Education Bureau
School-based Curriculum Development (Secondary) Section
2024/25 School Year

Promoting Cross-Disciplinary Collaboration to Implement "Interactive Laboratory Safety Animation" and "Computer Game on Reflection of Light" Learning Activities

Shau Kei Wan Government Secondary School

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School background

- A major concern of Annual School Plan (2024/25):
  To enhance learning and teaching effectiveness for academic excellence; To empower students to be proactive for lifelong learning

Targets	Implementation Strategy
To enrich students' learning experience and enhance their **generic skills** by promoting **STEAM Education**	To incorporate STEAM Education through a **cross-curricular approach**
	To organise STEAM-related workshops, training courses and activities

- **Teachers' concerns** about promoting STEAM education in Science Education
  - Unfamiliar with design thinking
  - Tight teaching schedule
  - Difficult to integrate different STEAM learning elements into Science Education

- The school joined the support service on Science Education offered by the EDB in 2024/25 s.y., aiming to
  - promote **STEAM education** through enhancing the connection between Science and other subjects to develop students' creativity and problem solving skills
  - develop **curriculum leadership** and **effective pedagogical strategies** to enhance learning effectiveness

Development Focus of Science Education

The school's **Science Education KLA** promotes **cross-disciplinary collaboration** to design and implement STEAM learning activities at junior secondary levels, such as **"Interactive Laboratory Safety Animation"** and **"Computer Game on Reflection of Light"** , strengthening students' ability to **integrate and apply** knowledge and skills of Science and other subjects to solve problems, and fostering **creative thinking** and **problem solving skills**.

- Development
  - **Review** the planning of STEAM learning activities for junior secondary levels, focusing on, for example, the **integrated application** of learning elements from different subjects and the opportunities for developing **creativity** and **problem solving skills**

Original plan (two learning activities as examples)

Level & Subject	Unit/Topic	STEAM Learning Activity	STEAM Learning Elements			
			Science Ed	Technology Ed	Arts Ed	Mathematics Ed
S1 Science	Water	Design and make a filtration column using simple materials	Filtration	Using a sensor to detect the clarity of filtrate	-	Ratio
S1 Computer Literacy	CoSpace	Using the platform to make an interactive animation	-	CoSpaces	-	-

- Teachers set **constraints**, such as the type of impure water and the maximum size of the filtration column, to develop students' problem solving skills.
- Students were encouraged to **design and make** the sensor device with **coding**.

Students were encouraged to create **different designs** to enhance their creativity through the use of the **engineering design process**.

A **science context**, such as a science laboratory, could be used to consolidate students' knowledge of laboratory safety.

  - **Design** and **implement** STEAM learning activities by
    - enhancing the connection between **Science** and **other subjects**
    - emphasising the **engineering design process** to encourage students to generate **diverse design ideas**
  - Conduct **collaborative lesson planning**, **lesson observation** and **evaluation**

Pedagogical designs and student learning

Level	Refined STEAM learning activities	STEAM learning elements		
		Science Ed	Technology Ed	Mathematics Ed
S1	**Portable Filtration Column** Design and make a portable filtration column for water purification	• Filtration	• **Production process**	• Rate
S1	**Interactive Laboratory Safety Animation** Design and make an interactive animation to enhance students' awareness of laboratory safety	• Safety in the laboratory	• **Production process** • Animating of design ideas in computer animation or video clips • Programming concepts	
S3	**Computer Game on Reflection of Light** Design and make a computer game to solve problems on reflection of light	• Reflection of Light	• **Production process** • Programming concepts	• Rectangular coordinate system • Reflection transformation, similar triangles, etc.

