

How to develop students' inquiry mind – a reflection of a case study



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School-based Science Curriculum

- 3-yr plan (investigation)
- Science concepts & skills
- Expected learning outcomes
- Unit plan - specific process skills

Learning

- Key Emphasis – Self-directed learning, Thinking, Experimenting, Presentation
- Authentic learning experience
- Critical Thinking, Creativity, Collaboration, Problem Solving skills
- Learning Journal

Assessment

- Assessment – a show time (assess on what've learnt)
- Written assessment: quizzes, tests, examination
- Investigative practical assessment

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School-based Science Curriculum

- 3-yr plan (investigation)
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Investigation (3-year planning)

S. 1	Basic Skills - Observing, Recording, Measuring Practical skills Presentation skills -oral, written, diagrammatic Scientific Investigation - Simple fair test - Simple laboratory report
S. 2	Practical skills Communication skills - Presentation, Discussion, Debate Scientific Investigation - Fair test (multiple variables) - Analyzing results, making conclusions, writing laboratory reports -Evaluating the investigation (method, sources of error) -Project Learning (I)
S. 3	Scientific Investigation— Designing their own investigations - Proposing hypothesis -Investigation (multiple variables) -Collecting and reporting data -Project Learning (II)

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EXPECTED LEARNING OUTCOMES - Secondary One

By the end of the school year, I expect to achieve the following outcomes:

1. **Practical skill**
able to handle 10 practical skills, pass the Practical Assessment
2. **Language Across Curriculum**
use complete sentences to
 - Express ideas
 - Describe observations
 - Write procedures for an experiment
 - Write a simple laboratory report
 - Write a brief explanations to explain phenomena.
3. **Scientific investigation – concept of 'FAIR TEST'**
able to
 - conduct Fair Test
 - write a simple laboratory report (procedure, diagram of set-up, result and conclusion)
 - Carry out a mini-project about pollution
4. **Reading to Learn**
 - Read at least 2 science books in a term

Developing Scientific Process skills

Abilities to be developed in S.1-3

- (a) to observe closely and carefully
- b) to classify
- (c) to measure accurately
- (d) to handle equipment and apparatus properly and safely
- (e) to communicate
- f) to infer from observations and experimental data
- g) to predict
- h) to propose hypotheses
- i) to interpret data
- (j) to control variables

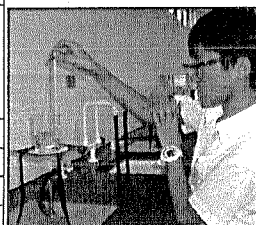


Syllabus for Science (S 1-3), p. 13

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Secondary One – 10 Basic Practical Skills

1. Transferring a small amount of liquid
-- using a dropper
-- pouring from bottle
2. Mixing solutions -- tapping on the test tube
-- stirring with a glass rod
3. Pouring solution from reagent bottle
4. Lighting a Bunsen Burner
5. Heating liquid -- using a beaker
-- using a boiling tube
6. Measuring -- temperature
-- length
-- volume
-- weight
-- time
7. Using a microscope
8. Making a microscope slide
9. Filtration
10. Evaporation -- using a watch glass
-- using an evaporating dish



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Unit plan

Unit 1: Introducing Science - Measuring


Aims:

1. To develop students' skills in handling measuring instruments properly;
2. To develop students' problem solving skills through measuring activities;
3. To develop students' critical thinking skills and creativity.

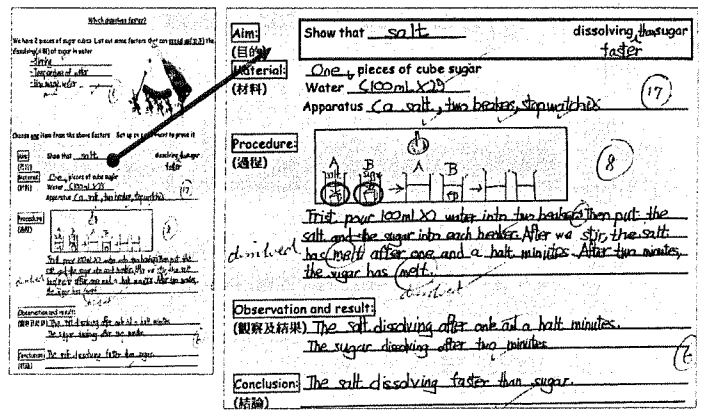
Teaching points:

Measuring	Key points	Remarks
...
Length	An oversized object – a long tape	- Allow students to use their own methods to find the length of a long tape. - After reporting their methods, allow students to discuss which method(s) is/are the best with reference to the advantages and limitations of the methods used.
...

