香港教育大學
The Education University of Hong Kong

Department of English Language Education

In-service Professional Development Programme: 4-day Course for Secondary School Teachers on Teaching Science Education Key Learning Area in the English Medium

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Contents

Teaching Science Education KLA in the English Medium

Course Coordinator: Dr Stella Kong
Contact:
Room no.: B4-1/F-42
Tel. no.: 2948 7259
email: stella@eduhk.hk

Introduction to the Course

This course aims to support the continuous professional development of practicing secondary school teachers of the Science Education KLA to develop and enhance your understanding of and competency in teaching science through English to enable effective student learning.

Specifically, the course aims to develop and enhance your understanding of and competency in:

1. planning to teach science through English that supports students' learning of science and the language of science;
2. using the language (English) of science to explain science concepts to students; and
3. helping students use the language of science to demonstrate their learning.

As science experts, you will be bringing to the course your knowledge of content. The course will be helping you to connect this content to its language i.e. the language you have to use to make the science content understandable to your students and, further, to enable your students use the language to demonstrate their learning.

You have, therefore, to be prepared to work a lot on analysing language use in science. This may be a bit of hard work for you if you are not used to focusing on language use but the exploration into language use is necessary to build an understanding of the content-language relationships, which is essential for teaching science through English.

You need to do microteaching on the last day of the course. You also have to do an assignment on designing a plan and learning materials for teaching a lesson / double lesson. It will therefore be useful if you can identify the topic / sub-topic you would like to work on for your microteaching and the assignment from the very beginning so that you can start working at it during the workshop time of the course. This will allow the lecturer and your classmates to provide you with feedback to help you improve. It will also make it easier for you to carry your work on it after the course.

Course Schedule
Morning session: 9.30 – 12.30
Afternoon session: 1.30 – 4.30

Day	Venue	Topic
1 (am)	B1-LP-07	Brief introduction to the course Rationale for teaching science through English Topic 1: Organising subject knowledge: Knowledge structures and graphics
1 (pm)	B1-LP-03	Topic 2: Content-language relationships: Content obligatory language, text structures, nominalisations and noun phrases
2 (am)	B1-LP-07	Topic 2: Content-language relationships: Content obligatory language, nominalisations and noun phrases
2 (pm)	D2-LP-03	Topic 2: Content-language relationships: Content obligatory language, nominalisations and noun phrases
3 (am)	B3-LP-06	Topic 3: Planning for integrating content-language teaching: Content-language objectives, content-obligatory language
3 (pm)	B3-LP-05	Topic 4: Designing learning and assessment materials for content-language learning
4 (am)	B3-LP-06	Topic 5: Explaining subject concepts: Using knowledge structures and related graphics and language
4 (pm)	B3-P-04	Microteaching: Preparation, delivery and feedback End-course evaluation

Assignment
A plan and related learning materials for a unit/topic of learning (of roughly a lesson / double lesson) to help students learn science and the language of science

Submission Date: 25th January 2019 (to stella@eduhk.hk)

Recommended Reading

Darian, S.G. (2003). *Understanding the language of science*. Texas: Texas University Press.

Halliday, M.A.K. (2004). *The language of science*. Volume 5 in J. J. Webster, (Ed.). The collected works of M.A.K. Halliday. London: Continuum.

Halliday, M.A.K. & Martin, J.R. (1993). *Writing science: Literacy and discursive power*. London: The Falmer Press.

Hooper, H. (1996). Mainstream science with a majority of ESL learners: Integrating language and content. In J. Clegg, (Ed.) *Mainstreaming ESL: Case studies in integrating ESL students into the mainstream curriculum.* Clevedon: Multilingual Matters Ltd.

Kong, S. (2008). Late immersion in Hong Kong: A pedagogical framework for integrating content-language teaching and learning. *The Journal of Asia TEFL*, *5*(3), 107-132.

Kong, S. (2009). Content-based instruction: What can we learn from content-trained teachers' and language-trained teachers' pedagogies? *The Canadian Modern Language Review, 66* (2), 229-263.

Kong, S. (2014). Designing content-language integrated learning materials for late immersion students, *TESOL Journal*, *6*(2), 302-331.

Richardson Bruna, K., & Gomez, K. (2009). *The work of language in multicultural classrooms: Talking science, writing science*. New York: Routledge.

Unsworth, L. (1998). “Sound” explanations in school science: A functional linguistic perspective on effective apprenticing texts. *Linguistics and Education, 9 (2),* 199-226.

Veel, R. (1997). Learning how to mean – scientifically speaking: Apprenticeship into scientific discourse in the secondary school. In F. Christie & J.R. Martin (Eds.) *Genre and institutions: Social processes in the workplace and school*. London: Cassell.

Walker, E. (2010). A systemic functional contribution to planning academic genre teaching in a bilingual education context. *Language Awareness,19* (2) 73-88.

Walker, E. (2011). How language-aware are lesson studies in East Asian high school context? *Language and Education*, *25* (3) 187-202.

Wellington, J., & Osborne, J. (2001). *Language and literacy in science education*. Philadelphia: Open University Press.

Topic 1
Organising Subject Knowledge: Knowledge Structures

Key concepts to learn

Concept 1: Subject knowledge is not simply facts but **organised relationships**.

Concept 2: **Knowledge structures** are one way of organising subject knowledge.

Concept 3: Knowledge structures (such as classification, cause-effect, comparison-contrast) are **core thinking skills** that apply across all subjects in the school curriculum and across different languages and cultures.

Concept 4: Knowledge structures can be represented in **graphic** forms (such as tree diagrams, flow-charts, tables).

Concept 5: Knowledge structures can be more fully represented in **extended language** (i.e. a full text, but not just words or graphics). In fact, language is almost the only means we have to represent knowledge structures (and thinking) in full.

Lecture: Knowledge structures and graphics

Knowledge Structures

Subject content knowledge is more than simply discrete facts. Subject knowledge (and human knowledge) is about how facts and information are related to and associated with each other. Subject knowledge is about how facts and information are organised and structured in meaningful ways. We can only make sense of the world around us if we can work out the relationships between discrete facts and objects. Subject knowledge involves **knowledge relationships**, not just facts. Knowing something involves understanding the associations and relationships between discrete facts and information. There are different ways in which discrete facts and information are related to each other. There are different terms used to refer to these ways, such as:

- cognitive processes
- conceptual processes/structures
- schema/schemata
- information structures
- knowledge structures

We are going to use the term "**knowledge structures**". There are also different ways of organising and naming knowledge structures. Some of the commonly recognised ways are:

- definition
- classification (through definition, description, exemplification etc.)

- sequence (e.g. processes, cycles, recounts)
- description (of properties, functions, structures, location, measurement etc.)
- cause and effect
- comparison and contrast
- evaluation (reasoned and informed judgment, criticism, argument, justification, recommendation etc.)
- hypothesis (reasoned and informed prediction, guesses etc.)

Knowledge structures are also not discrete structures on their own but they are related to each other. For example, within comparison and contrast, we can be explaining the cause-effect relationships within Object A and Object B. We often find the use of description and exemplification within classification, but description can also stand on its own as a knowledge structure. Human knowledge is so complicated that it is not surprising that any way of organising knowledge will not provide a simple picture. An entity / an object / a piece of information etc. is always related to many other things in many different ways. Despite the complexity of the relationships, it is still useful to explore how knowledge is organised in the subject disciplines. An awareness of this will be useful to subject teachers for helping their students understand what they need to learn in a more in-depth and meaningful way.

Now, think about what you have heard so far about "knowledge structures" with reference to what you know about "**concepts**" in your own subject. How do you understand the term "concepts" in your subject? How would you explain the relationship between concepts and knowledge structures?

Special features of knowledge structures

From what we have been discussing, we can see that knowledge structures have the following features:

1. Knowledge structures are ways of organising and structuring knowledge. Learners have to understand how knowledge is structured i.e. the relationships between ideas / facts in order to learn. They cannot just learn about individual discrete facts without understanding how they are related to each other. Knowledge structures are, in fact, **core thinking and organising skills**. They represent ways in which human beings put order and meaning into things in the world around us.

2. Knowledge structures can be applied **across the curriculum**. For example, the concept of a "sequence" can be used in many subjects:
   - Mathematics: a mathematical procedure
   - Science: a scientific experiment
   - History: a sequence of historical events
   - Geography: a cycle of events in natural phenomena (e.g. weather)
   - Literature: a sequence of imaginary events (story)

3. Knowledge structures are also **cross-cultural**. They can be transferred across cultures and languages. If a student has a concept of "sequence" through their first language learning at the primary level, the concept can be transferred to assist learning through a second language. Knowledge structures are therefore a source of very useful support for students learning through a second language, such as English in Hong Kong.

4. There are **graphic representations** of many of the knowledge structures. These graphic representations provide students with visual help to understanding the structures represented. They provide an easier access than language representations to support students' understanding. Visual representations are easier to understand than language representations, especially in a second language. They can also be used as support for students' language production. See the next page for some examples of graphics.

5. Each knowledge structure has its **related language forms and text structures**. For example, when we classify, we have to use certain language forms to classify. So, we can talk about the language of classification, the language of cause-effect, the language of comparison-contrast etc. Knowledge structures can therefore serve as a link between content knowledge and the language used to represent the knowledge, as shown in the diagram below.

Content-Language Relationship

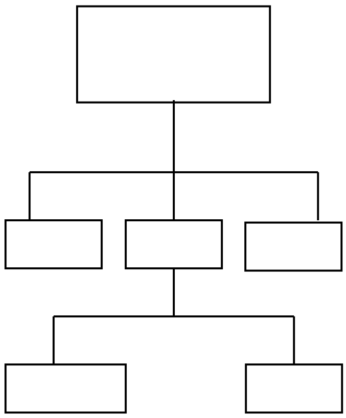
content ↔ knowledge structures ↔ language

In order to represent the knowledge relationships in knowledge structures, we have to use language at an extended text level. Only an extended text can represent and express the relationships between ideas / facts. Just words and just sentences cannot. When language is used to represent knowledge relationships in knowledge structures, individual words have to be organised and related to each other to form a structure as well. We call this a **text structure**. This means that not only knowledge has to be organised, language also has to be organised to (re-)present knowledge.