Strengthen students' mastery of the design process to develop their **creative thinking** and **problem solving skills**
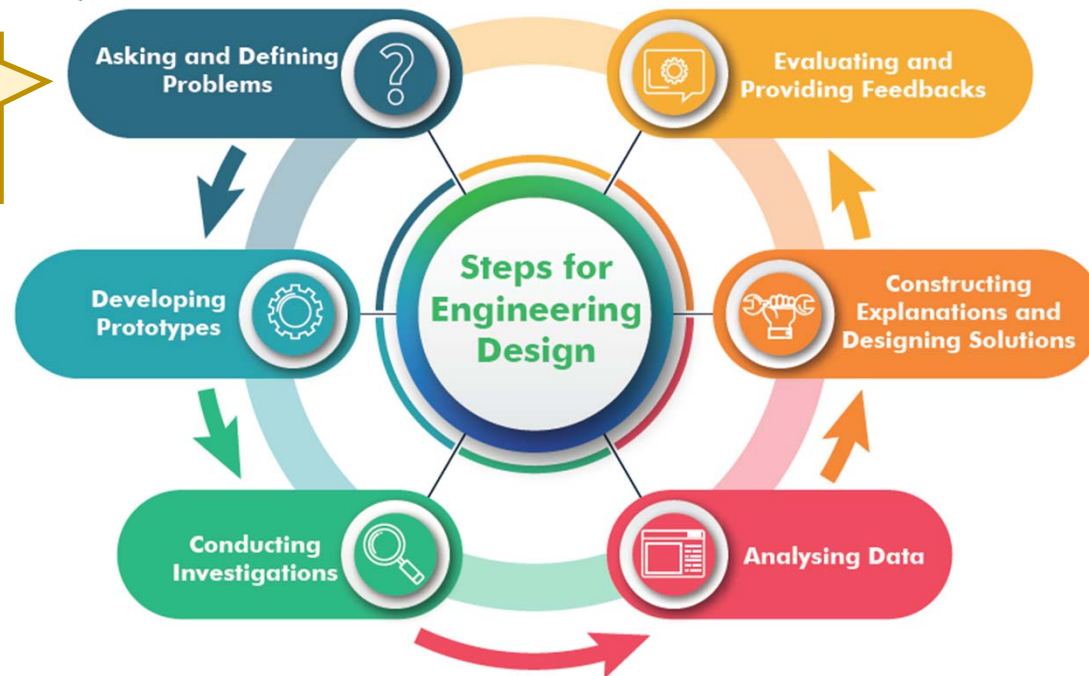
S1 Portable Filtration Column

Help students master the **basic steps** of the **engineering design process** (some steps of the activity are shown below).

Asking and Defining Problems:
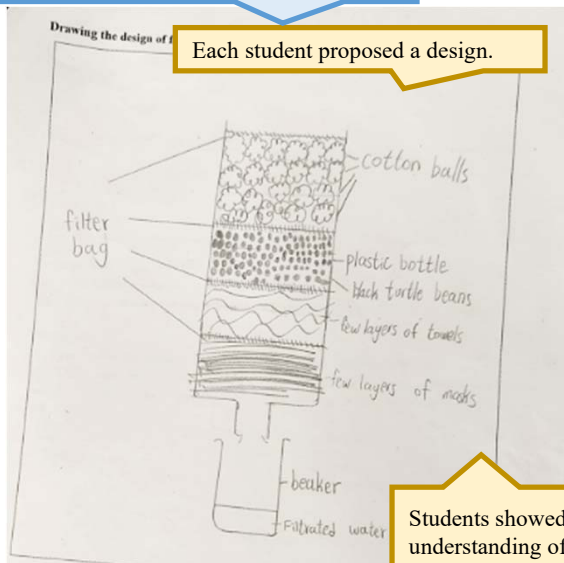Design and make a portable filtration column

A maximum size is set to enhance students' awareness of **dimensions** and develop their problem solving skills by **meeting this constraint.**

Help students **recap** their knowledge of filtration, and guide them in using **scientific knowledge** to solve the problem.

Asking and Defining Problems

Evaluating and Providing Feedbacks

Developing Prototypes

Steps for Engineering Design

Constructing Explanations and Designing Solutions

Conducting Investigations

Analysing Data

Science (S1-3) STEAM Learning Module

Developing Prototypes:

Each student proposed a design.

Drawing the design of f...

- cotton balls
- filter bag
- plastic bottle
- black turtle beans
- few layers of towels
- few layers of masks
- beaker
- Filtrated water

Students showed a basic understanding of the **principles of filtration**

1 Comparing different designs

Among the designs in your group, choose 2 designs based on the above criteria which have the highest possibility to meet the criteria and rate your designs.

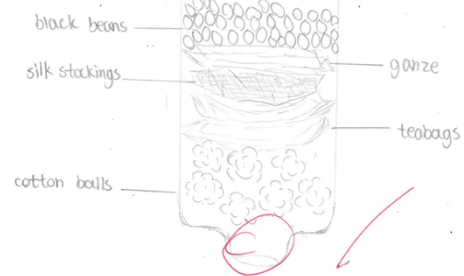Rate your designs (1-lowest, 5-highest)

Criteria	Design 1 ✓	Design 2 ✓	Design 3	Design 4
Effectiveness	5	4	3	4
Feasibility	5	5	4	5
Usability	4	3	3	2
Safety	4	5	4	5
Others (if any)				
Total	18	17	14	16

Encourage students to **create** and **evaluate** their designs to inspire **new ideas**, ultimately resulting in improved outcomes.
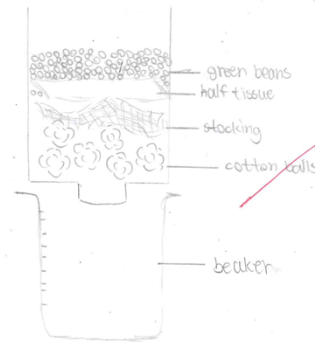
Each group proposed two designs after comparison.