Investigation – Fair Test (Secondary 1)

Show the effect of changing a certain variable Concept of FAIR TEST	Stirring → dissolving
More examples	temperature → dissolving
Awareness of Fair Test Rewrite experimental Procedures	
Conduct a simple Fair Test	Tissue absorption

Concept of a fair test - Assessment



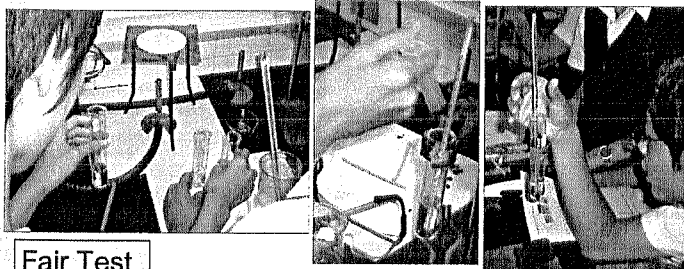
EXPECTED LEARNING OUTCOMES - Secondary Two

By the end of the school year, I expect to achieve the following outcomes:

- Practical skill**
10 practical skills, INVESTIGATIVE Practical Assessment
- Learning skill**
 - Summary of a topic
 - Mind Map/ Flow Chart / Tables
 - Learning Journal recording my experience in doing science
 - Essay-type question
- Scientific investigation**
 - Conduct a Fair Test
 - Tabulate data
 - Make prediction
 - Carry out repeated measurements
 - Analyse the data and draw conclusion
 - Evaluate their investigation & suggest improvement
- Reading to Learn**
 - Read at least 2 science books in a term

Skills/ Items for investigation	Suggested experiments Unit 7 Some Common Gases
Observation	Gases test
Drawing diagram	Diagram of testing starch in plant
Apparatus/ Instrument selection	Carbon dioxide is needed for photosynthesis
Fair Test concept	Conditions for photosynthesis
Procedure writing	Compare breathed & unbreathed air
Record the result	Light is needed for photosynthesis
Repeat measurement	Burning food (energy released)
Tabulate data	Burning food (energy released)
Presentation of data	Test the properties of gases
Prediction	Compare the breathed & unbreathed air
Conclusion	Conditions for photosynthesis
Evaluation & Reflection	Compare the breathed & unbreathed air

Example - Which food contains more energy content?



Fair Test

Accurate measurement

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Learning

- Key Concerns – Self-directed learning, Thinking, Experimenting, Presentation
- Authentic learning experience
- Critical Thinking, Creativity, Collaboration, Problem Solving Skills
- Learning Journal

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Authentic Learning experience



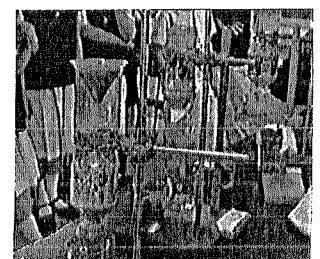
Critical thinking, creativity, collaboration



Clarity?

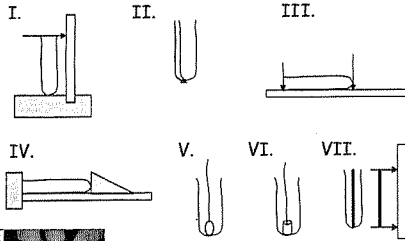
Speed?

How to compare fairly?



- Filtration - Filter column competition

Problem solving- Find the depth of a boiling tube



Learning Journal

- Notes written by themselves during the lessons
- Summary of learning contents
- Home experiments (5 a year)
 - Observe an egg in vinegar
 - Home-made indicator
 - Self-evaluation on investigations conducted
 - Comment on a sample lab report and re-write it
 - Investigation on a rubber band
- Self-study material of the related topics
- Reflection: most impressive topics or feelings

Home experiment: Egg in vinegar

On 2nd Feb, I started to do this experiment.

1st Day
I put egg in soda, lemon juice, ~~vinegar~~ vinegar and these are vinegar. just by using different liquid.

2nd Day
When I put the egg in it, many tiny bubbles appear than the others appeared immediately on its surface. After a hour, the shell became so soft, that it felt surface.

3rd Day
There were more bubbles and the surface of an egg remained. Also, it felt soft.

4th Day
The bubbles later disappeared, they still in air. The skin of the egg is all covered. The egg

Home experiment: Testing household solution by home-made indicator

The photograph shows a student in a lab coat using a pipette to add a liquid to a test tube. The test tube contains a solution that has changed color, indicating an acid-base reaction. The student is looking at the color change.

Learning Journal

-Difficulties, improvement, further investigation

Evaluation of this experiment:
From this experiment, I learn how to make some successful home-made indicator. I also learn how to find some suitable apparatus when I don't have the professional apparatus. For example I can use the small white boxes to replace the test tubes, I can also use a small bowl and a chopstick to replace the mortar and the pestle. I also learn that not all the plants are suitable to be the home-made indicators. From the procedure of dropping the solution, I learn that we cannot drop too much solution everytime, otherwise we cannot know the result clearly. For example, I add too much tea so I cannot know the result clearly.

If I have chance to do this experiment again, I will use more plants to do it because I want to know is there any some features between the plants that can't be the indicator. I also want to use my tears to be one of the solutions, but I need to buy an onion to make me cry first.