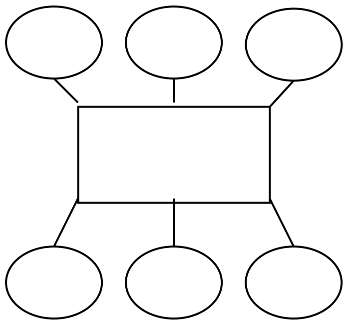
It is useful to develop students' awareness and understanding of knowledge structures as part of their learning in the subject areas. It is also helpful to students if they can be **explicitly** taught how particular language forms and text structures are used to represent knowledge in different knowledge structures. This is the language of the academic subject discipline that subject teachers know but English teachers do not. We will look into the related language forms of different knowledge structures in the next topic.

Examples of graphics in different knowledge structures

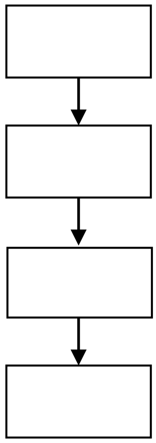
A.



B.



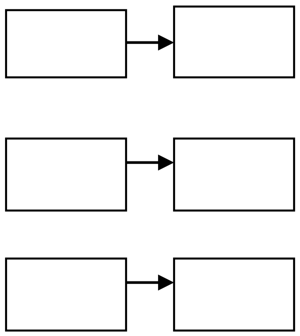
C.



D.

Features	Object 1	Object 2

E.



F.

Aspect	For	Against

Examples of language forms in different knowledge structures: Content-obligatory language of knowledge structures

The following are some examples of language forms of different knowledge structures. These language forms can be considered the content-obligatory language of the knowledge structures i.e. they are essential to representing the knowledge structures.

Write down the knowledge structure each box of language represents.

1. Noun phrase + BE + noun/adjectival/prepositional phrase • *Mount Everest is the highest mountain.* • *The Nile is 4145 miles long.* • *Hong Kong is on the southeast coast of China.* 2. There + BE + noun phrase • *There are markings on the container.* 3. Noun phrase + HAVE + noun phrase • *A snail has two pairs of feelers.* 4. Relative pronouns • *who, which* 5. Adjectives/adjectival phrases 6. Possessive pronouns • *its, their* 7. Prepositions/prepositional phrases of place • *at, above, below, between, in the south of, to the north of, on the coast* of 8. Quantifiers • *some, many* 9. Demonstratives • *this, these* 10. Verb phrases • *is made of, is made up of, is used for/to, is situated at* 11. Frequency adverbs • *always, often, never, usually* 12. Adverbs of degree • *relatively, extremely, slightly, quite* 13. Phrases of probability • *It is certain/likely/probably/possible that*

1. Adjectives of opinions • *good, bad, right, wrong, satisfactory, unsatisfactory* 2. Verbs of preferences and opinions • *like, dislike, approve, disapprove, prefer, think* 3. Adverbs • *enough, too*

1. Verbs of class membership
   - *BE, HAVE, contain, include, consist of, comprise* (active voice)
   - *BE classified/grouped/divided/arranged/categorised into* (passive voice)
   - *BE classified/grouped/categorised/classed as* (passive voice)
2. Species nouns
   - *kinds, types, categories, classes, groups*
3. Frequency adverbs
   - *always, never, mostly, often, usually*
4. Possessives
   - *his, her, their, its*
5. Quantifiers
   - *some, many, several, a number of*
6. Relative pronouns
   - *who, which, that*

Examples of sentence patterns

1. Classifying from general to specific
   - *Matter <u>is classified into</u> 3 <u>types</u>.*
   - *Matter <u>is classified as</u> solid, liquid, gas.*
   - *<u>There are</u> 3 <u>types of</u> matter.*
2. Classifying from specific to general
   - *Oxygen <u>is classified as</u> a gas.*
   - *Oxygen <u>is a type/kind/form of</u> gas.*

1. Defining verbs
   - *BE, means, is called, is known/defined as*
2. General class nouns
   - *person, instrument, method*
3. Relative pronouns
   - *who, which, that*
4. Defining relative clauses
   - *Gravity is a force <u>which attracts objects towards the centre of the earth</u>.*
5. Verb phrases
   - *is used for/to, is made of*

Examples of sentence patterns

1. term = general class + specific characteristics
   - *A barometer is an instrument that measures air pressure.*
2. term = specific characteristics + general class
   - *A triangle is a three-sided plane figure.*

1. Passive voice 2. Imperatives 3. Active verbs/verbs of action 4. Sequence connectives • *first, then, next, finally, in turn, during, after, before, earlier, later* 5. Connectives of purpose • *to, in order to, so as to, so that* 6. Connectives of time • *when, after, before* 7. Prepositions/prepositional phrases of space and time • *at, about, around, towards, on, over, between*

1. Verbs of causes • *cause, result in, produce, bring about, lead to* 2. Causal connectives • *so that, because (of), so, therefore, since, as, as a result, consequently* 3. Subordinate clauses (indicated by *when, because, if, as, so that*) 4. Verb phrases • *is due to, is a result of* 5. Adverbs of frequency • *generally, usually, often, seldom, never* 6. Adverbs of certainty • *certainly, probably, likely, possibly, unlikely* 7. Demonstratives and article • *this, these, the*

1. Conditionals • *if...then* 2. Modals of probability • *can, could, may, might, ought to, should, would* 3. Verb phrases • *result in, is due to* 4. Adverbs of certainty • *probably, likely, perhaps, maybe* 5. Verbs of hypothesising • *think, doubt, believe, assume* 6. Connectives of conditions • *unless, even if, whether...or* 7. Phrases of probability • *It is probable/likely/possible/impossible/unlikely that*

1. Additive connectives
   - *and, both, also, furthermore, in addition*
2. Adversative connectives
   - *however, whereas, but, although*
3. Comparatives and superlatives
   - *-er, -est*
4. Phrases of comparison
   - *similar to, different from, as...as, the same as, more/less than, like*

1. Connectives
   - *For example, For instance*
2. Verbs
   - *exemplify, illustrate*
3. Prepositions
   - *such as, like*
4. Other phrases
   - *is a/an case/example/instance of*

Workshop: Knowledge structures in science

Work in groups of 3. Think of the different topics in the science curriculum at different levels. Complete the table below.

Level of students	**Topics / Sub-topics**	**Content objectives** **Students should be able to** (use an assessable verb to start each one below)**:**	**Knowledge structures**	**Graphics**

<u>Choose a topic / sub-topic</u> that last one (double) lesson, from the above or from other areas of the science curriculum, to work for your assignment and microteaching.
<u>Work out the content objectives and knowledge structure(s)</u> for your topic.

Topic 2
Content-language Relationships:
Content-obligatory Language and Text Structures

Key concepts to learn

Concept 1: Content-obligatory language is language essential (i.e. obligatory) to the content. We can think of content-obligatory language as consisting of language at two levels. First, the word level: content-obligatory vocabulary, which is mainly subject-specific vocabulary. Second, the sentence / text level: **the language of knowledge structures**, which is needed to represent the knowledge relationships.

Concept 2: Content-obligatory language at the sentence / text level can be identified in the form of text structures. **Text structures** are language organised in certain forms (structures) to represent the relationships (structures) organised in knowledge structures.

Concept 3: Each knowledge structure has its own **corresponding** text structure(s).

Concept 4: Subject concepts involving knowledge structures and **nominalisations** represented in texts / text structures have to be **deconstructed / unpacked** for students to help them understand the knowledge relationships.

Lecture: Content-obligatory language (i.e. language of knowledge structures) and text structures

We mentioned in Topic 1 that knowledge structures have their related language forms and text structures. Specific language forms and text structures of each knowledge structure are obvious at both the sentence level and the text level. In this topic, we are going to examine the specific sentence structures and text structures of different knowledge structures. We are going to examine how different knowledge structures are represented in different **sentence structures and text structures** and how language is used to represent meanings in different knowledge structures. We are also going to examine why these knowledge structures and their corresponding language are important in the subject areas.

To understand why the language of knowledge structures is important in the subject areas, we can first think of the concept of content-obligatory language. **Content-obligatory language** means language essential (i.e. obligatory) to the content i.e. without using these particular language forms, the content cannot be represented. For example, we cannot represent the process of photosynthesis without using the words essential to representing the subject concepts involved (i.e. **content-obligatory vocabulary** e.g. *photosynthesis, oxygen, carbon dioxide, water, chlorophyll, sunlight*). However, only using the content-obligatory vocabulary cannot represent the knowledge relationships involved in the process of photosynthesis. The language of process (a knowledge structure) is also needed to represent the relationships involved in a process (mainly sequence and cause-effect).

Content-obligatory language therefore consists of language at two levels: vocabulary and sentence / text. Content-obligatory vocabulary represents the subject concepts and content-obligatory language represents the knowledge relationships between subject concepts. Content-obligatory vocabulary is subject-specific vocabulary i.e. vocabulary used only in a particular subject or used with a particular meaning in a subject. For example, *photosynthesis* is a subject-specific vocabulary to science; *solution* as a subject-specific vocabulary in mathematics means an answer and in chemistry means a mixture of a solute and a solvent. Content-obligatory language (at the sentence and text level) is the language of the knowledge structure in which the content is organised (representing the knowledge relationships involved). For example, we represent the process of photosynthesis with **both** the subject-specific vocabulary of photosynthesis and the language of the knowledge structure of a process. A process involves a sequence of events that are linked in a cause-effect relationship, therefore the language of sequence and the language of cause-effect is needed. This language has to be organised in a particular text form / text structure to represent how the content is organised. The text structure of the knowledge structure of process is called a process explanation, reflecting the sequence and the cause-effect relationships. Each knowledge structure has its own corresponding text structure(s).

English medium teachers need to have an understanding of how language is used to represent meanings in organised ways in their subject. Without this knowledge, they cannot use the language appropriately to explain the knowledge relationships involved in the subject content and they will not be able to teach students how to use English appropriately to express their understanding of subject meanings. Students need to know how to produce longer and better-developed written texts in English to be able to demonstrate and develop their content knowledge in English medium learning.

We are going to look at the content-obligatory language and text structures of science texts by analysing four different but common text structures in science in the following aspects:

1. The purpose of a text which signals the knowledge structure represented;
2. The structure of the text: how many parts there are and how the parts are related to each other;
3. Typical language forms including content-obligatory vocabulary.

