosing the best way	40%	65%
1.6	Justifying the best way	45%	75%
1.7	Defining variables	70%	80%
1.8	Safety	60%	75%

Findings
Final draft

Section	Criteria	% achieved
2.1	Division of labour	90%
2.2	Procedure	55%
2.3	Result	75%
3	Evaluation of experiment	100%

Discussion

Students were weak in planning. Why?

1 - Planning your project

Setting out what you are going to investigate/design
1.1 Set a clear aim for your project – What do you want to do/make/find out? Can you break this down into smaller steps or objectives which will help you to plan your project? We want to find out how the fingerprints can be revealed clearly. For instance, we want to test which material can let fingerprints be revealed the most clearly. We also want to test out whether a clean or dirty surface of a finger would affect the clarity of the revealed fingerprints. >> Try to break it down into point form. Do you want to investigate how wet / dry // how various powder would affect the clarity of the fingerprint?

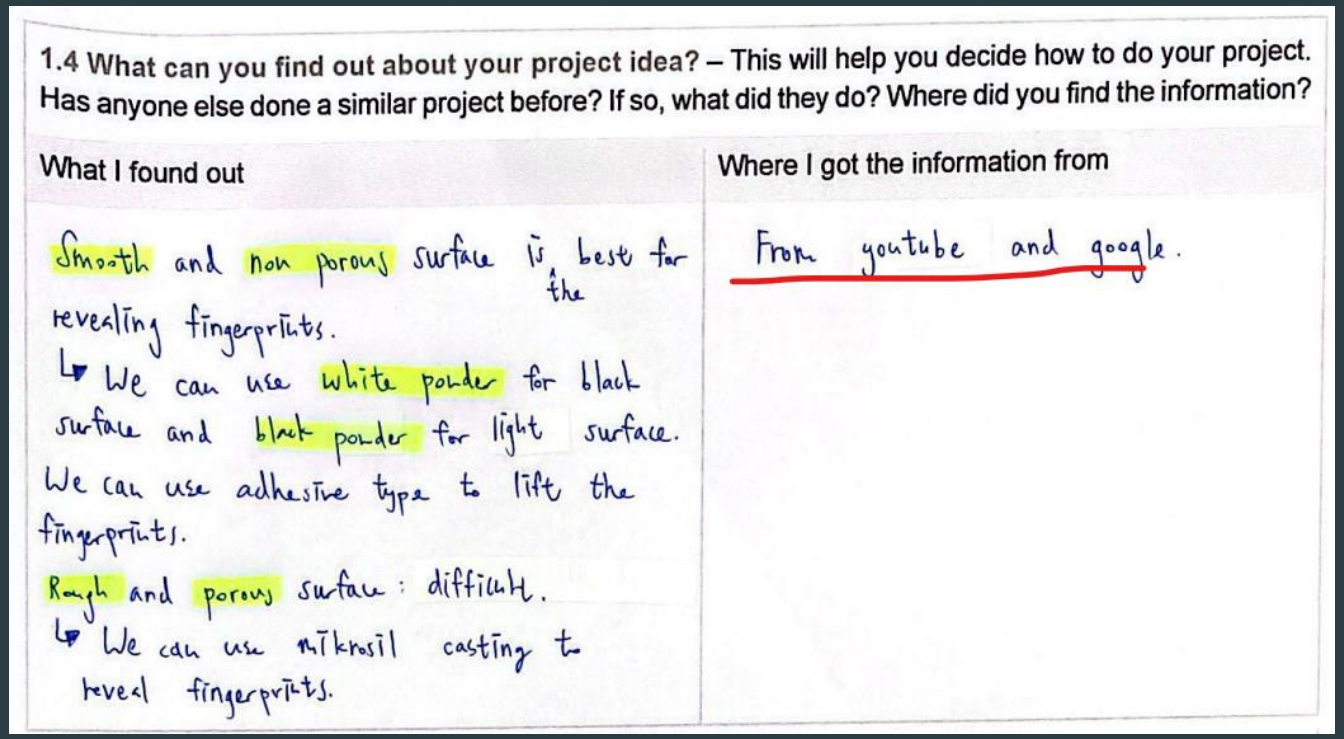
Discussion

Students were weak in planning. Why?