Drawing the designs of filtration columns

Design 1 :

- black beans
- silk stockings
- ganze
- teabags
- cotton balls

Design 4 :

- green beans
- half tissue
- stocking
- cotton balls
- beaker

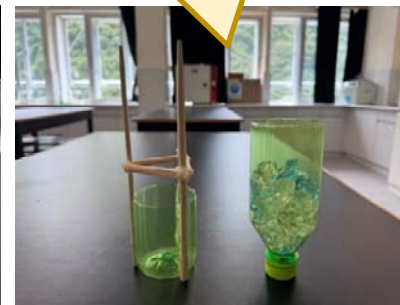Students made their prototypes.

A **hanging** filtration column

The filtration column can **stand securely** without external support.

It is convenient to **assemble and disassemble** the filtration column.

Conducting Investigations:

The filtrate is clear with relatively low NTU values

4 Results

Design 1 :

	Water before filtration	Water after filtration
Appearance	brown, dirty	clear
Turbidity (NTU)	1000ntu	63.5 ntu

Amount of water collected in 2 minutes: 200 cm³

$$\text{Rate of filtration} = \frac{\text{Amount of water collected in 2 minutes}}{\text{time}} = 100 \text{ mL / minutes}$$

S1 Interactive Laboratory Safety Animation

Task: Design and make an interactive laboratory safety animation using a 3D virtual platform

The **design process** provides a structured approach to develop students' creativity and problem solving skills.

Each student has the opportunity to create their own design solution, fostering **creativity**.

2. **Ideate**
(a) Initial design

Draw **four** different scenes in the Science laboratory to enhance students' awareness of laboratory safety:

1	2
3	4

1. **Define the problem**

Problem:	S1 students lack adequate awareness of laboratory safety
Users	S1 students (coming academic year)
Users' needs:	
Design brief:	Design and make an interactive animation on laboratory safety

Guide students to **understand users' needs**, allowing them to create solutions that are **relevant and effective**, and use vibrant graphics and sound effects to enhance their interest

(b) Comparing different designs

Rate your designs (1-lowest, 5-highest)

Criteria	Design 1	Design 2	Design 3	Design 4
Accuracy				
Clarity				
Interaction				
Feasibility				
Others (if any)				
Total				

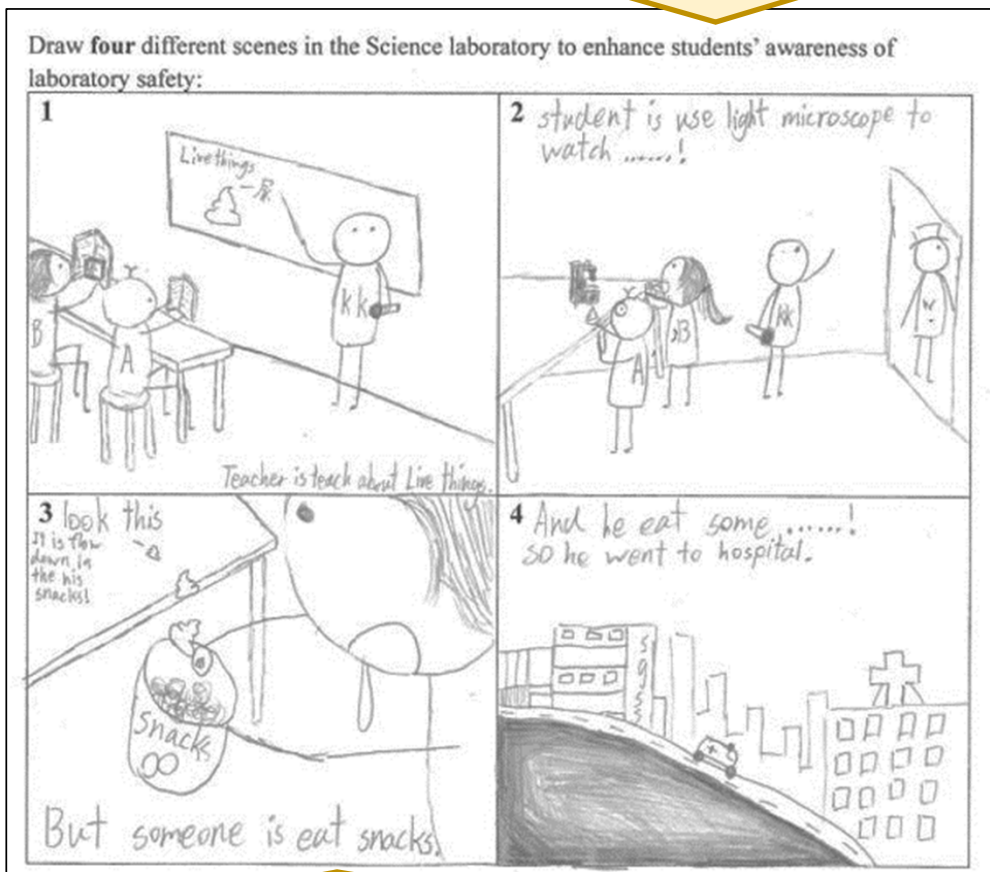Encourage students to **evaluate** their designs to inspire **new ideas**, ultimately resulting in improved outcomes.