We are also going to see how the use of **nominalisations and noun phrases** are specific to academic texts and how they create problems for students. We will look into how teachers can **deconstruct / unpack** subject concepts involving knowledge structures and nominalisations to explain these concepts clearly to students.

Nominalisation is the process of changing a verb (that represents a concrete action in real life e.g. *move, transpire*) into a noun (that represents an abstract concept that exists in human brain as knowledge e.g. *movement, transpiration*). When we try to make sense of what is happening in the environment, we can turn concrete actions into abstract concepts. Then we can further explain and relate these abstract concepts to one another. For example, when we learnt that there is a cause-effect relationship between the two concrete actions of 'air moves' and 'plants transpire', we need to turn 'air moves' into *air movement* and 'plants transpire' into *transpiration (of plants)* so that we can say that '*the transpiration rate increases with increased air movement*'. This simple sentence (subject – verb – complement) represents very complicated concepts that can only be represented in many more sentences if we do not use nominalisations. Just putting together the two clauses into, for example, '*when air moves,* *plants transpire*' does not represent the complicated meaning involved. However, to help students understand the complicated concepts involved in a sentence such as '*the transpiration rate increases with increased air movement*', the teacher needs to deconstruct / unpack it to reveal the underlying relationships. The lecturer will show you how to deconstruct / unpack this.

A noun phrase consists of a head noun extended by a pre-modification (e.g. an adjective) and/or post-modification (e.g. a prepositional phrase, a relative clause).

The four common text structures we are going to analyse are:

- Information Report
- Process Description
- Process Explanation
- Comparison-contrast

The following table shows the knowledge structures and the corresponding text types / structures and typical language use. Note that the same knowledge structures are represented in different text types / structures:

Text type & structure: Parts [^ = followed by; ( ) = optional]	**Knowledge structures**	**Typical language forms**
Information Report Definition of phenomenon^ Specific descriptions OR General classification^ Specific descriptions **Purpose:** To <u>give information</u> or to <u>define</u> a phenomenon	Classification Definition Description	**Language of classification:** ▪ passive verbs: *is/can be categorized/ divided/classified into…* ▪ active verbs: *include, consist of, contain* ▪ species nouns: *groups/types/classes/ kinds/categories of…* **Language of definition:** ▪ active verbs: *is, means, refers to* ▪ passive verbs: *is called, is known/ defined as, is formed by* ▪ nouns: *a process of, the meaning/ definition of* ▪ relative clauses: *which/that/where + verb* ▪ if-clause, when-clause **Language of description:** ▪ prepositional phrases ▪ adjectival phrases
Process Description Identification / Definition of the process / phenomenon to describe^ Description sequence **Purpose:** To <u>tell</u> the sequence of events in a process	Sequence Description	**Language of sequence/process/route:** ▪ verbs: *follow, is followed by* ▪ nouns: *step, stage* ▪ verb + prepositional phrase → route ▪ prepositional phrases ▪ conjunctions: *before, after, prior to, when* ▪ connectives: *first, second, firstly, secondly, next, then, finally* ▪ when-clause
Process Explanation / Factorial Explanation Identification / Definition of the process / phenomenon to explain^	Cause-effect Sequence	Language of sequence **Language of cause-effect:** ▪ causal verbs: *cause… to…, result in, produce, bring about, lead to, increase* [&

Explanation sequence/Explanation **Purpose:** To <u>explain</u> the cause-effect relationships in the sequence of events within a process		verbs (*make, produce, remove, increase*)] ▪ causal nouns: *the result of, the reason of, the consequence of, the cause of, the effect of* ▪ causal connectives: *therefore, so, consequently* ▪ causal conjunctions: *since, because, so that* ▪ causal clauses: when-clause, if-clause
Comparison-contrast Statement of comparison^ Points / Details of comparison^ (Summary of comparison) **Purpose:** To <u>compare</u> two or more entities	Comparison-contrast	Language of description **Language of comparison:** ▪ parallelism ▪ negation (*not*) ▪ verbs: *differ from, distinguish, is the same as* ▪ nouns: *differences, similarities* ▪ adjective phrases: *compared with, different from, same as, similar to* ▪ comparatives, superlatives ▪ conjunction: *both, and, but, not only … but also, whereas, while* ▪ connective (additive, contrastive): *moreover, in addition, however, nevertheless*
Procedure Goal^ Method / Steps^ (Results / Evaluation) **Purpose:** To <u>instruct</u> how to do something	Sequence	**Language of instruction:** ▪ imperatives (to tell what to do) ▪ quantifiers (to tell how much/many is needed) ▪ prepositional phrases (to tell when, where and how to do things)
Persuasion Thesis^ Arguments^ Reiteration **Purpose:** To <u>persuade</u> / <u>argue for</u> some points of view	Evaluation	**Language to tell views:** ▪ Modality (e.g. *should*) ▪ Connectives (additive, adversative) **Language to give evidence:** ▪ Language of cause-effect ▪ Language of exemplification
Discussion Statement of the issue^ Arguments for and against^ (Recommendation / Restatement of the issue) **Purpose:** To <u>discuss</u> some points of view	Evaluation Comparison-contrast	**Language to tell views:** ▪ Modality (e.g. *may*) ▪ Connectives (additive, adversative) **Language to give evidence:** ▪ Language of cause-effect ▪ Language of comparison-contrast ▪ Language of exemplification
Recount Orientation / Topic^ Events in time order^ (Evaluation) **Purpose:** To recall past events	Sequence	▪ Verbs in past tense ▪ Prepositional phrases to tell when, where and how

Workshop: Content-obligatory language (i.e. language of knowledge structures) and text structures

Activity 1: Identifying the knowledge structures and language use in textbook texts
The following are some extracts of texts from local science textbooks. Use the information from the table above to:

1. identify the knowledge structure(s) represented;
2. identify or suggest a graphic to represent the knowledge structure(s);
3. circle the content-obligatory vocabulary;
4. underline the language of the knowledge structure(s).

Text 1

2. *Pressure Law*

Pressure Law states that for a fixed mass of gas at constant volume, its pressure is directly proportional to its temperature measured in Kelvin (K).

Text 2

When the air hole is closed, less air is mixed with the coal gas and it does not burn completely. Therefore, it gives out less heat and the flame is yellow.

When the air hole is opened, more air is mixed with the coal gas. Therefore, it burns well and gives out more heat, and the flame is blue.

Text 3

Transpiration is the loss of water vapour from the surfaces of plants due to evaporation controlled by the plants themselves (Fig a). Over 90% of the total water loss takes place through the surfaces of leaves. This process transports water and minerals up the plants and also keeps the tree cool. It is reported that a tree of 500 kg can lose more than 20 L (20 kg) of water per hour in a hot summer afternoon through transpiration.

The rate of transpiration is affected by a number of factors. Temperature, relative humidity and air movement are some of the factors.

Fig a

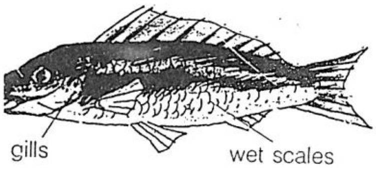
Text 4

earnt

Animals can be classified into ____________ and ____________.

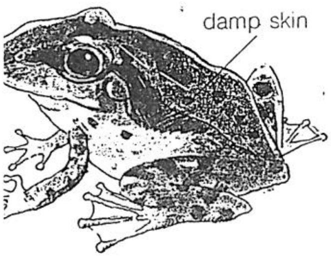
Vertebrates can be classified further into 5 different groups. Study the characteristics of each group below:

ish (魚類):



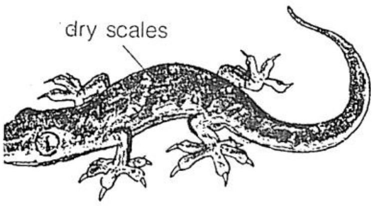
Their bodies are covered with scales. They live in water and breathe with gills (鰓).

mphibians (兩棲類):



Their bodies are covered with damp skin. Their young have gills but adults have lungs. They can live both in water and on land.

eptiles (爬蟲類):



Their bodies are covered with dry skin or horny scales. They live mainly on land.

rds (鳥類):

Their bodies are covered with feathers. Their front limbs (前肢) are developed into wings.

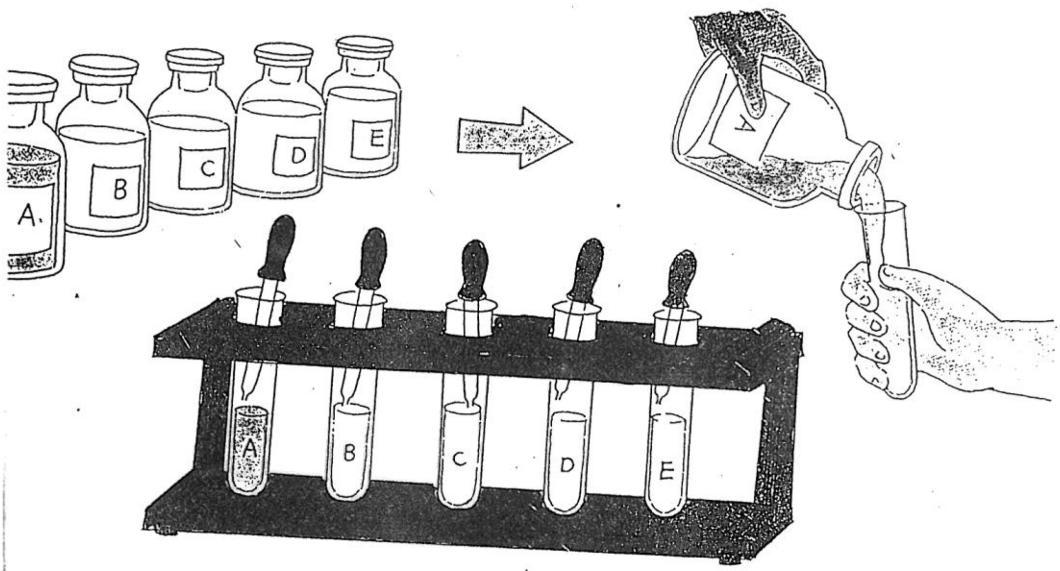
Text 5

ctivity 1.3 **An experiment (實驗) with solutions (溶液)**

1 On your bench (實驗桌), there are 5 bottles of solutions labelled A, B, C, D, and E.

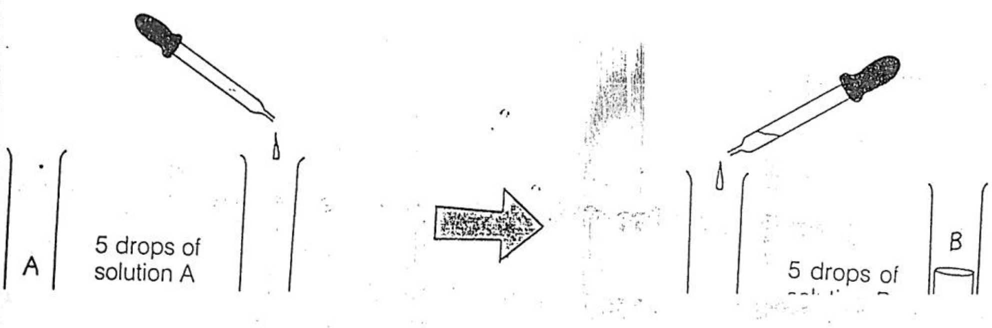
2 Pour a little of each solution into 5 test tubes. Label the test tubes A, B, C, D and E respectively.