1.3 What are the different ways that you could complete your aim? – Write your aim in the Centrebelow, and put your ideas around the outside. If you want to add extra drawings/diagrams,thenplease include these at the end of the workbook orseparately.		
Preparing materials.	Finding data on internet.	Work with partner.
Do the experiment.	write your aim here Figure out which method is the best on revealing fingerprints.	Ask teacher if we have any problem.
Observing the change in different experiment	Do the table of conclusion,	Do the preventive measure,

Discussion

Students were weak in planning. Why?

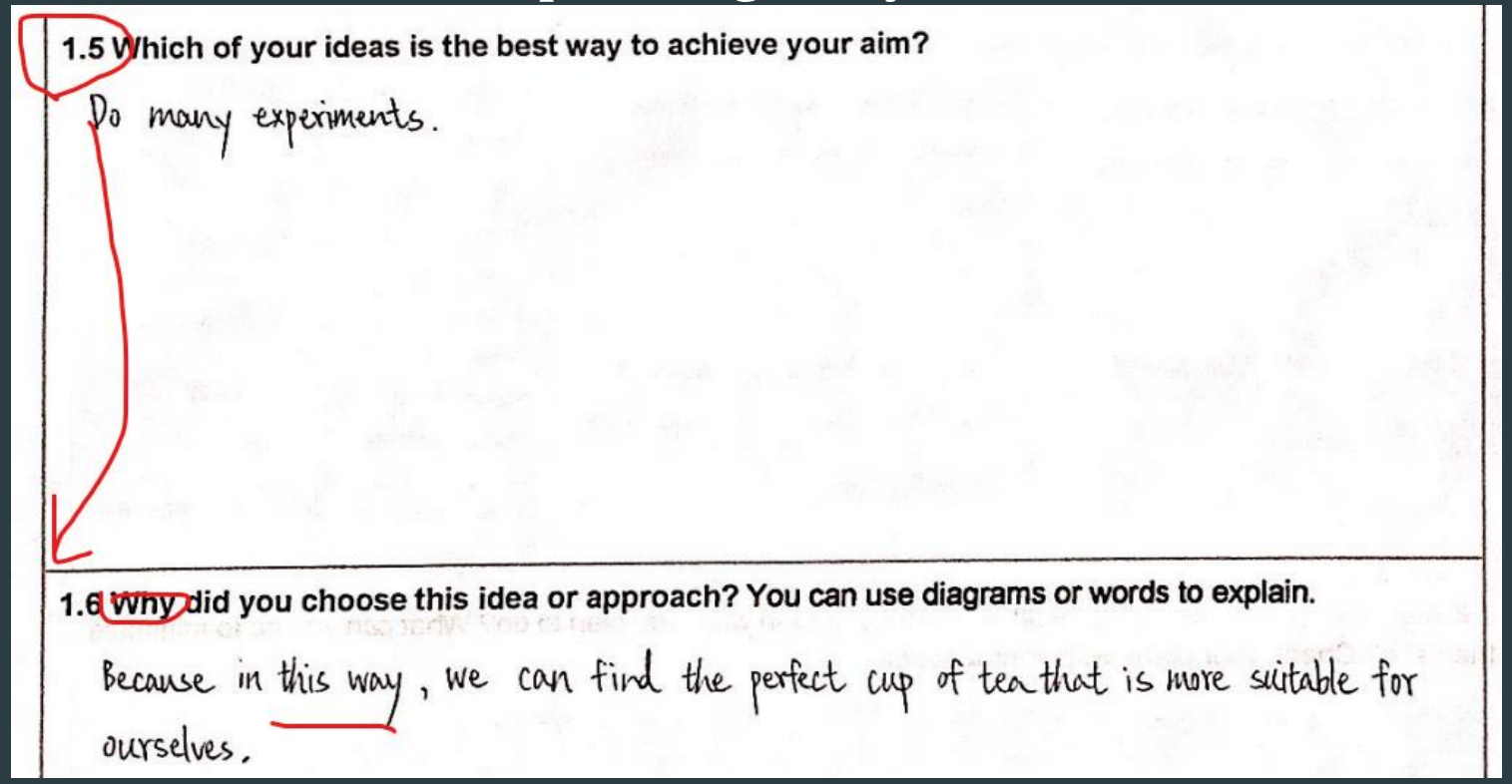


1.4 What can you find out about your project idea? – This will help you decide how to do your project. Has anyone else done a similar project before? If so, what did they do? Where did you find the information?