(c) Final design

Draw **four** different scenes in the Science laboratory to enhance students' awareness of laboratory safety:
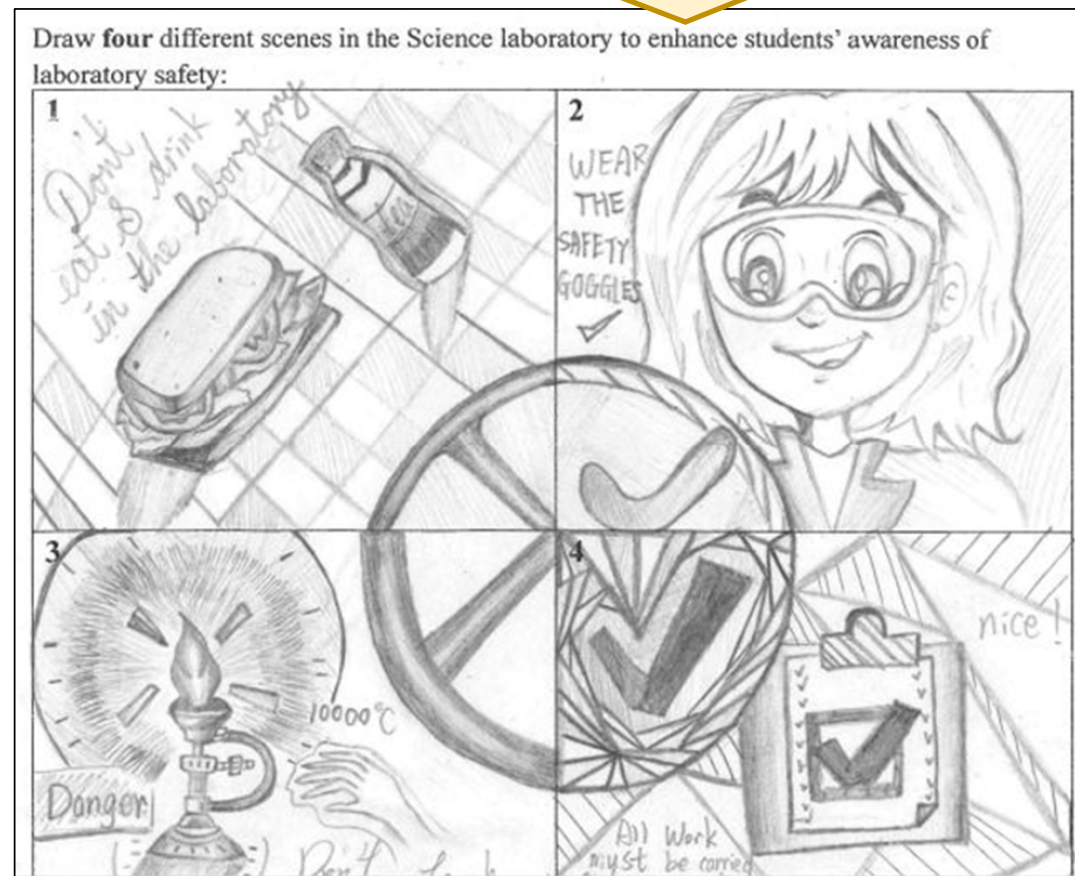
1	2
3	4

Some learning and teaching activities in the laboratory were illustrated.

Some laboratory safety precautions were illustrated.

Draw **four** different scenes in the Science laboratory to enhance students' awareness of laboratory safety:

1. Teacher is teach about Live things. Live things.
2. student is use light microscope to watch ......!
3. look this. It is flow down in the his snacks! But someone is eat snacks!
4. And he eat some ......! So he went to hospital.