3 Put a dropper (滴管) into each test tube.



4 Take a clean test tube. Put 5 drops of solution A into the test tube.

5 Add 5 drops of solution B to it.



Text 6

3.1 What is metabolism?

Metabolism refers to all the chemical reactions that take place within a cell to keep it alive. It consists of catabolism and anabolism.

1 Catabolism

Catabolism refers to all the **breaking-down** reactions within a cell. In **catabolic processes**, complex molecules are broken down into simpler ones. For example, during respiration (呼吸作用), glucose (葡萄糖) molecules are broken down into water and carbon dioxide to release energy.

2 Anabolism

Anabolism refers to all the **building-up** reactions within a cell. In **anabolic processes**, complex molecules are synthesized (合成) from simpler ones. For example, glucose molecules react with each other to form starch.

Text 7

4 Air movement

The rate of transpiration increases with increased air movement. Since water vapour which diffuses from stomata accumulates near the leaf surface, faster air movement will help remove water vapour. This **increases the concentration gradient of water vapour** between the leaf and the drier air outside. The **rate of diffusion**, and therefore the rate of transpiration, will be increased.

[from Pang & Cheung, 2003, p.29]

Text 8

2.2 How were cells discovered?

Learning target
To be able to explain how the development of microscopes helped in the discovery of cells

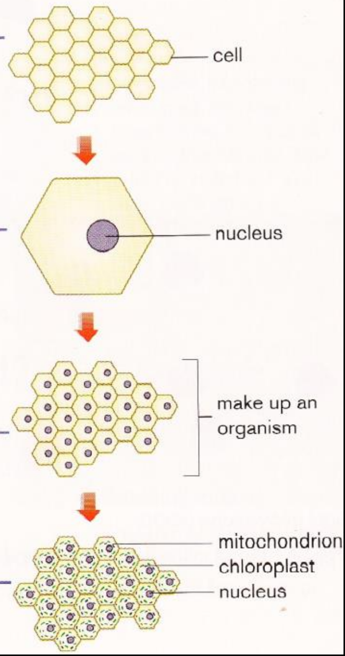
Before the invention of **microscopes** (顯微鏡), no one knew about the detail of the parts of an organism. Microscopes are tools for magnifying very small objects.

In 1590, Jansen invented the **compound microscope** (複式顯微鏡) which had two lenses. **Cells** are said to have been discovered by Robert Hooke in 1665. He used an improved compound microscope to examine cork from the bark of a tree. He saw that cork consisted of many boxes (Fig 2.3). He called these boxes 'cells'.

During 1650 and 1700, **nuclei** (細胞核) and unicellular organisms (organisms with one cell only, e.g. bacteria) were observed by Antony van Leeuwenhoeck with a simple lens. In 1827, the quality of lenses was greatly improved by Dolland. This allowed more understanding of cells using the microscope.

In 1839, **cell theory** was proposed by Schleiden and Schwann. It states that the basic unit of structure and function in organisms is the cell. This is a very important concept in biology.

During 1880s and 1900s, **chloroplasts** (葉綠體) and **mitochondria** (線粒體) were discovered.



Activity 2: Analysing 4 different text types & structures in science texts
Follow the instructions below each text to identify:
1. the purpose and the knowledge structures;
2. the text type and the text structure;
3. the language use.

Use the knowledge structures and text structures table to help you.

Text 1

What are living things made up of? *The basic units of living things are cells. Cells make up all living things just like the plastic toy bricks making up a toy house.* *Some tiny living things, such as Amoeba and bacteria, are made up of only one cell. They are called single-celled organisms.* *Other living things, such as plants and animals (including humans), are made up of more than one cell. For example, the human body is made up of about 100 trillion (100,000,000,000,000) cells, of more than 200 types. Each type of cell has a different shape and special functions.* [taken from Understanding Integrated Science 1A, Aristo, pp.136-7]

1. **Purpose of the text**
   Read through the text to identify the main purpose of the text.
   a. What does the text aim to do? What is the key message in the text?

   ____

   b. What knowledge structures are represented in the text?

   ____

2. **Structure of the text**
   Read the text again to identify the purpose of each paragraph. Use a verb (that can be related to a knowledge structure) to state the purpose of each paragraph.

   Paragraph 1: to ____

   Paragraph 2: to ____

   Paragraph 3: to ____

   Paragraph 1 plays a different role from Paragraphs 2-3. Paragraph 1 _______________ (start with a verb that relates to a knowledge structure) while Paragraphs 2-3 __________ _________________________ (start with a verb that relates to a knowledge structure).

   We call this type of text an ____________________________, which consists of two parts:

Part 1: ______________________________

Part 2: ______________________________

The specific description gives details of / more information about a class of entities.

3. Typical language forms

Circle all the content-obligatory vocabulary.
Draw a cross on all the language of <u>definition</u>.
Underline all the language that <u>describes</u> / gives further information.
Put in a rectangle the language that gives examples.

What kind of language is left unmarked?

An information report requires mainly the use of the language of ____________ and the language of ______________ (refer to the underlined words above).

Text 2

Respiration: Ventilation of the lungs

Ventilation of the lungs is the process by which air is inhaled and exhaled. This process is the first stage in respiration.

When we inhale, air containing 21% oxygen enters the respiratory system through the mouth and the nose. The air passes through the larynx and the trachea into the two bronchi, which divide into many bronchioles. The air passes into these bronchioles, which connect to tiny sacs called alveoli. Gaseous exchange takes place in these alveoli. When we exhale, air containing less oxygen but much more carbon dioxide goes back from the alveoli to the bronchioles and then to the bronchi. From the bronchi, air goes back to the trachea and the larynx and then goes out of the respiratory system through the mouth and the nose.

1. Purpose and knowledge structure of the text

The purpose of the text is to ____

The main knowledge structure represented is ____________________________

A possible graphic to represent the knowledge structure is ____________________

2. Structure of the text

Paragraph 1: to ____

Paragraph 2: to ____

There are two parts in this text:

Part 1: ______________________________ (Paragraph 1, which <u>defines</u> the phenomenon / process to be described)

Part 2: ________________________________ (Paragraph 2, which <u>describes</u> the sequence of events in the process)

We call this type of text a ______________________________, which differs from a process explanation in that there are no _______________________ relationships in a process description.

3. Typical language forms

Circle all content-obligatory vocabulary.
Put in a rectangle the language of <u>definition</u>.
Put in a square all the verbs that <u>describe</u> what happens in the process of ventilation of the lungs.
Draw a line across all the prepositional phrases that <u>describe</u> the direction of events.
Put in brackets all relative clauses (a clause started by *which* or *that*) that provide more <u>detailed description</u> of a key entity in the topic.

What other language is left?

A process description requires the use of the language of _____________________ and the language of _____________________.

4. Nominalised words / phrases; noun phrases (and deconstructing / unpacking and chunking)

Write down the two nominalisations used in the text:

____

<u>Underline</u> the noun phrases used in the text and circle the head noun in each one. Chunk up the most complicated noun phrase.

Deconstruct / Unpack one of the nominalisations:

____

____

____

____

____

____

Text 3

1 Tooth decay

Tooth decay (蛀牙) is also known as dental caries. It is caused by the chemical actions of oral bacteria on food debris. Oral bacteria, food debris (mostly sugar) and saliva (唾液) form a sticky, thin layer called **plaque** (牙菌膜) on the teeth surface. Bacteria digest the sugar in the food debris to produce acid. The acid then begins to dissolve the enamel and makes small holes. When the hole gets larger, the bacteria can then reach and digest the dentine and the tissue in the pulp cavity. Eventually, the tissue in the pulp cavity is infected. The acid will irritate the nerves and cause pain.

[from Pang & Cheung, 2003, p.93]

1. Purpose and knowledge structure of the text

The purpose of the text is to ______________________________

The main knowledge structure represented is ______________________________

A possible graphic to represent the knowledge structure is ____________________

2. Structure of the text

Sentences 1-2: to ______________________________

Sentences 3-8: to ______________________________

There are two parts in this text:

Part 1: ______________________________ (Sentences 1-2, which identifies / defines the phenomenon / process to be explained)

Part 2: ______________________________ (Sentences 3-8, which explains the cause-effect relationships in the sequence of events involved in the process).

We call this type of text a ______________________________, which differs from a process description in that there are ____________________ relationships between the steps in the process.

3. Typical language forms

Circle all content-obligatory vocabulary.
Put in a rectangle the language of definition.
Put in a square all the verbs that describe what happens in the process of tooth decay. What kind of verbs are they?
Put in a triangle all the connectives used. What kind of connectives are they?
Underline all noun phrases that provide more detailed description of a key entity in the topic.

What other language is left?

A process explanation requires the use of the language of ____________________ and the language of ____________________.

4. Noun phrases (deconstructing / chunking)

Underline the noun phrases in the text and circle the head noun in each one. Chunk up the most complicated noun phrase.

Text 4

Aerobic and anaerobic respiration in humans

Both aerobic respiration and anaerobic respiration take place in humans. Aerobic respiration requires oxygen. Anaerobic respiration does not.

Aerobic respiration takes place when there is enough oxygen supply. Anaerobic respiration takes place when we cannot have enough oxygen to produce the energy we need through aerobic respiration, for example, when we exercise. Aerobic respiration produces energy, water and carbon dioxide. Anaerobic respiration produces a much smaller amount of energy and it produces lactic acid instead of water. Lactic acid is poisonous, causing pains and cramps in our muscles.