What I found out	Where I got the information from
Smooth and non porous surface is best for the revealing fingerprints. ↳ We can use white ponder for black surface and black ponder for light surface. We can use adhesive type to lift the fingerprints. Rough and porous surface : difficult. ↳ We can use mikrosil casting to reveal fingerprints.	From youtube and google.

Discussion

Students were weak in planning. Why?



1.5 Which of your ideas is the best way to achieve your aim?

Do many experiments.

1.6 Why did you choose this idea or approach? You can use diagrams or words to explain.

Because in this way, we can find the perfect cup of tea that is more suitable for ourselves.

Discussion

Students were weak in planning. Why?

They were accustomed to cook-book experiments with

- Single objective
- Single purpose
- One method to do the experiment
- No information enrichment
- No need to justify the appropriateness of the methods

Discussion

Students were weak in planning.

How their work can be modified through corrective feedback?

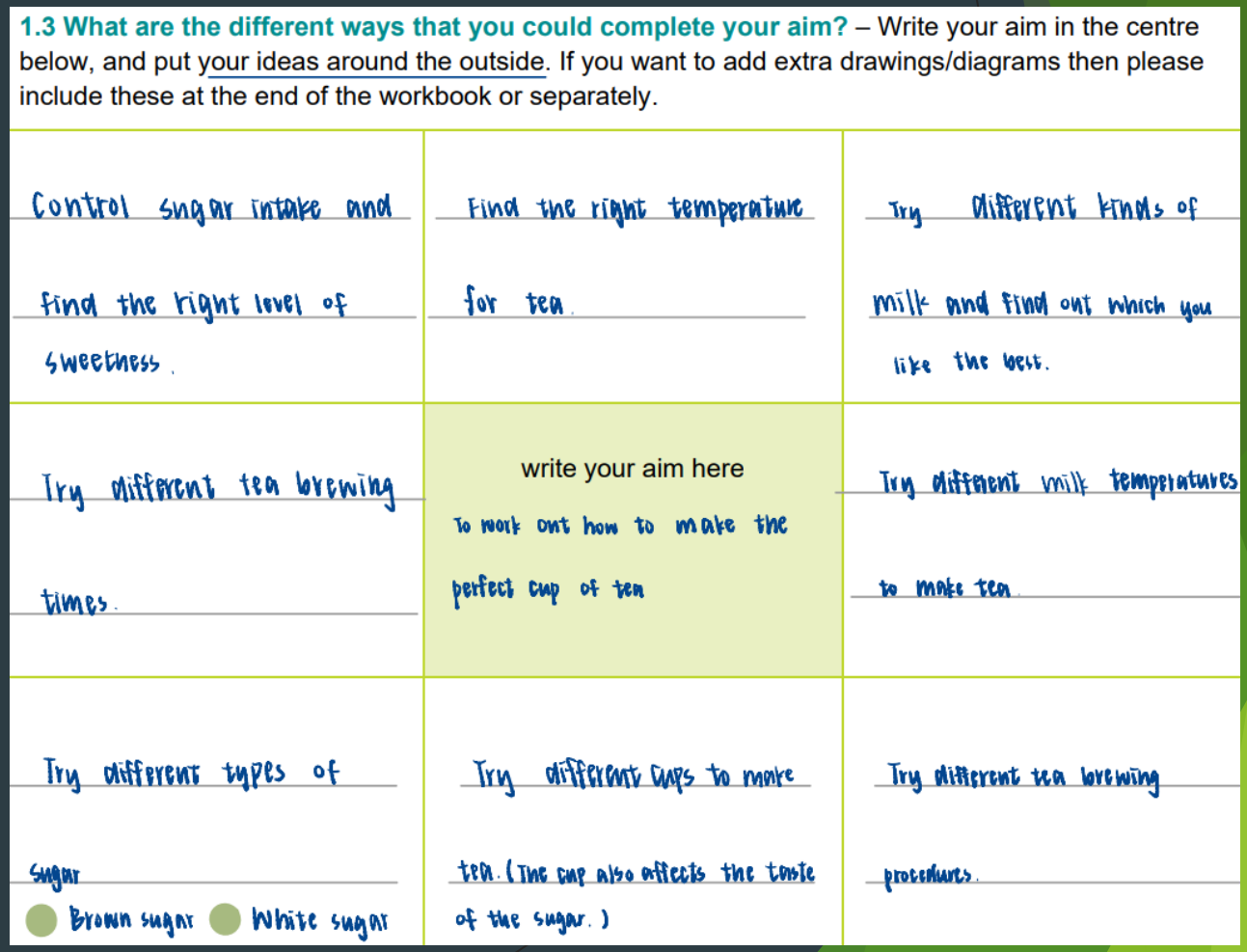
1.1 Set a clear aim for your project – What do you want to do/make/find out? Can you break this down into smaller steps or objectives which will help you to plan your project?

