A topic-based approach to addressing the language demands of science

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Presenters:

Dr Seah Lay Hoon
Learning Sciences Lab
National Institute of Education

Madam Chua Kiat Eng
West View Primary School

Targeted topic: Heat and temperature

Primary 4 syllabus

- What is heat
- What is temperature
- Effects of heat

- Students have much prior knowledge and experiences of heat phenomena but their conceptions may not necessarily align with the scientific perspective
- Easy for us to underestimate the challenges students face in making the leap

Students' statements about heat

- In your group, examine the students' statements containing the word 'heat'
- Discuss:

(1) What do these statements indicate about the students' ideas of heat?

(2) How could these statements be converted so that they can be more aligned with the scientific perspective?

What do these statements indicate about the students' ideas of heat?

Some common misconceptions

- Heat is a substance.
- Heat and temperature are the same OR Temperature is a measure of the heat content of a body
- Temperature is a property of a particular material or object. (Metal is naturally cooler than plastic).
- Heat and cold are different, rather than being opposite ends of a continuum.
- Heat rises.

Some useful references on students' alternative conceptions

- http://www.eskimo.com/~billb/miscon/opphys.html
- http://www.cyberphysics.co.uk/PGCE/Misconceptions/heat&temperature.htm

WHAT COULD THE SOURCES OF THE STUDENTS' MISCONCEPTIONS BE?

See also Carl A. Doige & Terence Day (2012) A Typology of Undergraduate Textbook Definitions of 'Heat' across Science Disciplines, International Journal of Science Education, 34:5, 677-700, DOI: 10.1080/09500693.2011.644820

Common words used in this topic

- Hot/cold
- Heat
- Source of heat
- Temperature
- Heat gain/loss
- Heat flows
- Expand/expansion
- Contract/contraction
- Change in state
- Good conductors of heat
- Poor conductors of heat

Comparison of everyday and scientific use of words related to 'Heat'

Words	Everyday use	Scientific use
Hot/cold	Absolute	Relative
Heat	Verb Heat is hot Heat comes from sunlight	Verb/noun (but without mass and volume) Ice contains heat Heat is a different form of energy from light
Source of heat	Specific heat 'generator' that is 'hot' Heat can be 'produced' from nowhere	Anything that has higher temperature Heat is transferred from one entity to another or converted from another form of energy
Temperature	Equivalent to 'heat'	Temperature: intensive property But heat is not
Expand	Due to a variety of causes	Thermal expansion: due to transfer of energy as heat
Heat flow	Not common	Basis for all changes due to heat

Conceptual and language demands of the topic

- Conceptual demands (common misconceptions)
- Language demands (challenges imposed by the use of language)
  - Cold and hot as absolute (rather than relative)
  - Expand (and) increase in size

Name:_____( )

What is heat?

Everyday meaning of heat	Scientific meaning of heat
Write a sentence using the word 'heat'	*Find 2-3 sentences in the textbook using the word 'heat'*
	How would scientists define 'heat'?

Reference to textbook p. 17

Compare what you know about heat with how heat is defined by scientists. How are they different?

My ideas	Ideas from the class

Possible activities

- Use some of the statements generated by students as formative assessment
- Ask students periodically whether they consider these statements as True or False
- If false, how could they change the statements into a true statement.

True-False statements

Statement	For each of the statement, decide whether you think it is true or false.			Construct a 'true' statement for those that are false
	Before reading	After reading	After instruction	
Heat is hot.		[p.]		
Fire is a kind of heat.		[p.]		
Heat is a temperature.		[p.]		
		[p.]		
…..				
…….				

Recognizing text-types

What are the common text-types found in the textbook on this topic?

- What are text-types?
- How do we recognise text-types?
- Exercise:
  - What are the main text-types in each of the chapters found in a textbook?
  - How do you know?

Common text-types in Science

Text structure	Signal words
Cause-effect	Therefore, as a result, leads to, so, because of, thus, in order to, if…then
Problem-solution	Fortunately, unfortunately, therefore, trouble, problem, issue, challenge, answer, solution, conclusion
Compare-contrast	Different from, the same as, similar to, as well as, but, compared to, in contrast, however, like, unlike, more, less
Time-order	First, next, then, last, finally, meanwhile, following, before, after, on [date]
Description	For example, for instance, in addition, also, too, some, most, all, other
Question-answer	What, where, why, who, how, when, does