Aerobic respiration and anaerobic respiration in humans take place under different conditions and produce different products according to the needs of the situations.

1. **Purpose and knowledge structure of the text**

The purpose of the text is to ____

The main knowledge structure represented is ______________________________

A possible graphic to represent the knowledge structure is ____________________

2. Structure of the text

Paragraph 1: to ____

Paragraph 2: to ____

Paragraph 3: to ____

There are three parts in this text:

Part 1: **Statement of comparison** (Paragraph ____, which states that both aerobic and anaerobic respiration takes place in humans but under different conditions)

Part 2: **Points of comparison** (Paragraph ____, which <u>compares</u> the _____ aspects of differences between aerobic and anaerobic respiration)

Part 3: **Summary of comparison** (Paragraph ____, which is a <u>summary</u> statement of the comparison made in the text)

3. Typical language forms

Circle all content-obligatory vocabulary.
Put in a rectangle all the language of comparison, including comparison connectives, adjectives (in comparative form), negation.
Underline all parallel but contrastive language use.

What other language is left?

4. Nominalised words / phrases; noun phrases (and deconstructing / unpacking and chunking)

Write down two nominalisations used in the text:

____

Deconstruct / Unpack one of the nominalisations:

____

____

____

____

____

Highlight the noun phrases in the text and circle the head noun in each one. Chunk up the most complicated noun phrase.

Topic 3
Planning for Integrating Content-Language Teaching: Content-obligatory Language and Content-Language Objectives

Key concepts to learn

Concept 1: The basic principle of planning for English medium teaching is to **integrate content and language teaching** i.e. plan for the teaching of content and language at the same time using **content-language objectives**.

Concept 2: Language objectives provide both the teacher and the students with **targets for language learning** to work towards. Without language objectives, content learning through English will not necessarily lead to language learning, thus defeating the curriculum goals of teaching through a second language.

Concept 3: Language objectives are **language learning objectives** arising from the content (learning) objectives i.e. they specify the language learning needed for learning the content and are therefore **content-language learning objectives**; the language part comes from the content-obligatory language.

Concept 4: Language objectives can only be achieved by students if they are appropriate in terms of both **level of difficulty and amount** (i.e. students cannot learn at too difficult or too much a level). Content obligatory language therefore has to be adjusted to the ability of the students and **not all content-obligatory language has to be language objectives**. The teacher needs to make a pedagogical choice to optimise student learning.

Lecture: Content-language Objectives

What are content-language objectives?

Like content objectives, language objectives are learning objectives i.e. they describe the learning outcomes of a unit of learning which learners are expected to be able to achieve on completing the unit. While content objectives describe learning outcomes with respect to the subject content, language objectives describe learning outcomes with respect to the language that learners have to learn to use for learning the content. As you have learnt from the previous topic, most content knowledge has to be represented in content-obligatory language. Other means (such as graphics, music, drawings) can also be used but the more complex the knowledge relationships become, the more we rely on language to represent them. Language is probably the sole means to represent and communicate human knowledge that has accumulated over the past many years. If students have to learn certain content, they have, therefore, also to learn the content-obligatory language. The language objectives (i.e., the language students have to learn), therefore, come from the content-obligatory language. Since this language must be obligatory to the content, you need to identify content-language objectives.

Why do we need content-language objectives?

The content-language objectives are an important part of a teaching plan for English medium teaching. They ensure that the teacher knows what content and what language students do not know before learning a unit and will learn by the end of the unit. The content-language objectives are important because of at least two reasons: 1) a curriculum goal of English medium teaching is that students learn English by learning subject content through English, thus the English learning goals (i.e. the language part in the content-language objectives) have to be specified before learning starts so that the teacher can plan how to support students' English learning; 2) if content has to be taught through English, students will only be able to learn the content if they understand / learn the English (we can in fact see the content-obligatory language as part of content learning in that unless students learn the content-obligatory language, they cannot access / understand / learn the content). This is also the reason why learning content through English is more effective than just learning English through English. Learning content through English can expose students to the English of different subjects that learning English through English cannot achieve (you cannot expect an English teacher to teach, for example, the English of science).

There is another way to look at why content-language objectives are needed. Let's consider the following situation. A teacher wants to help students learn how to describe the functions of different parts of a microscope. If s/he has no content-language objectives in mind, s/he may use any or all of the following language forms when s/he explains the function of, for example, the mirror:

- *The mirror reflects light.*
- *The mirror can reflect light.*
- *The mirror is used to reflect light.*
- *The mirror is for reflecting light.*
- *Light is reflected by the mirror.*
- *The use of the mirror is to reflect light.*
- etc.

This means that students have to learn to understand a number or all of these language forms. This will of course be immensely difficult for students especially at the initial stages of English medium education when students' English of the subject is still at a low level. Planning for content-language objectives therefore has the advantage of focusing both the teacher's and the students' minds on particular language use for a specific content objective. This helps to lessen the language load on the students, thus making learning through a second language easier to manage. It also helps students gain greater control of the language specified in the content-language objectives because of the teacher's conscious and repeated use. This is particularly helpful for students who have just started learning through English.

To consider the above situation further, think of the following example:

Content-language objective:

Students should be able to use <u>the following sentence structure</u> to describe the functions of different parts of a microscope:

__________ is used to ________________.

This means students only have to learn **one** language form to tell the functions of different parts of a microscope. They therefore have to learn to use the following sentences:

- *The mirror is used to reflect light.*

- *The eyepiece is used to* ________________.
- *The objective lens is used to* _______________.
- *The stage is used to* ___________________.
- *The coarse adjustment knob is used to* _______________________.
- *The fine adjustment knob is used to* ___________________,
- etc.

With repeated exposure and repeated opportunities to use the same language form for the same purpose, students will find it easier to learn the language and the content through the language.

Content-language objectives give both the teacher and the students the language forms to learn for the content. The teacher knows what kind of language s/he has to use and to teach the students to use in the context of the topic, and the students know what language they are expected to learn to use for the content they have to learn.

How do we identify / write content-language objectives?
The language forms in the content-language objectives are chosen from the content-obligatory language. As learning objectives, content-language objectives have to be taught and assessed (though not necessarily formally). Thus, content-obligatory language that students already know does not have to be a content-language objective.

As we have learnt before, content-obligatory language consists of content-obligatory vocabulary and the language of knowledge structures (such as the language of cause-effect, the language of comparison-contrast). Often, the content-obligatory vocabulary is new but the language of the knowledge structures may not be new. Remember, knowledge structures are across the curriculum and across topics within the same subject. So students may have learnt some of this language in other topics in your subject or in other subjects. Also remember, however, that having students only learn words / vocabulary will *only* make the learning more difficult for students because they have no way to connect and to understand the relationships between ideas using only words. Connected and extended language (in the form of the language of knowledge structures) is always necessary to help students learn connected ideas / concepts / knowledge relationships.

When choosing the language forms from the content-obligatory language, consider the following criteria:

- Which language of the knowledge structures / text structures students do not know or may need to revisit for learning (bearing in mind that learning requires multiple exposure and revisiting);
- Some content-obligatory language can be too difficult at this stage of students' learning and so it may have to be for receptive learning only (i.e. the teacher will use it but students are only expected to receptively understand it without learning to use it, thus it is not a learning objective);
- There is a limit to what students can learn within a specific time / unit of learning. When the amount of content-obligatory language is so much that it is beyond students' ability to learn all of it, choices have to be made (this in fact also applies to the amount of content to learn).

N.B.: When writing content-language objectives, it is useful to specify them as **learning objectives** i.e. what you expect students to be able to **do** to demonstrate that they have learnt at the end of the lesson / unit. The following are some useful hints:

- Start a learning objective by saying "Students should be able to…";
- Use a behavioral / assessable verb to describe what students should be able to do e.g. *to describe, to explain, to give instruction, to define* etc. (not verbs like *to know, to understand, to be aware of* etc. because unless students do something assessable, you cannot tell whether they know or understand etc.). Such verbs can usually reflect a knowledge structure.

Workshop: Planning an EMI lesson

A lesson plan for a successful EMI lesson needs to include:

1. **Clear and achievable objectives** for content **AND** the English students need to learn the content. Probably no more than two are manageable for one lesson.
   - ***Content learning:*** what students are expected to be able to *do* for the content by the end of the lesson.
   - ***Language learning:*** what new English (vocabulary + language of knowledge structures) students will focus on to learn the content.

2. **A procedure** which makes clear to students what new content ideas they are learning and the English that expresses that content.
   - *A brief description of **how the new content will be explained*** to students and **how the content-language relationships will be made explicit.**
   - *A brief description of **the work students will be expected to do*** to explore the content themselves i.e. more than just copying or repeating, **using** the language of the content **productively**.

3. **The scaffolding which the teacher will provide** to help students understand **AND** use the language of the content.
   - **Non-linguistic support** in the form of diagrams, models, demonstrations, etc.
   - **Written support** on worksheets or blackboard/PowerPoint
   - **Spoken support** through emphasis, repetition, etc.

Writing an EMI lesson plan (see the sample below)

Choose a lesson you are going to teach. Use the sample lesson plan below to:

1. write the **content-language learning objectives** at the top of each plan;
2. describe the **prior knowledge** students will have before the lesson;
3. describe the **main stages in the lesson** in the *procedure column* – what you and/or the students will do;
4. write the **important language** you or the students need to use in the *language column* (This is the new content-obligatory language that occurs at each stage);
5. write the **scaffolding** that you will use to help students understand or use the new language in the *scaffolding column* (This should include use of the blackboard or PowerPoint or other means by which you will bring the language to the attention of students and help them understand or use it);
6. **check your plan by reading across each row**: At each stage the procedure would be clear and should be matched (where necessary) by the important language and the scaffolding which supports students' understanding or use of that language.

Write your lesson plan following this procedure and the example given in the sample plan.

Sample Lesson Plan

Class level: S2	**Subject:** Science	**Topic:** Acids and alkalis	**Sub-topic:** Indicators for testing acids and alkalis

Content objectives: Students should be able to:
1. prepare red cabbage extract;
2. use red cabbage extract as a natural indicator to test if a solution is an acid and an alkali;

Content objectives are where students do not have to produce language to achieve the objectives.