-We want to find out how the fingerprints can be revealed clearly.
-We want to test which material can let fingerprints be revealed the most clearly.
-We want to test out whether a clean or dirty surface of a finger would affect the clarity of the revealed fingerprints.
-We want to test how various powder would affect the clarity of the fingerprint

Discussion

Students were weak in planning.

How their work can be modified through corrective feedback?



1.3 What are the different ways that you could complete your aim? – Write your aim in the centre below, and put your ideas around the outside. If you want to add extra drawings/diagrams then please include these at the end of the workbook or separately.

Control sugar intake and find the right level of sweetness.	Find the right temperature for tea.	Try different kinds of milk and find out which you like the best.
Try different tea brewing times.	write your aim here To work out how to make the perfect cup of tea	Try different milk temperatures to make tea.
Try different types of sugar Brown sugar White sugar	Try different cups to make tea. (The cup also affects the taste of the sugar.)	Try different tea brewing procedures.

Discussion

Students were weak in planning.

How their work can be modified through corrective feedback?

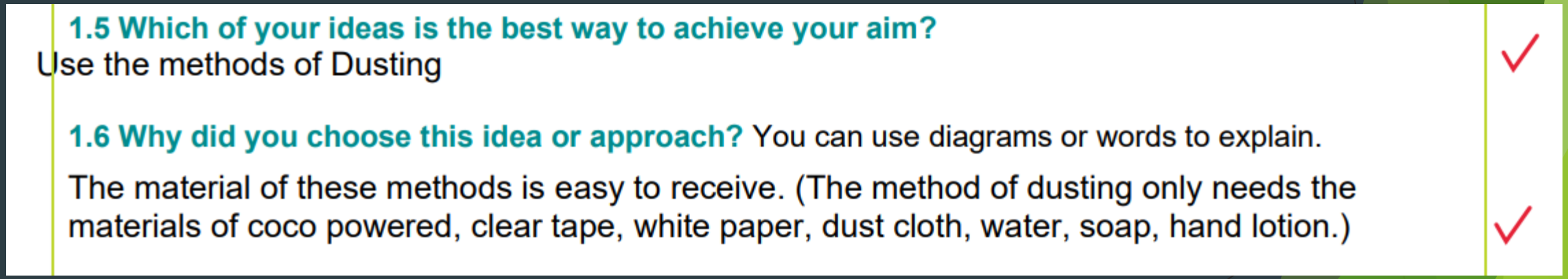
1.4 What can you find out about your project idea? – This will help you decide how to do your project. Has anyone else done a similar project before? If so, what did they do? Where did you find the information?

What I found out	Where I got the information from
-The temperature of hot water for brewing good tea is 50-80℃. -In general, the ratio of tea to water is roughly 1:50 = 1g tea:50mL water. -For ordinary oolong tea, it is recommended that the first brewing time be 60 seconds, the second brewing time can be shortened to 50 seconds because the tea relaxes. And then the third, fourth, and fifth brewing time is 60 seconds to add 10 and 20 seconds. Black tea is about 60 seconds for the first and second brews, and 50 seconds after the third brew. -Pu'er tea is taste better if it compares to black and green tea.	Online: [4 taboos for drinking tea #https://health.tvbs.com.tw] [How many tea leaves should we put in tea? #http://health.tvbs.com.tw] [6 tea brewing tips for beginners #https://www.bella.tw/articles/novelty/30069]

Discussion

Students were weak in planning.