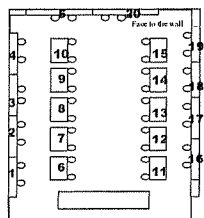
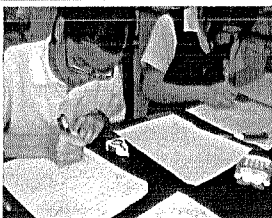
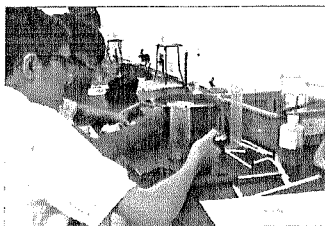
Students' Reflection

near in Form 1, we only learnt about the basic things in the laboratory. But in this year, we really learn about SCIENCE. It's funny, truly and really interested. I hope I will learn more in the coming year. I learnt how to write a lab report. I learnt how to be a real scientist and I knew how to observe well.

Anything change in my attitude of learning science?
Yes, I became more keen on doing experiments and I became more sensitive to the things around science.

Investigative Practical Assessment

5 mins.	Seating allocation (2 students in a group)
45 mins.	Read the question, discuss, design, do the experiment
40 mins.	Write the laboratory report individually.

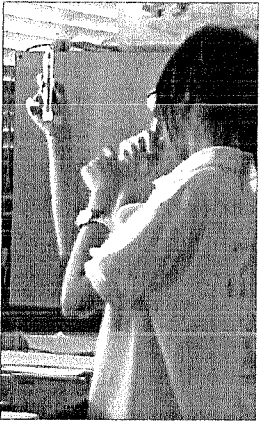


Investigative Practical Assessment

Problems

Unit	Questions	Measurement
Unit 9 Phy.	- How the height of the ramp affects the distance a marble traveled in the track? - How the materials of the paper spinner affects its falling speed?	Time, Length Time
Unit 10 Chem.	- How the concentration of acid affects the reaction between Mg and dilute acid? - How temp of water affects the amount of CaCl ₂ dissolves?	Volume, temp. Time, temp, vol., length
Unit 7 Bio.	- Compare the amount of oxygen in breathed air when you are at rest and when you have just finished an exercise	Length, time

Investigative Practical Assessment



Metal reacts with acid

find out whether the concentration of acid will affect the reaction of magnesium and dilute acid.

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Problem Solving – preparing different concentrations of acid

Name	Acid (cm ³)	Water (cm ³)	The result/ rate			
Time	acid	water	temperature	starting	ending	Group 1
Base 1	2cm ³	8cm ³	24°C	29°C	50 g/s	1
Base 2	3cm ³	7cm ³	24°C	31°C	1:10 (1)	2
Base 3	2cm ³	8cm ³	24°C	31°C	2:25 (1)	1
Base 4	4cm ³	6cm ³	24°C	28°C	1:10 (1)	1
Base 5	4cm ³	6cm ³	24°C	28°C	1:10 (1)	1
Base 6	4cm ³	6cm ³				

	0	1	2	3	4	5	6	7	8	9	10
A. 5ml acid + 5ml water (1ml)											
B. 5ml acid + 4ml water (1ml)											
C. 5ml acid + 3ml water (1ml)											
D. 5ml acid + 2ml water (1ml)											

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Evaluation & Reflection

Evaluation

In this experiment, I had made quite a lot of mistake. I always put the ramp and the track not in a proper way, it will affect the marble. So, I decide to do repeated experiment to avoid this. Another mistake is no communication with my partner. I also let the marble go without asking her if she was ready or not. That make us need to do once more in order to have a fair test. I think I need to have a confirm and well planned before doing the experiment.

procedure (2)

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Students' Reflection

The most important topic I learned in this test is I really need to think by myself not following the books. I need to think how to do the experiment by myself. I need to following the steps that thought by myself to do the experiment. It is very new to me.

In this year, I really know what is science. How to study science. It's not just reading from the books. It doesn't like history. We need to think by ourselves, doing experiment by ourselves. It's quite hard for me. I'm not a people who like thinking. I just like following the books. So it improves my thinking skills.

Through writing these lab reports, I learned how to observe things. I really think that it is good. I need to improve it.

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My Reflection

Perseverance

Learning Science

Learning Content –

Scientific knowledge

Generic skills

Learning Strategies –

1A (Authentic learning experience)

3C (Critical Thinking, Creativity, Collaboration)

1P (Problem solving)

Assess what they have learnt

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My Reflection

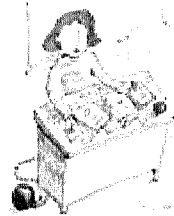
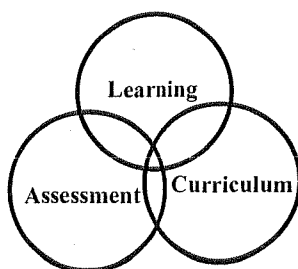
Difficulties

- Curriculum & Textbook
- Learning Diversity of students
- Implementation of Change
- Teachers

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Curriculum Planning

A school-based holistic plan



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Thank You!

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