Content-language objective: Students should be able to:
1. use the following when-clause to compare the colour changes when they add red cabbage extract to acids and alkalis:
   <u>*When*</u> *we put red cabbage extract into ________ (an acidic solution), the red cabbage extract* <u>*changes from*</u> *purple* <u>*to*</u> *red.*
   <u>*When*</u> *we put red cabbage extract into ________ (an alkaline solution), the red cabbage extract* <u>*changes from*</u> *purple* <u>*to*</u> *green.*

All learning objectives are achievable by students within the time of the unit.

Relevant prior knowledge:
Students can:
1. classify hydrochloric acid as an acidic solution, and ammonia solution as an alkaline solution, and distilled water as a neutral solution.
2. tell that acids and alkalis are corrosive.

Basic information about the class and the lesson is concise and relevant.

Time (mins)	Procedure	Key language (content-obligatory language) used by teacher or students	Language support/scaffolding
5	<u>**Revision**</u> 1. T recalls the concept of acids and alkalis to get Ss ready for the lesson.	<u>Word level</u>: *acids, acidic, alkalis, alkaline, neutral* <u>Sentence level</u>: *xxx is an acid / alkali.* *xxx is acidic / alkaline.*	1) Write the words on the BB. 2) Show pictures of different acids and alkalis.

Important procedures are described briefly but clearly.

Key language is listed. This only refers to the content obligatory language, not everything the teacher or students say.

A variety of scaffolds are used to support the oral language: written, visuals…

The content-language objective is on the BB (not on PPT) for Ss' reference throughout the lesson.

Headings make it clear what the focus of each stage is.

5	**<u>Lead-in</u>** 2. T explains the reason why we need an indicator to test for acids and alkalis. 3. T tells Ss the content and language learning objectives for the lesson: *Today we are going to learn how to…. and you will also learn to use when… to tell ….*	<u>Word level</u>: *corrosive, indicator* <u>Sentence level</u>: *We use an indicator to test for acids and alkalis because acids and alkalis are corrosive.*	1) Write the words on the BB. 2) Show a picture of red cabbage extract 3) Write the content and language objectives on the BB: red cabbage extract → acid? alkali? *When we put red cabbage extract into …, the red cabbage extract changes from purple to …*
10	**<u>Experiment 1</u>** 4. T guides Ss to prepare for the red cabbage extract step by step.	The language of sequence to talk about the procedure of the experiment.	1) T demonstrating with all necessary equipment while talking.
20	**<u>Experiment 2</u>** 5. Ss use the red cabbage extract prepared as an indicator to test for acids and alkalis 6. T reminds Ss to tell the experiment results by using '*the red cabbage extract changes from purple to…'* (the second part of the language objective written on the BB) 7. Ss compare the colour changes in the test. 8. T writes down Ss' experiment results on the BB using the language objective on the BB and gets Ss to say the experiment results again to consolidate their learning. 9. Ss record the experiment results in their log book.	<u>Sentence level</u>: *When we put red cabbage extract into* (an acidic solution)*…, the red cabbage extract changes from purple to red.* *When we put red cabbage extract into* (an alkaline solution)*…, the red cabbage extract changes from purple to green.*	1) T draws a flow chart to show the steps of the experiment. 2) T uses different colour chalks to write down Ss' experiment results using the language objective on the BB.

The language use is straightforward and easily accessible to students.

Key language includes word and sentence levels (and could include text level in an appropriate topic).

	Application 10. T asks Ss to make their indicator at home and test for some solutions commonly found at home (e.g. detergent) and record the findings in a worksheet.	Sentence level: *When we put red cabbage extract into* _____________, *the red cabbage extract changes from purple to* _________.	1) A worksheet that requires Ss to gradually write the full sentence to record the results (refer to the learning activity).

Key language includes word and sentence levels (and could include text level in an appropriate topic).

A checklist for EMI lesson plans

This checklist can be for your own use or for a peer to help you. A pair of fresh eyes is always helpful and there can be different perspectives.

		Yes/no
Is sufficient contextual information provided: • Subject/topic/sub-topic • Students' background • Prior learning in this topic		
Suggestions for improvements:		
Are the learning objectives clear?	***Objectives***	
Do the language forms specified come from the content?		
Are they achievable?		
Suggestions for improvements:		
Is each stage in the lesson clearly described i.e. what the teacher and/or students will do?	***Procedure***	
Is the plan realistic? Can it be completed in the time available (a single or double lesson) with the class described?		
Suggestions for improvements:		
Is the content-obligatory language specified in the language column at the stage at which it is introduced?	***Language***	
Suggestions for improvements:		
Is scaffolding listed? Is the language suitably scaffolded? Look at the procedure and language columns. See if new language is being used and decide whether students will need support to understand or use it.	***Scaffolding***	
Suggestions for improvements:		

Topic 4
Explaining subject concepts:
Using knowledge structures & related graphics and language

Key concepts to learn

Concept 1: Students need a lot of support to understand explanation / instruction in English, especially continuous academic English compound with complex concepts. **<u>Do not solely use English</u>**, with no other support, to explain.

Concept 2: An explanation focusing on a **<u>knowledge structure</u>** helps students understand the **<u>key relationships</u>** in complex content; the related **<u>graphic</u>** of a knowledge structure provides students with a **<u>visual support</u>** to understanding the knowledge relationships (e.g. classification, cause-effect, comparison-contrast).

Concept 3: An explanation focusing on a knowledge structure also helps the teacher to identify **<u>the language of the knowledge structure</u>** that supports students' understanding of the key relationships (e.g. classification, cause-effect, comparison-contrast).

Workshop: Using knowledge structures & related graphics and language to organise an explanation

Activity 1
Analysing the transcript of an explanation
<u>Watch</u> the video of a microteaching (How the heart beats) and <u>highlight</u> the words in the transcript* below that tell:

1. how the teacher creates a **gap for learning** (i.e., telling students the learning objective);
2. how the teacher relates the explanation to students' **daily life experience**: How does this support students' learning?
3. the **visual aids** she uses to support her explanation: How are the visuals related to the key concept?
4. the **key relationship** (in terms of a knowledge structure) of the explanation and the **graphic** she uses to provide support for students' content and language learning;
5. the strategies she uses to help / get **students to use** the content obligatory language;
6. the **signposting strategies and language** she uses to steer students through the explanation;
7. the **repetitions** she uses to help students catch important points;
8. use of **questions**
9. the way she **corrects** students' language.

[*<u>underline</u> the English used to achieve each point above; (brackets) the content]

Note that the explanation is not a monologue of the teacher but it involves students' participation all the way through.

<u>Give 2 suggestions</u> for improving the explanation:
1.
2.

<u>Write</u> down the **content-language objective** of the explanation.
Students should be able to

Transcript

T: Now… class, last time we talked about the structure of the heart, and today we will look at the action of heartbeat [Pointing at the words she has written on the board]. Now, first of all, can you all put your hand over your heart? [Putting her hand over her heart and keeping her hand there as she talks] Try to feel for your heartbeat. Alright? Can you feel it? How many of you can feel the heartbeat? [Students laughing] So put up your hand [raising her hand], those of you can feel the heartbeat. Very good… I think most of the class can [Putting her hand back on your heart]. Those who can't can press harder. Okay? [Students laughing] Now you can feel the action, but how is the action produced? [Keeping her hand on the heart] And why is it important to us? [Hand gesture on 'why'] Now, you know that the heart needs to beat all the time to keep us alive, right? And why is it important? When the heart beats, it helps to push the blood around the body. But how is the action produced? Now, you have learnt about the structure of the heart, and you know that the wall of the heart is made of muscles. [Gestures to mime the wall of the heart] Alright? What can muscles do to make the heart beat? And idea?

Ss: Contract.

T: Contract. Very good. If this is the heart [Making the shape of a heart], right, the heart actually would contract [Making the shape of the heart smaller], and would it contract all the time? So what happen after contraction? [Keeping the small shape of the heart] The muscles…

Ss: Relax.

T: Relaxes [Making the shape of the heart larger], very good. So, the heart will keep contracting, relaxing, contracting and relaxing [Making the shape of the heart smaller and larger, smaller and larger]. And to demonstrate this action, I have brought here a simple setup [Taking up the bulb and the tube], but I need a helper to help me with the demonstration. So, any volunteer, volunteer? [Looking at the students with an enquiring gesture] Okay, Eliza [Pointing at Eliza], you are the monitor, so come out please. [Gesturing her to come out] Alright, first of all, I will show you what these setups are [Raising the bulb and the tube for students to see]. This is a rubber bulb. [Raising the rubber bulb] Alright, a rubber bulb. [Writing the words on the board] And inside the bulb [Pointing at the bulb], I have put some red liquid, so the bulb stands for… [Pointing at the bulb and gesturing 'what'] What do you think the bulb stand for? [Gesturing students to answer]

Ss: The heart.

T: The heart, very good. Now, this will stand for the… one of the chamber of the heart. [Pointing at the bulb] And inside the red liquid will stand for… [Raising the tone to signal students to answer]

Ss: Blood.

T: Blood, very good. Alright, now, first of all, can you… ah…put this [Raising the tube] over the rubber bulb… [Letting the student have the tube and holding it together with the student] Okay… Alright, now I connect a glass tube to the rubber bulb, like this. [Connecting the tube to the bulb and show the class] Can you hold the bulb itself? [Giving the setup to the student to hold] Alright? Okay… Now, watch this student, do the demonstration… Observe carefully, watch carefully, what will happen? [Pointing to the setup, helping the student to get the setup right] When she starts to squeeze onto the rubber bulb slowly… [The student squeezes too much] Slowly… [Students laughing] slowly, slowly, slowly, alright? [Putting her hand beside the setup and moving her hand to model a slower action] And hold it like this… thank you. And you can squeeze it harder. Alright, try again? Okay, what can you see? Now, this action actually demonstrate one of the stage of the muscles. [Gesturing her hand to show movement of the muscles] Just now you mentioned that the muscle will contract and relax, is that right? [Gesturing her hand to show the movement of contraction and relaxation] So, is it contraction or relaxation here. The heart muscles… [Holding her fist to signal contraction]

Ss: Contract.