A student felt unwell after eating snacks in the laboratory and was sent to the hospital for treatment.

Draw **four** different scenes in the Science laboratory to enhance students' awareness of laboratory safety:

1. Don't eat & drink in the laboratory
2. WEAR THE SAFETY GOGGLES ✓ nice!
3. Danger! 10000°C Don't ......
4. All work must be carried

Students created 360º photos.

This activity demonstrates how to create **relevant scenarios for students** to develop their creative thinking and problem solving skills.
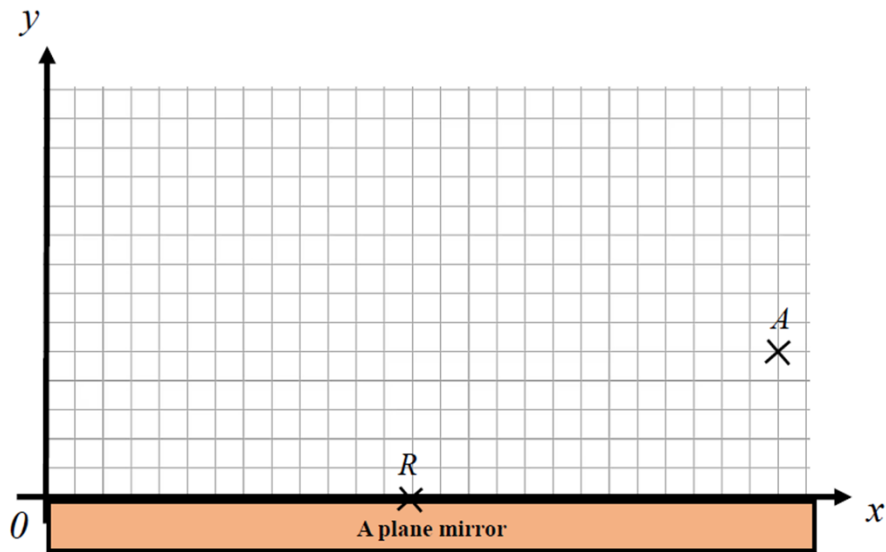
S3 Computer Game on Reflection of light

Task: Design and make a computer game on reflection

Help students recap the knowledge of **rectangular coordinate system** and the **law of reflection**.

Objective: Use the law of reflection and mathematical knowledge to find the points on the reflected ray.
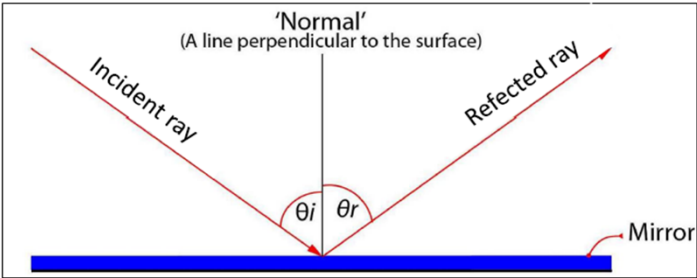

1. Define the range of values for the x-coordinate and y-coordinate of the points in the above coordinate plane.

   Range of x values: _____ $\leq x \leq$ _____ , where x is an integer.

   Range of y values: _____ $\leq y \leq$ _____ , where y is an integer.

2. The Law of Reflection

   'Normal'
   (A line perpendicular to the surface)

   Incident ray

   Refected ray

   θi θr

   Mirror

   The law of reflection states that the angle of incidence is equal to the angle of reflection.

   _____ = _____

3. Write down the coordinates of points A and R.

   $A =$ _____ and $R =$ _____

4. Point A is the starting point for the incident ray and point R is the point of reflection.
   (i)   Draw the incident ray and the reflected ray.
   (ii) Write down the coordinates of the point(s) lying on the reflected ray.

5. Add other FOUR starting points in any suitable position and mark them in the above coordinate plane.
   (i)   Using the same point R, draw the corresponding incident rays and the reflected rays
   (ii) Write down the coordinates of the point(s) lying on the reflected ray.

Coordinates of the starting point of the incident ray				
Point(s) on reflected rays				

Computer Literacy lesson

Objective: Design a Python game on reflection

Tool: online-python.com and w3schools.com

1. Define the problem

Problem:	Students lack opportunities to consolidate their knowledge of science and mathematics
Users	*S1-3*
Users' needs:	*Fun, challenging, customizable (e.g. with options)*
Design brief:	Design and make a computer game on reflection

> Guide students to **understand users' needs**, allowing them to create solutions that are **relevant and effective**.

2. Ideate

(a) Initial design

> Guide students to consider **different features** of computer game design, encouraging them to develop **various design ideas**.