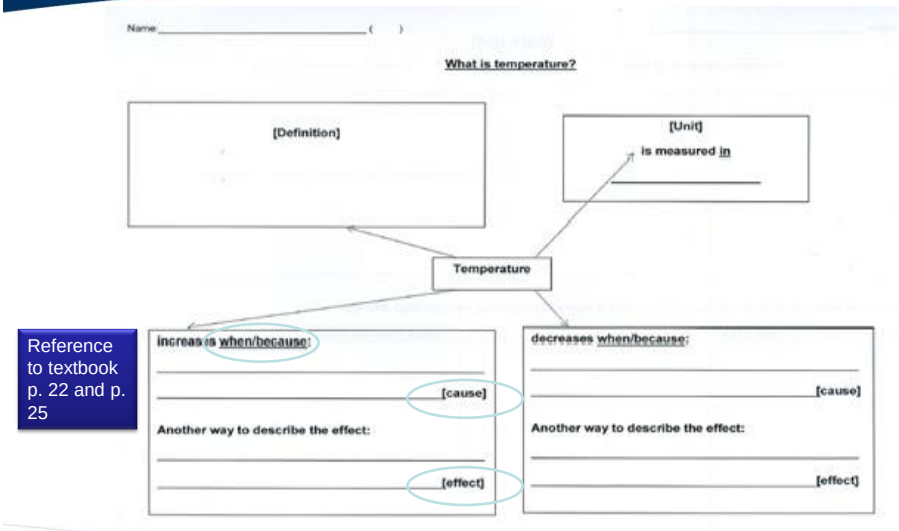
Some other generic scientific words (text-types) used in this topic

- Cause
- Effect
- Observe/Observation
- Infer/inference
- Predict/prediction

Why is it important to support students in recognizing text-types?

Possible ways to teaching text structure

1) Guide students to identify text type through signal words



Reference to textbook p. 22 and p. 25

Possible ways to teaching text structure

1) Identify text type through signal words
2) Use appropriate graphic organizer for specific text structure

Relevant graphic organizer for particular text-type

Text structure	Graphic organizer
Cause-effect	Identify cause and effect 
Problem-solution	Identify problem and solution
Compare-contrast	2-t tables
Time-order	Flow-chart
Description	Pictures-words
Question-answer	Identify question-answers; student self-generate questions

Possible ways to teaching text structure

1) Identify text type through signal words
2) Use appropriate graphic organizer for specific text structure
3) Scaffold the process for writing a particular text type

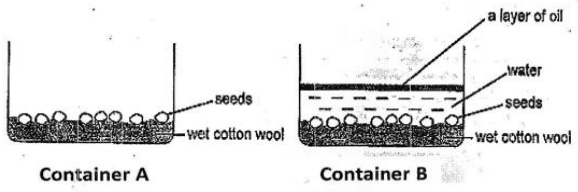
Consistent and long-term instruction is needed!

CONSTRUCTING TEXTS

Description of data

- Test item in Term 1 Continual Assessment [CA]
- Give a reason why the seeds in container B did not germinate.

Siti carried out an experiment on the germination of seeds using two containers A and B as shown below.



After two days, the seeds in container A germinated but the seeds in container B did not.

Accepted answer: 'There is no air for the seed in container B to germinate.'

Analysis

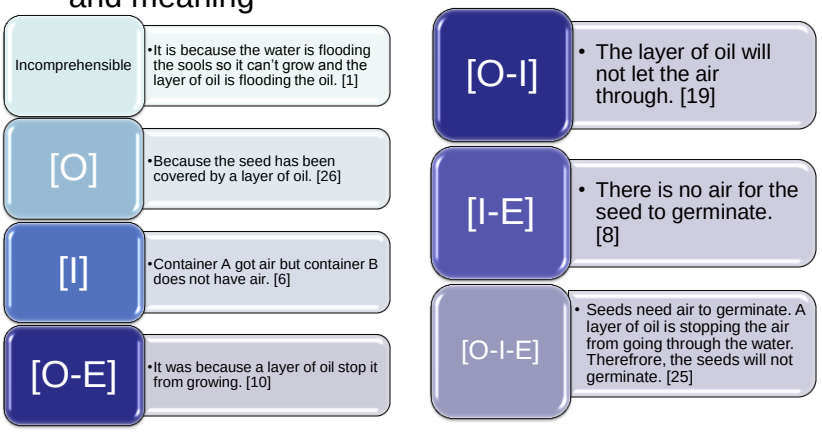
- Three explanatory foci were identified from the students' explanations:

Observable cause [O]	Inferred cause [I]	Effect [E]
•depicted the observable agent that led to the non-germination •Eg. A layer of oil, excessive water	• depicted the non-observable agent that led to the non-germination • Eg. Absence of air	•depicted the consequence of the given cause •Eg. essential condition for growth; prevented from growing

Teachers' expected answer: [I]-[E]

Some findings from baseline study

- Wide variety of explanations in terms of both type and meaning



Number of incomplete explanations = 61
Number of explanations not aligned with scientific account = 24

General principles

- Make transparent the requirements of the questions
- One way to do so is to identify the distinct components within the expected responses
- Provide scaffolds, which could be in the form of question prompts, sentence starters, connectors etc, to structure the construction of these components
- Support students in the synthesis of these components into a coherent response

Useful references

- Books:
  - Language and Literacy in Science Education Philadelphia: Open University (2001)
  - Language and Literacy in Inquiry-based Science Classrooms, Grades 3-8 (2010)
  - Writing in Science in Action: Strategies, Tools and Classroom Video (2011)
  - *Reading in Secondary Content Areas: A Language-Based Pedagogy.* University of Michigan Press (2008).
- Websites:
  - http://www.scienceandliteracy.org/teachersupport/strategyguides
  - www.readingrockets.org/strategies
  - http://www.heinemann.com/wisia/

Coming up….

A TEACHER'S PERSPECTIVE AND HER IMPLEMENTATION EXPERIENCE