Teaching to Learn, Learning to Teach in the Primary Science Classroom

Tan Poh Hiang
Anne Wong
Judy Lee

Maximum of 9 people at each table

To access these slides, join the U in Primary Science collaboration group in OPAL, and go to the Resources for Science Teachers forum.
Models

1. What are models?
2. How can models be used to support science learning?
3. What are some considerations in the use of models?
When helping our students learn about the water cycle, we usually discuss the following:

- Steam is a form of water vapour, and hence it is invisible.
- ‘Cloud’ is formed when water boils.
Learning about Condensation

Students often struggle to understand the process of condensation because water vapour is invisible.

How can we help students visualise the process of water vapour condensing to form ‘cloud’/water droplets?

Groups of 4/5
Using the materials provided, explain how water vapour condenses on a cooler surface.
Learning about Condensation

Affordances versus Constraints

In what ways did your model afford and constrain your explanation of condensation?
What are models?

Models represent objects, processes, or events and capture the structural, behavioural, or functional relations significant to understanding these interactions (Hubber & Tytler, 2013).

A model is designed with a specific purpose by the modeller (Van der Valk et al., 2007).
(Possible) Models in Primary Science

1. **Replicas or Physical Model**
   - Digestive system

2. **Computer Model**
   - Simulation (e.g., electrical system; energy conversion; ecosystem games)

3. **Analogue Model**
   - Transportation vs circulatory system

4. **Prototype or Plan**
   - Heat: Ice-cream container design
   - Electrical System: Light house

5. **Molecular Model**
   - Plant and animal cells

6. **Mental Model**
   - Concept map/drawing
Replica or Physical Model

e.g., *Digestive System*
Computer Model
e.g., *Simulation*

My shirt will dry faster when the water in it evaporates quicker! How can I increase the rate of evaporation?

To investigate how temperature affects the rate of evaporation

Drag the items needed for each set-up.

- 25°C
- 35°C

[Image of a simulation interface]

Click on the object to turn
Analogical Model
e.g., Transportation System vs Circulatory System

How does the circulatory system move oxygen around the body?
How does the bus transportation system move us between home and school?
Analogical Model

e.g., *Transportation System vs Circulatory System*

<table>
<thead>
<tr>
<th>Transporting us from home to school</th>
<th>Transporting oxygen from lungs to hand</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Transporting us from home to school" /></td>
<td><img src="image2" alt="Transporting oxygen from lungs to hand" /></td>
</tr>
</tbody>
</table>

**Transporting us from home to school**
- Home
- Bus interchange
- School

**Transporting oxygen from lungs to hand**
- Lungs
- Heart
- Blood vessel
- Blood
- Head
- Hand
- Leg

**Example:** Transportation System vs Circulatory System
Prototype or Plan

e.g., *Boat Making*
Molecular Model
e.g., Plant and Animal Cells

Contributed by:
Rosyth School
Mental Model
e.g., Concept Map/Drawing
Why Use Modelling?

Scientific practice involves the construction, validation and application of scientific models, so science instruction should be designed to engage students in making and using models.

David Hestenes, 1996
Why Use Modelling?

Enhances understanding of science

Provides opportunities for engagement

Fosters thinking and process skills
# The Rope Analogy for Electric Circuit

<table>
<thead>
<tr>
<th>Analog</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Person pulling on the rope</td>
<td>Battery, the energy source</td>
</tr>
<tr>
<td>Person raising hands</td>
<td>Bulb lighting up</td>
</tr>
<tr>
<td>Rope moving</td>
<td>Electric current flowing</td>
</tr>
<tr>
<td>Rope moves when it is taut / connected throughout</td>
<td>Electric current flows only if circuit is closed</td>
</tr>
</tbody>
</table>

Use of the rope analogy in a UK class

[https://www.youtube.com/watch?v=cxygNY4Jw6M](https://www.youtube.com/watch?v=cxygNY4Jw6M)
Use of Simulation

Use of Video
USE OF ANALOGIES

WHAT AND WHEN TO USE

Analogies are tools for reinforcing thinking skills and conceptual understanding (Harrison, 2008; Taylor & Coll, 2008). Teaching with analogies, besides being fun and motivating for students, can also help them visualise complex ideas, phenomena or objects that cannot be observed directly using our senses. When a teacher draws an analogy between two objects, ideas, or experiences, he is making explicit comparisons of certain aspects or attributes of the two that are relevant to the learning. Analogies can make abstract concepts familiar and easier to understand when the teacher compares them with everyday objects and experiences. Some common analogies include the eye and a camera, the heart and a pump, or the brain and a computer. Analogies can be used to extend a line of argument or to draw an inference when making comparisons.