Features	Design ideas
Levels of difficulty and related content	
Number of questions to answer	
Number of attempts allowed to answer	
Scoring	
Optional	
Timer	
Quitting method	
Information, e.g. encouragement	
Others	

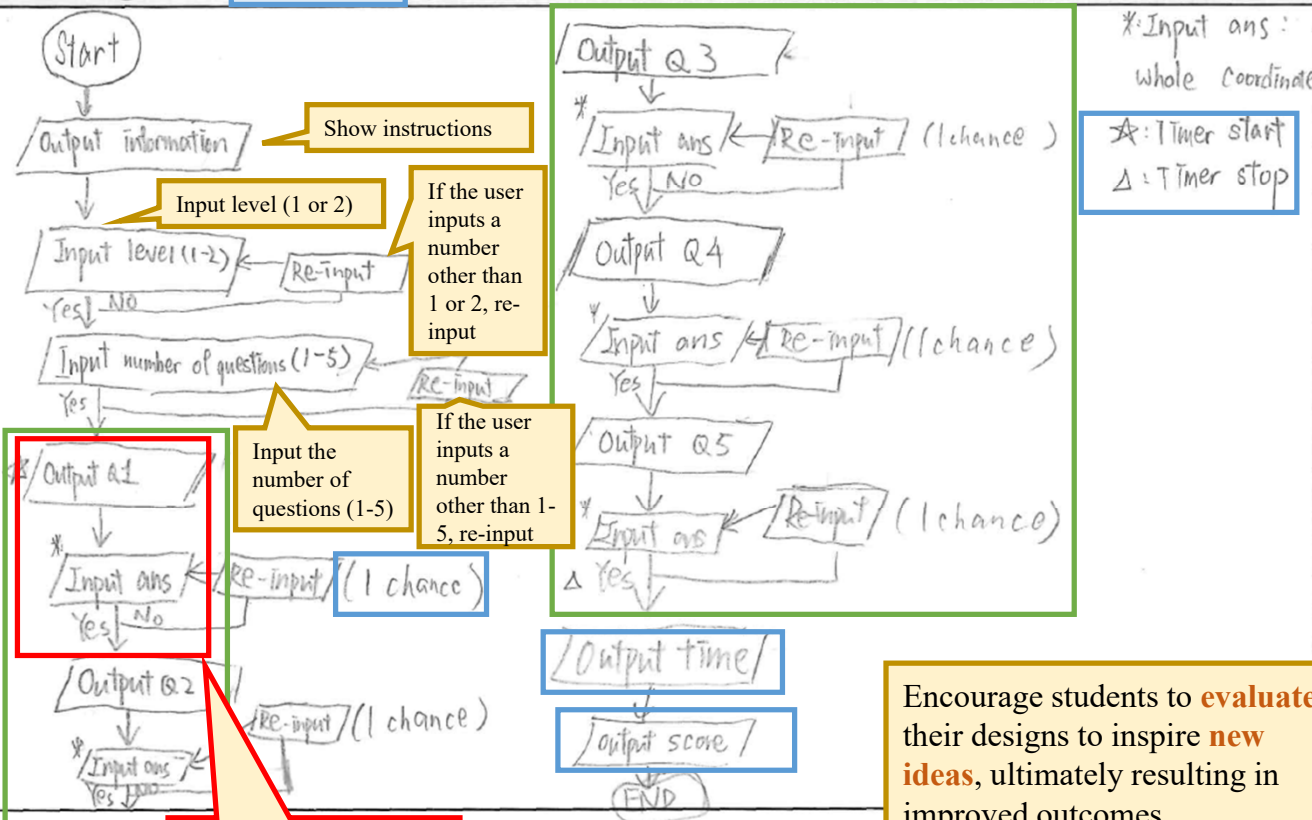> Sample questions were provided to **encourage students' creative thinking**:
> - Which of the following points is formed when a given starting point is reflected across a vertical line through the point of reflection?
> - Given the x- and y-coordinates of the starting point A and the point of reflection, which of the following points lies on the reflected ray?

The flow diagram helps students **visualise** the logic and flow of their program and **identify potential errors** in their design before they start coding.