How their work can be modified through corrective feedback?



1.5 Which of your ideas is the best way to achieve your aim?

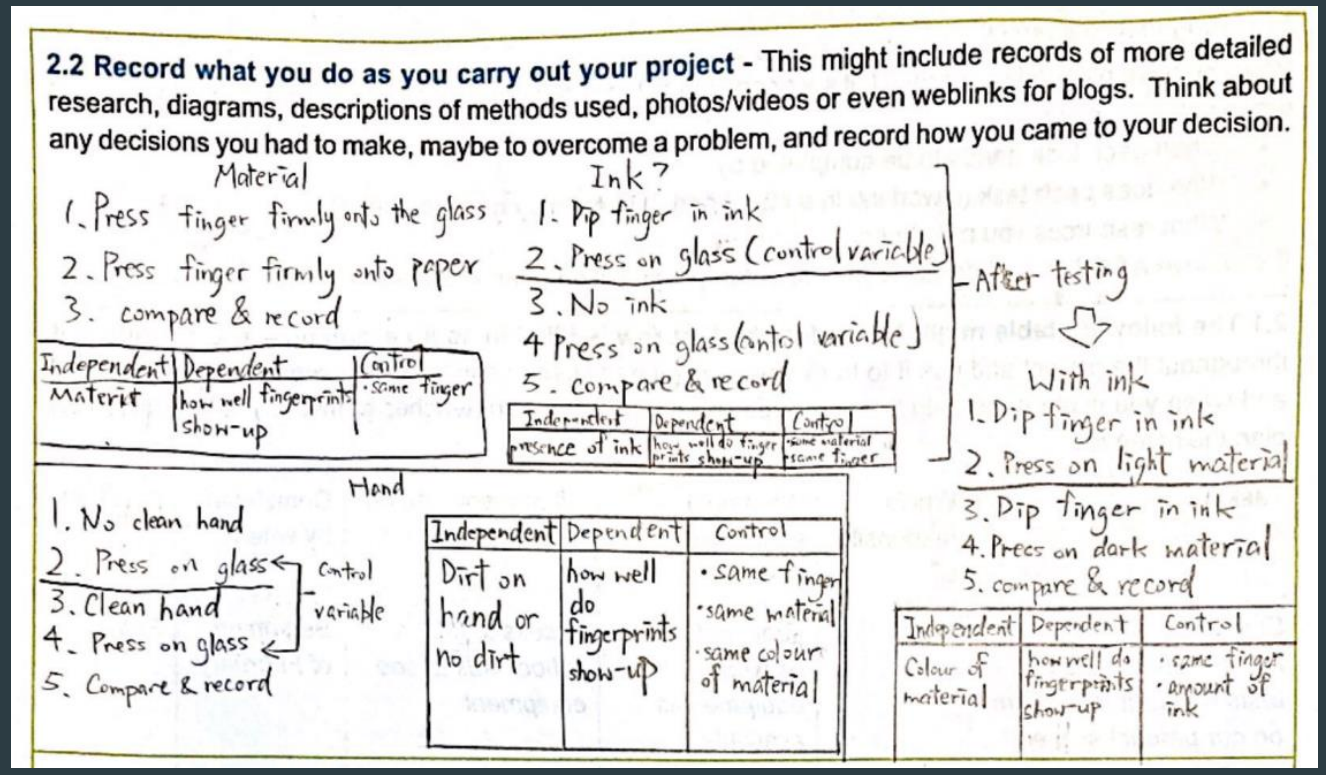
Use the methods of Dusting

1.6 Why did you choose this idea or approach? You can use diagrams or words to explain.

The material of these methods is easy to receive. (The method of dusting only needs the materials of coco powered, clear tape, white paper, dust cloth, water, soap, hand lotion.)

Discussion

Students were strong at implementing experiments.