T: Contract, all agree, alright? Now, show the class again please. [Gesturing the student to show the class the setup again] Alright, now, hold it like this. [Pointing at the rubber bulb] When the chamber contract, when the muscles contract, what happen to the size of the chamber? [Pointing at the rubber bulb and then looking at the students to elicit a response] Can you see that actually the size changes? What is the change?

Ss: Smaller.

T: Smaller, very good. [Leaning her head forward to signal a response to the students] Now, when the chamber become smaller in size, what happen to the liquid inside? [Pointing at the red liquid in the tube] You can see that the liquid goes… up. [With her hand going up along the liquid] Because you can see the liquid level rising on the glass tube. Now, very good… Now, what hap… what, what, what is the action of the liquid then? [Running her hand along the glass tube in an upward direction] It flows… When you squeeze, right, when the heart contracts, it goes out of the heart. Very good. Now, this is a very important action of the heart, alright? We call this systole… [Writing the word on the board] systole. Systole… what does it mean? It means that when the heart muscle contracts… [Writing the phrase on the board] when the heart muscle contract, the size of the chamber becomes smaller… good. [Drawing an error and writing the second phrase after the arrow] And then, therefore [drawing another arrow], it leads to… blood flow [signalling the blood flow to the students], is that right? So what is the direction of blood flow? Blood flows… [Writing the words on the board] into the heart or out of the heart?

Ss: Out.

T: Very good. Blood flows out of the heart. [Writing the full phrase on the board] Now, can you get it? Alright? So, this is the first stage of the heartbeat. When the chamber contracts, it forces blood out of the heart [Gesturing the movement as she talks], and this is called systole [Pointing at the writing on the board]. Alright? Now, we go to the next step… [Going towards the student with the setup] So can you squeeze on the heart again? [Helping the student with the setup] And hold it like this. Alright, now, the student is going to show you the next step. [Looking at the class] When she starts to release the rubber bulb slowly [With gesture], you can see that… [Pointing at the liquid in the tube, with her hand going down the tube] Yes, you can now start the demonstration, release the bulb slowly… So what happen to the liquid level inside? [Pointing at the liquid level] Very simple, right? Yes…

Ss: Liquid level drops.
T: Very good, so complete sentence, right? The liquid level drops back into the rubber bulb. [Gesturing the drop of the level along the tube] And what causes the drop of the liquid into the rubber bulb? [Pointing at the rubber bulb] It's because of the change in size of the rubber bulb, remember? [Gesturing the changes of size with her hand] So what is the changes in size of the rubber bulb this time? [Pointing at the rubber bulb]. It becomes… expand, very good. It becomes… bigger. [With her hand showing a bigger size] Here comes another term. After systole, what happen to the heart chamber? [Pointing at the words on the board] The heart will then undergo the next stage, which is called diastole. [Rubbing off 'rubber bulb' and writing 'diastole' on] Diastole. Now, during diastole, actually the opposite would occur. Now we can make use of the same paragraph here to describe diastole by changing the words underlined. [Pointing at the words on the board] So can anyone do it? Try. How do you describe diastole? Yes… [Looking at the class and signalling a student to answer]
Ss: Ah… heart muscles expand…
T: The heart muscles… Now, I put it down first, right? And then? [Writing on the board]
Ss: Size of chamber becomes bigger…
T: Good, go on? [Writing on the board]
Ss: Ah… blood flows into the heart…
T: Blood flows…
Ss: …into the heart.
T: Very good. Alright, now, take a look at the… the… ah… suggestion of this student. She got it mostly right. However, let us go to the first part. [Pointing at the first line of the writing] Now, remember that just now we mentioned that muscles have two actions, right? [Holding up two fingers] Contract [Hands holding together]… and… instead of expand [Hands moving apart], we say… any suggestion? [Gesturing a student to answer] We use the word… re-, re-
Ss: Relax.
T: Relaxes. Good. So, instead of expand……Expand will be in fact similar to this one. [Pointing at the board] You say that the chamber becomes… larger, bigger, or the chamber expand. So let us put expand here as well, alright? So we can say expand here or bigger. [Writing the word down] But for the action of the muscle, now it is important, because it is a specific term as well. Muscle can only contract and… relaxes. [Writing the word on the board] Is that clear? Alright?

Planning and writing a script to explain a concept
<u>Write a script</u> to explain a key concept in your chosen topic. Follow these steps:
1. Identify a concept from the topic you have chosen for your post-course observation;
2. Identify the key knowledge relationships involved (there can be more than one but focus on the KEY relationships, which should not be more than 2) e.g.
    - cause-effect,
    - sequence,
    - comparison-contrast,
    - definition,
    - classification…

3. Write down the content-obligatory language needed i.e. the key vocabulary and the language of the knowledge relationships involved;
4. Plan the stages of the explanation:
   - Naming / defining the concept (N.B.: Definitions are most difficult to understand)^
   - Explanation of key relationships in logical order^
   - Summarising / revisiting definition of the concept
5. Identify a graphic that matches the key knowledge relationship(s) e.g.
   - flow chart,
   - table,
   - tree diagram,
   - diagram,
   - graph…
6. Use the graphic as the key scaffold / skeleton to lead through the explanation;
7. Consider as many of the following scaffolds as possible to support students' learning:
   - signposting (e.g. review, advance organiser, transition, closing),
   - repetition / paraphrasing,
   - questioning,
   - focusing students on key language.

Topic 5
Designing learning and assessment materials for content-language learning

Key concepts to learn

Concept 1: **Students have to use the language to learn** both the content and the language. Language use is productive learning. Receptive learning, by simply listening to the teacher or even reading, is not as effective as productive learning, where students have to produce a product.

Concept 2: **Students have to be taught to use the language** to show their learning. Simply teaching content and assuming that students can use the language to show their understanding will only result in students not being able to use the language at all.

Concept 3: Learning materials have to be designed with the understanding of the need to provide **language support** for students to help them learn to use the language. **Text structures and related graphics** provide very effective language support and **information transfer activities** (text → graphic → text) are particularly useful.

Concept 4: The principle of **gradual release of scaffolding** (language support) is important to help students to be gradually able to use more and more language on their own.

Workshop: Designing materials for content-language learning

Activity 1

Study the following information transfer activity and answer the following questions:

1. What knowledge structure is represented in the activity?

2. What graphics are used? How do the graphics relate to the knowledge structure?

3. What language form is used?

4. How are students helped to gradually be able to use the language form? What scaffolds are provided for the students to help?

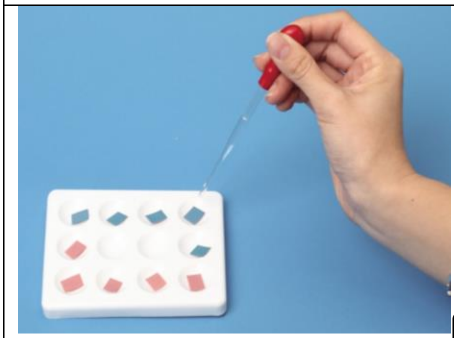
5. How many times do students have to use the language form? How likely is it that students can learn to use this form to talk about cause-effect?

Indicators

Cause

When ***we add dilute hydrochloric acid to tea,***
the tea changes colour.

Effect



Cause

When ***we add dilute hydrochloric acid to <u>red</u> litmus paper,***

____

____

Effect

Cause

When ***we add dilute hydrochloric acid to <u>blue</u> litmus paper,***

____

____

Effect

	Dilute hydrochloric acid	Distilled water	Dilute sodium hydroxide solution
Colour change of **<u>blue</u>** litmus paper	RED	BLUE	BLUE
Colour change of **<u>red</u>** litmus paper	RED	RED	BLUE

Cause

When ***we add dilute sodium hydroxide solution to <u>red</u> litmus paper,***

____

____

Effect

Cause

When ***we add dilute sodium hydroxide solution to <u>blue</u> litmus paper,***

____

____

Effect

extract of red cabbage leaves

Cause

When ______________________________________
____
__________________ ,
the extract turns reddish purple.

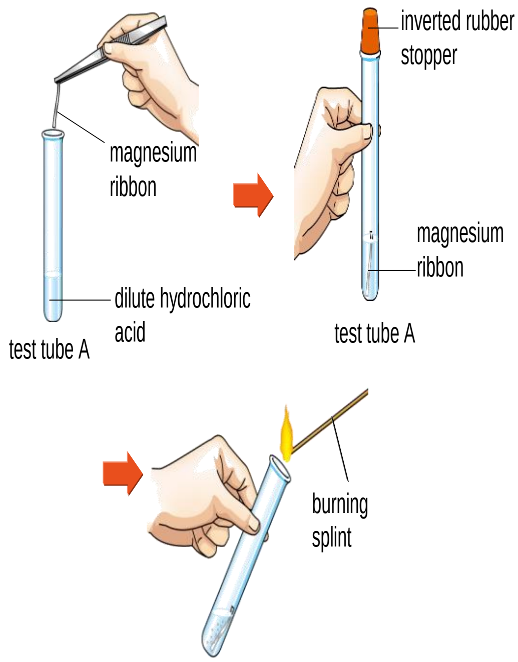
Effect

Plant	Distilled water	Dilute hydrochloric acid	Dilute sodium hydroxide solution
Red cabbage leaves	REDDISH PURPLE	RED	GREEN

Cause

When ______________________________________
____
__________________ ,
the extract turns green.