Other ways whereby explanations can be made clearer through the use of analogies are as follows: the analogy of a river flowing can be used to explain the flow of electrons in circuits when teaching the topic on electricity. In primary level mathematics, when a teacher introduces the concept of parallel lines, he can introduce the
Challenges When Using Models in Teaching and Learning

01. Lack the necessary visual imagery to understand the model.
02. Incognisant of boundary between model and reality.
03. Miss key attributes so misunderstand purpose of model.
04. Stick with least sophisticated model.
05. Difficult to apply model in different contexts.
06. Learn the model rather than the concept.
# Teacher-created vs Student-created Models

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Teacher-created model</th>
<th>Student-created model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>To explain difficult concepts, and to help students visualise abstract processes</td>
<td>To elicit students’ naïve conceptions and their understanding over time</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Examples</th>
<th>Teacher-created model</th>
<th>Student-created model</th>
</tr>
</thead>
<tbody>
<tr>
<td>• condensation of water vapour in the air; • current flow in a closed circuit; • frictional force between two surfaces; and • heat gain or heat loss.</td>
<td>• human digestive system; • home lighting, and lighting in decorations; • plant and animal cells; and • water cycle.</td>
<td></td>
</tr>
</tbody>
</table>
Small Group Discussion: Student-created Model

Based on a pair of student-created models on Plant Transport System, discuss the students’ level of understanding for plant transport system. What makes you say so?
Considerations

Go to www.menti.com and use the code 48 06 80

1. Grab your phone
2. Go to www.menti.com
3. Enter the code 48 06 80 and vote!
Considerations

Choice of materials

Test alternatives

Students’ voice

Refine

Communicate ideas

Assess understanding
The task provided the students with the platform to be cognitively engaged and actively constructing knowledge throughout the process as everyone was given the opportunity to contribute their ideas. This increased the students’ ownership of their own learning and in turn, increase their intrinsic motivation to learn. They enjoyed the lesson so much that they have been asking for more of such lessons in the future.

Irene Tan Ying Fong
ST/Science
Holy Innocents’ Primary
Suggested Sequence of Learning

1. Introduce what the model is intended to show and find out what ideas students already have about that phenomenon.

2. Carry out the modelling activity.

3. Discuss the following aspects with students:

<table>
<thead>
<tr>
<th>Talk about</th>
<th>Analyse by identifying</th>
</tr>
</thead>
<tbody>
<tr>
<td>• how the model is like the actual concept/target, and</td>
<td>• positive features of model,</td>
</tr>
<tr>
<td>• how the model is different from actual concept/target.</td>
<td>• negative features of model, and</td>
</tr>
<tr>
<td></td>
<td>• features of the models that are ignored.</td>
</tr>
</tbody>
</table>

4. Return to the ‘big idea’ at the end.

5. Invite students to explain their understanding of the activity.
Hone our knowledge and skills as science teachers in the use of models and modelling by

- understanding the nature of what a model is;
- understanding the scope and limitations of models;
- selecting, developing and/or modifying existing curricular models to support students’ learning; and
- understanding how students construct their own models and providing them with appropriate feedback.

(Gilbert, 2004)
Share your thoughts

Go to www.menti.com and use the code 48 06 80

1. Grab your phone
2. Go to www.menti.com
3. Enter the code 48 06 80 and vote!
Thank you!

Tan_Poh_Hiang@moe.gov.sg
Anne_Wong@moe.gov.sg
Judy_LH_Lee@moe.gov.sg


References