2.2 Record what you do as you carry out your project - This might include records of more detailed research, diagrams, descriptions of methods used, photos/videos or even weblinks for blogs. Think about any decisions you had to make, maybe to overcome a problem, and record how you came to your decision.

Material

1. Press finger firmly onto the glass
2. Press finger firmly onto paper
3. compare & record

Independent	Dependent	Control
Material	how well fingerprints show-up	· same finger

Ink?

1. Dip finger in ink
2. Press on glass (control variable)
3. No ink
4. Press on glass (control variable)
5. compare & record

Independent	Dependent	Control
presence of ink	how well do finger prints show-up	same material same finger

After testing ⇩

With ink

1. Dip finger in ink
2. Press on light material
3. Dip finger in ink
4. Press on dark material
5. compare & record

Independent	Dependent	Control
Colour of material	how well do fingerprints show-up	· same finger · amount of ink

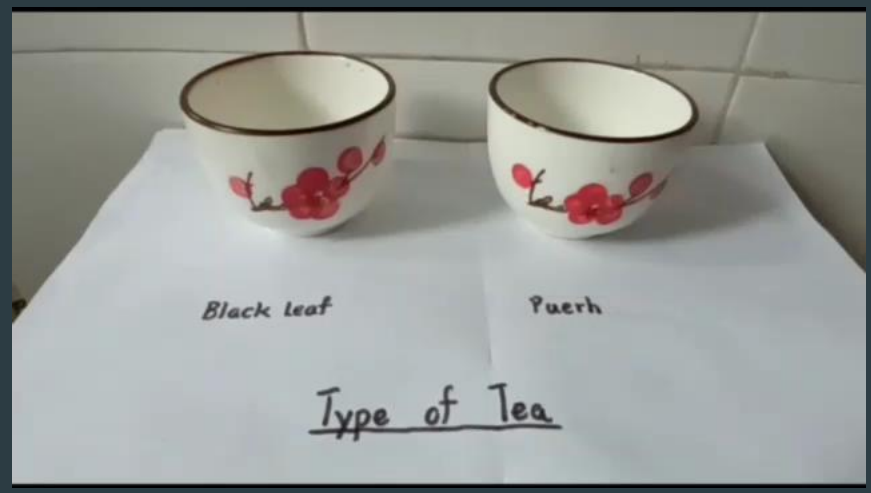
Hand

1. No clean hand
2. Press on glass ← Control variable
3. Clean hand
4. Press on glass ←
5. Compare & record

Independent	Dependent	Control
Dirt on hand or no dirt	how well do fingerprints show-up	· same finger · same material · same colour of material