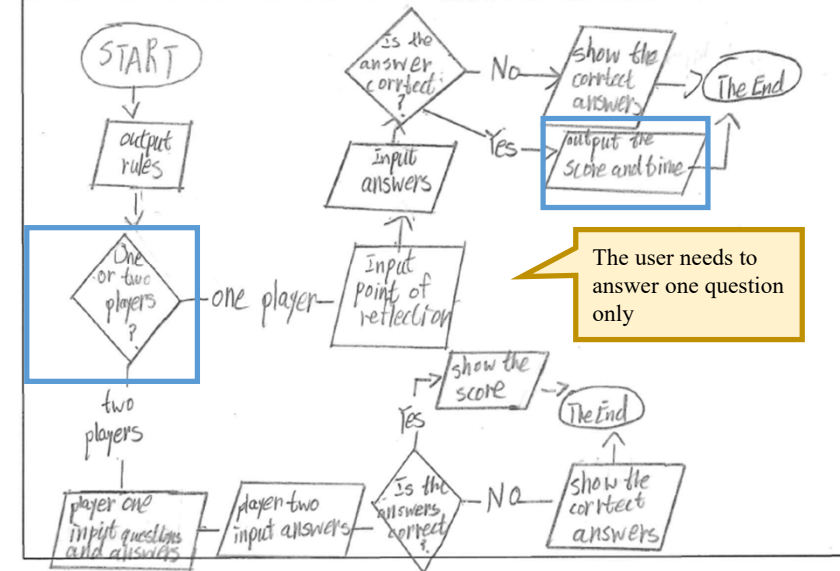Students' flow diagrams, illustrating their **initial design ideas**

Design 3

Flow diagram

START

output rules

One or two players?

two players

player one input questions and answers

player-two input answers

Is the answers correct?

Is the answer correct?

No → show the correct answers → The End

Yes → output the score and time

Input answers

Input point of reflection

one player

show the score → The End

Yes

No → show the correct answers

The user needs to answer one question only

Flow diagram   Design 1

Start

Output information — Show instructions

Input level (1-2) ← Re-input — Input level (1 or 2)

Yes | No

Input number of questions (1-5) ← Re-input

Yes

If the user inputs a number other than 1 or 2, re-input

Input the number of questions (1-5)

If the user inputs a number other than 1-5, re-input

Output Q1

Input ans ← Re-input (1 chance)
Yes | No

Output Q2

Input ans ← Re-input (1 chance)
Yes | No

Feedback:
Should repeat (n-1) times, where n is the number of questions entered

Output Q3

* Input ans ← Re-input (1chance)
Yes | No

Output Q4

Input ans ← Re-input (1chance)
Yes

Output Q5

Input ans ← Re-input (1chance)
Δ Yes

Output time

output score

END

*: Input ans: whole Coordinate

☆ : Timer start
Δ : Timer stop

(1 chance)

Encourage students to **evaluate** their designs to inspire **new ideas**, ultimately resulting in improved outcomes.

Criteria	Design 1	Design 2	Design 3	Design 4
Application of knowledge	3	4	5	5
Fun	4	4	5	4
Interaction	5	5	5	5
Feasibility	4	3	5	4
Others (if any)	3	3	5	5
Total	19	19	25	23

3B06 3 20 9

Students' final designs

(c) Final design — **Design 1**

Features	Design ideas
Levels of difficulty and related content	Three levels : Easy Hard Nightmare
Number of questions to answer	5
Number of attempts allowed to answer	∞
Scoring	one mark for each questions Full mark is 5
Optional	
Timer	Related to the levels : Easy → 3 mins Nightmare → 10 mins Hard → 5 mins
Quitting method	Press the reset button
Information, e.g. encouragement	Explanation of the questions
Others	/

Feedback:
Students wrongly expressed the time constraints. The correct time constraints should be:
Easy → 10 min
Hard → 5 min
Nightmare → 3 min

(c) Final design — **Design 3**

Features	Design ideas
Levels of difficulty and related content	Level 1/2/3 1: form 1 2: form 2 3: form 3
Number of questions to answer	3/5/7
Number of attempts allowed to answer	3 time
Scoring	less than 20s +10 try not over than 3 tim +1 long than 20s +3 answer correct +10. try over than 3 time −2 wrong +5
Optional	
Timer	20s each question
Quitting method	No
Information, e.g. encouragement	Yes
Others	Yes

If the answer is correct after failure, add 5 marks only.