Effect

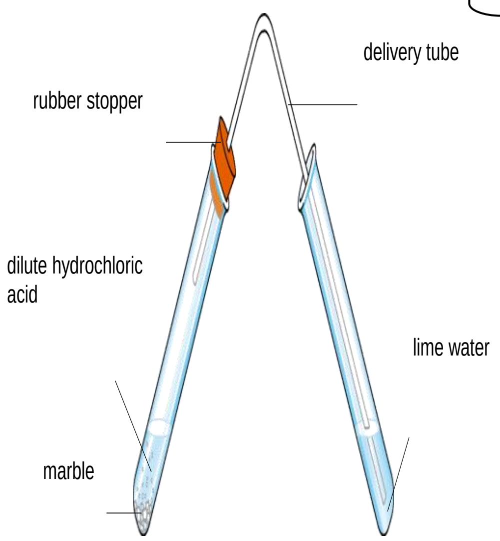


Cause

When ______________________________________
____
____________ ,
____

Effect

Metal and Acid 1. copper	______________________________________ ______________________________________ ______________________
2. iron	______________________________________ ______________________________________ ______________________

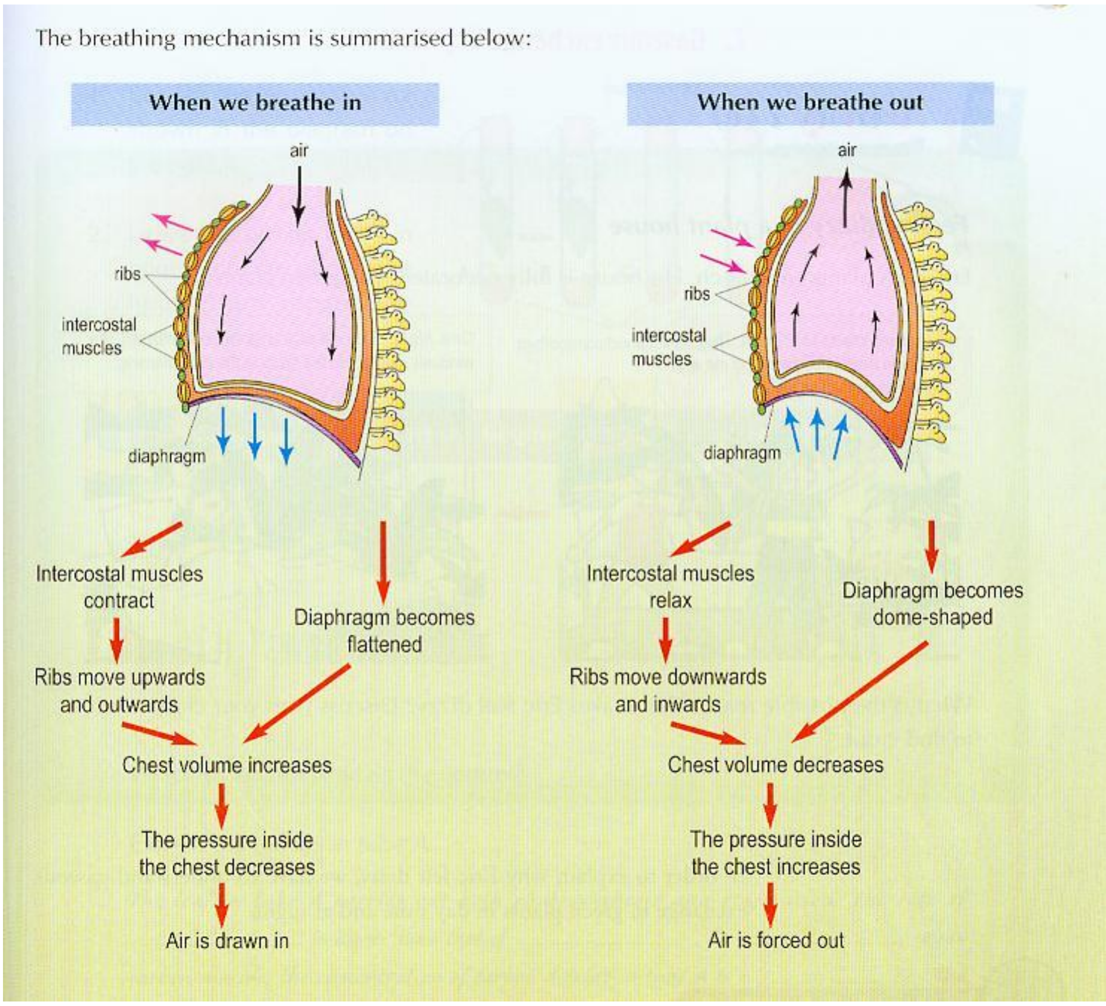
3. aluminium	______________________________ ______________________________ ____________
4. zinc	______________________________ ______________________________ ____________
	Cause When ______________________ ______________________________ ____________ , ______________________________ Effect
Metal and Acid 1. chalk	______________________________ ______________________________ ____________
2. stone	______________________________ ______________________________ ____________
3. building materials	______________________________ ______________________________ ____________

Activity 2

Comparing content support and language support in information transfer activities

The following are two versions of the same information transfer activity. Study them carefully and answer the questions that follow.

Breathing mechanism
The following diagrams show the process (i.e. what happens) when we breathe in and breathe out air.



[Taken from Chan, W.K., Luk, W.Y., & Kong, S.W. (2005). Understanding integrated science for the 21st century. Hong Kong: Aristo Educational Press Ltd.]

Version 1
Use the diagrams to complete the following text:

When we breathe in and out, air is forced into and out of the lungs by the ______________ muscles, the ribs and the ______________.

When the intercostal muscles __________, the ribs move _________ and __________ and the diaphragm becomes ___________. This causes the volume of the chest to ___________ and the pressure inside the chest therefore _____________. Air is thus drawn in.

When ____________________________, the ribs move ___________ and _________ and the diaphragm becomes ______________. This causes ____________________ _______________ and pressure inside the chest therefore ___________. Air is thus pushed out.

Version 2
Use the diagrams to complete the following text:

__________ *we breathe in and out, air* _________________________ *of the lungs by the intercostal muscles, the ribs and the diaphragm.*

_________ *the intercostal muscles contract, the ribs move upwards and outwards and the diaphragm becomes flattened. This* _______ *the volume of the chest to increase and the pressure inside the chest* ____________ *decreases. Air is* _______ *drawn in.*

_________*the intercostal muscles relax,* _____________________________________
____
____
____

Questions

1. What knowledge structures and text structure are represented in the text in the two versions? How does the graphic match with them?

   Knowledge structures =

   Text structure =

   Graphic =

2. What do students have to write in Version 1? What can they learn with this version?

3. What is the key problem in the design of this version (consider the match between the graphic and what students have to write)?

4. What do students have to write in Version 2?

5. Describe the language support provided in Version 2 and how the language support is gradually taken away. What can students learn from this version?

6. Other than language support and the gradual release of language support, what should be another principle for the design of an information transfer activity that can lead to student learning (**Hints:** (1) copying will probably not lead to learning; thinking is important for learning. (2) consider how the graphic and the text can complement / supplement rather than overlap)?

Activity 3
Designing an information transfer activity

Text 1: Reading text

Aerobic and anaerobic respiration

The most efficient form of respiration is aerobic respiration: this requires oxygen.

Glucose + Oxygen = Carbon Dioxide + Water + Energy

This word equation for aerobic respiration means: "**sugar and oxygen are turned into carbon dioxide and water, releasing energy**".

When oxygen is not available, some organisms can respire anaerobically i.e. without air or oxygen. Yeast can respire in both ways. Yeast gets more energy from aerobic respiration, but when it runs out of oxygen it does not die. It can continue to respire anaerobically, but it does not get so much energy from the sugar. Yeast produces ethanol (alcohol) when it respires anaerobically and ultimately the ethanol will kill the yeast. This is the word equation for anaerobic respiration in yeast.

Glucose = Carbon Dioxide + Ethanol + Energy

We can respire in both ways too. Anaerobic respiration takes place when you exercise. When you exercise hard, your muscles need to release more energy from glucose and your body can't get enough oxygen to the cells. So, you use anaerobic respiration. This is where the body respires without oxygen and produces lactic acid. In anaerobic respiration the glucose is only partially broken down, and lactic acid is produced - together with a much smaller amount of energy. Your cells cannot respire anaerobically for very long because lactic acid is poisonous, causing pains and cramp in your muscles. To get rid of the cramp, we have to breathe very deeply for a few seconds to break up the lactic acid.

Graphic: Complete the design of the following table for students to read the text to get the key differences between aerobic and anaerobic respiration in humans.

	Aerobic respiration	**Anaerobic respiration**
Oxygen supply	Requires ___________	Does not require ___________
Condition under which it takes place	When there is enough ________ supply.	When you need more _________ but have less ___________ supply than you need.

Text 2: Design a writing activity for students to write **a comparison-contrast text** to explain the differences between aerobic and anaerobic respiration in humans using the information in the table.

N.B.:

1. A comparison-contrast text has 3 parts:
   Statement of comparison^ [state that aerobic respiration and anaerobic respiration are different]
   Points of comparison^ [compare each aspect of difference one by one]
   Summary of comparison [summarise the main differences]
2. Language use:
   - parallelism
   - negation
   - comparative connectives and conjunctions
   - comparatives

What language support do you need to provide students with to enable them to do the writing activity?

Now, design a learning activity for the topic you have chosen.

Assessment

If students have to learn the English of the content at the sentence and text levels, they have to be assessed on their ability to use appropriate sentences and texts to demonstrate their learning of the content. If you do not assess students' English in any way, you cannot expect students to pay any attention to the quality of their English in their learning and production. If you show them that it is important (by rewarding effective use of content obligatory English) then they should take it more seriously.

The same principles that apply to the design of learning materials for content-language learning apply to the design of the assessment materials.

There two main ways of assessing content and language.

1. *One mark that grades both the language and the content together.* This means that to get a top mark, students must show that they can give a correct content answer using accurate content obligatory English.
2. *Two marks, one for content and one for English.* The total of the two marks gives the final mark. You need to decide on the percentage allocation for the marks between content and language.

Consider ways in which you can include some assessment activities that will require students to show their ability to use the English of science. Think about:

1. What percentage of the exam / test paper(s) will require the use of the English of science;
2. How can this part that requires the use of language be added to the exam / test papers: as a completely additional part (in which case, how do you adjust the marks to other parts to include this, how many marks will be given to this part?); as a replacement of another part (which part can it replace, how many makes will be given to this part?)
3. What other issues do you need to consider?

<u>Checklist for learning activities</u>

This checklist can be for self-evaluation or peer evaluation.

		Yes/no
Is there a clear **learning aim** in the activity?	***Objectives***	
Does the activity help students to **learn something new rather than test** what students already know?		
Do the students have to **process knowledge** (think rather than just recall or cut & paste) in order to complete the activity?		
<u>Suggestions for improvements:</u>		
Is the activity **language rich**? Do students have to use the **English of the content** to complete the activity?	***Language***	
<u>Suggestions for improvements:</u>		
Are the **instructions** for students clear and precise?	***Procedure***	
Is the activity **realistic**? Can it be completed with the knowledge in the time available (a single or double lesson) with the class described?		
<u>Suggestions for improvements:</u>		
Is the language suitably **scaffolded**? Is **scaffolding gradually released** during the activity to enhance learning?	***Scaffolding***	
<u>Suggestions for improvements:</u>		