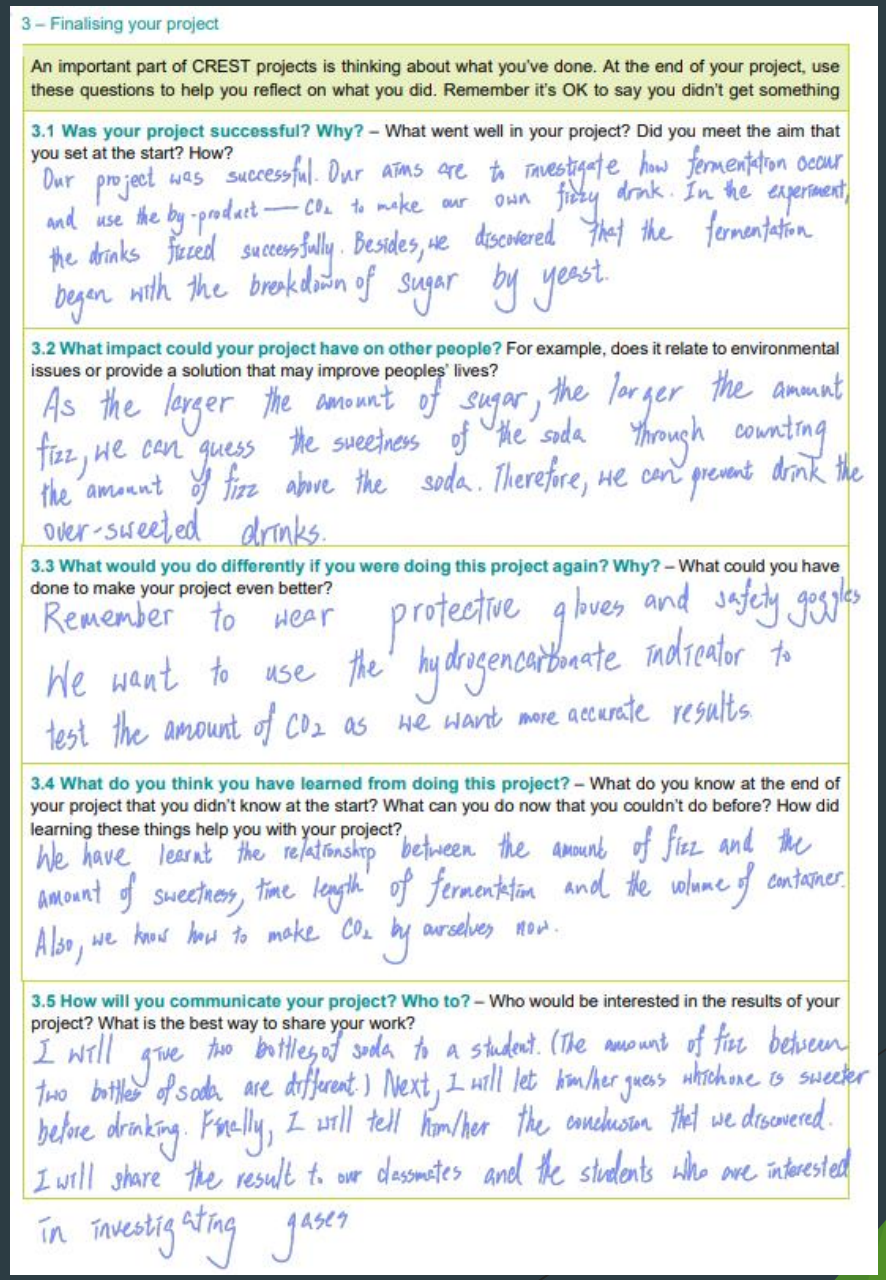
Discussion

Students were strong at implementing experiments.



Discussion

Students were strong at evaluating what they have done.



3 – Finalising your project

An important part of CREST projects is thinking about what you've done. At the end of your project, use these questions to help you reflect on what you did. Remember it's OK to say you didn't get something

3.1 Was your project successful? Why? – What went well in your project? Did you meet the aim that you set at the start? How?

Our project was successful. Our aims are to investigate how fermentation occur and use the by-product — CO_2 to make our own fizzy drink. In the experiment, the drinks fizzed successfully. Besides, we discovered that the fermentation began with the breakdown of sugar by yeast.

3.2 What impact could your project have on other people? For example, does it relate to environmental issues or provide a solution that may improve peoples' lives?

As the larger the amount of sugar, the larger the amount fizz, we can guess the sweetness of the soda through counting the amount of fizz above the soda. Therefore, we can prevent drink the over-sweeted drinks.

3.3 What would you do differently if you were doing this project again? Why? – What could you have done to make your project even better?

Remember to wear protective gloves and safety goggles
We want to use the hydrogencarbonate indicator to test the amount of CO_2 as we want more accurate results.

3.4 What do you think you have learned from doing this project? – What do you know at the end of your project that you didn't know at the start? What can you do now that you couldn't do before? How did learning these things help you with your project?

We have learnt the relationship between the amount of fizz and the amount of sweetness, time length of fermentation and the volume of container. Also, we know how to make CO_2 by ourselves now.

3.5 How will you communicate your project? Who to? – Who would be interested in the results of your project? What is the best way to share your work?

I will give two bottles of soda to a student. (The amount of fizz between two bottles of soda are different.) Next, I will let him/her guess whichone is sweeter before drinking. Finally, I will tell him/her the conclusion that we discovered. I will share the result to our classmates and the students who are interested in investigating gases

Limitation

How to make planning, implementation, and evaluation (PIE) learning cycle ‘iterative’?

Conclusion

Planning ✗

(6B Putting forward logical scientific argument)

→ ☑ after corrective feedback

Implementation ☑

Evaluation ☑

PIE cycle is generally successful in helping students' home experiments


thank you