ONLINE PYTHON BETA

🚀 Try New

main.py +

```
153    print("GAME END")
```

Ln: 153, Col: 18

▶ Run   ↪ Share $ Command Line Arguments

```
*********************************************************************
                    Welcome to my Python Game!
Use Law of Reflection and mathematical knowledge to find the required points.
Each question carries 10 marks. And 5 marks for 2nd attempt.
1. Decide the level (S1/S2/S3) of questions you want to attempt.
>> Please enter 1/2/3 and then press ENTER.
2. Decide the number (1/2/3/4/5) of questions you want to attempt.
>> Please enter 1/2/3/4/5 and then press ENTER to start the game.
*********************************************************************
```

Show instructions

```
3
Level S3 is chosen.
```

It is expected that this level demands a higher level of integrated application of mathematics and science knowledge.

```
3
3 questions are chosen.
Question 1
[S1] Based on the given grid line paper, the point of reflection is (13,0) .
When the starting point of the incident ray is (26,5). find the ending point of the reflected ray.
Enter the coordinates e.g. (a,b) of the ending point and then press ENTER.
(0,5)
You are correct!
You got 10 marks.
```

Students may find the answer using:
- reflection transformation
- the law of reflection

```
.............
Question 2
[S2] Based on the given grid line paper, the starting point of the incident ray is (26,11) .
When the ending point of the reflected ray is(0,11). find the point of reflection.
Enter the coordinates e.g. (a,b) of the point of reflection and then press ENTER.
(13,0)
You are correct!
You got 10 marks.
.............
Question 3
[S3] Without using the grid line paper, the point of reflection is (13,0) .
When the starting point of the incident ray is (20,7). find the ending point of the reflected ray.
Enter the coordinates e.g. (a,b) of the ending point and then press ENTER.
(0,12)
You are wrong!
Please enter again!
(0,13)
You are correct!
You got 5 marks.
.............
Your time taken is 11.372 seconds.
Your total score is 25 marks.
GAME END


** Process exited - Return Code: 0 **
Press Enter to exit terminal
```
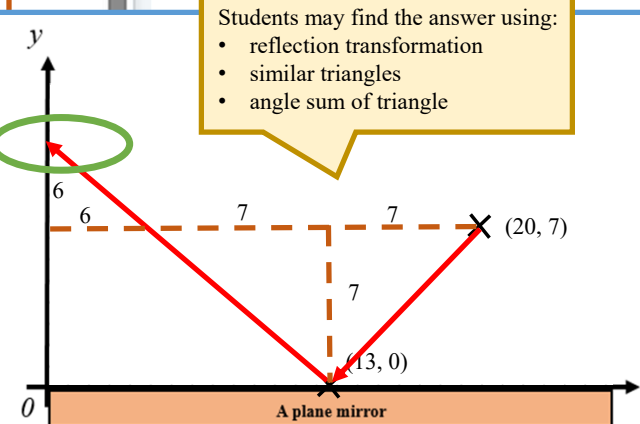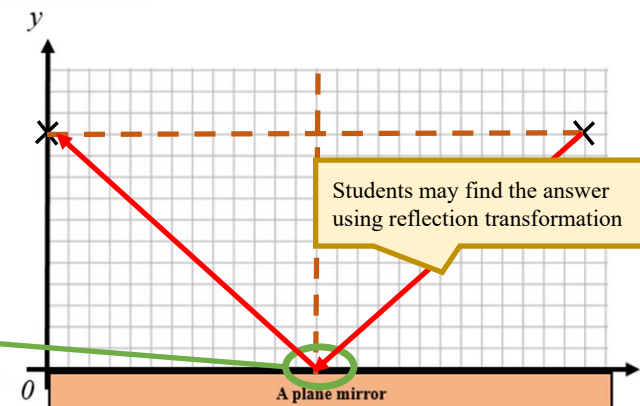

Students may find the answer using reflection transformation

A plane mirror

Students may find the answer using:
- reflection transformation
- similar triangles
- angle sum of triangle

(20, 7)

(13, 0)

A plane mirror

(Diagram not drawn to scale)

This activity exemplifies students' **integrated application of cross-disciplinary knowledge and creative thinking** in designing the computer game, preparing them for future challenges in real-life contexts.

Reflection and ways forward

- **Transformative Experience:** Engaging in **cross-curricular STEAM planning and implementation** has been an inspiring journey that has reshaped cross-disciplinary learning and teaching, enriching both **student and professional growth**

- **Holistic Curriculum Planning:** Joint planning supports **curriculum alignment** and **scaffolds learning**, resulting in a more cohesive and meaningful educational experience

- **Collaborative Growth:** Cross-disciplinary teamwork expands teaching strategies, encourages mutual support, and highlights the value of **ongoing peer mentoring and professional development**

- **Enhanced Student Engagement:** **Integrating subjects** in real-life contexts, such as "Interactive Laboratory Safety Animation" and "Computer Game on Reflection of Light", significantly boosts **student interest and learning**

- **Skill Development:** These activities foster **generic skills**, including creativity, critical thinking, problem-solving, collaboration, and a **passion for learning**

- **Looking Ahead:** The success of collaboration inspires a **continued commitment** to inclusivity, innovation, and joy in learning and teaching