LANGUAGE DEVELOPMENT STRATEGIES FOR THE TEACHING OF SCIENCE IN ENGLISH

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Abstract

While most teachers recognize the urgent need to help students who lack proficiency in the English Language better grasp scientific concepts and principles, many are unaware of the role they ought to play in lowering the language barrier in science learning. Fewer still have been taught specific techniques for supporting students' use of English in learning science. This article aims to provide some ideas into how teachers can be that language and content mediator in the science classroom, successfully intervening in language related problems and a result of that, optimise their students' potential in learning science.

Introduction

The implementation of the teaching of Mathematics and Science in English in Malaysia has raised certain concerns regarding the ability of Limited English Proficiency (LEP) students to follow lessons in their second language. Generally, while most teachers recognize the urgent need to help students who lack proficiency in the English Language better grasp scientific concepts and principles, many are unaware of the role they ought to play in lowering the language barrier in science learning. Fewer still have been taught specific techniques for supporting students' use of English in learning science.

The use of language development strategies to help LEP students learn science better may be considered a relatively new aspect of science teaching in Malaysia. Science teachers have to now be cognizant that they need to actively seek and implement ways of lowering the language barrier in the teaching and learning of science in English. Besides being the content mediator, science teachers are also required to be the language mediator in the science classroom if they are to successfully intervene in language related problems in order to optimise their students' potential in learning science.

The role of language in science learning

What is the connection between language and learning? Well, as Henderson and Wellington (1998) very succinctly put it, "The quality of the classroom language is bound up with the quality of learning." (p. 36). Wellington and Osborne (2001) further explains that "language development and conceptual development are inextricably linked. Thought requires language, language requires thought" (p. 6). Explained from the Vygotskyian point of view, when a learner uses words, he or she is helped to develop concepts. Language thus acts both as a psychological tool that helps a learner to form thought as well as a mental function in itself.

With reference to science education, Wellington and Osborne (2001) underlines that research findings indicate that language, in all its forms, matters to science education. In particular, it is not just the language in itself but rather what educators do with language. This is because what educators do with the language inadvertently affects how the learner uses the language and that is fundamental to the learning of science.

Thus, the next question that arises then is “Why is language important in science education?” With regards to this, literature suggests that one of the important features of science is the richness of the words and terms it uses and that students need to at some point be able to advance into “abstract” thought with the use of language, if they are to master key scientific concepts (Wellington and Osborne, 2001; Kober, n.d.).

Language problems and science learning

According to Henderson and Wellington (1998) “For many pupils the greatest barrier to learning science is the language barrier” (p. 35). One of the major reasons why language becomes a barrier to Limited English Proficiency learners is because scientific terms, whether technical or non-technical, are unique in nature and they are seldom encountered in other contexts or in English as a Second Language instruction (Kober, year not available). Jarrett (1999) adds that academic language is more abstract than social language and that in science, common words can take on specialized meanings. As such, the most obvious challege faced by LEP students in learning science is having to learn a new language at the same time they are required to acquire new subject matter. It is thus not surprising that LEP students sometimes experience difficulties moving to higher level of abstraction as they do have the support of language connections.

Wellington and Osborne (2001) observe that whilst research shows that one of the major difficulties in learning science is learning the language of science, “experience would suggest that science teachers often consider it to be of marginal relevance to the learning of science” (p. 1) This scenario which is rather unfortunate, is further aggravated when teachers ignore the language needs of LEP students in content courses when under pressure to cover the syllabus. They further add that in general, teachers who teach content do not recognize language learning opportunities. If there is any effort at all in incorporating language development, they just concentrate on vocabulary development.

The role of teachers in lowering the language barrier

One of the key factors in helping LEP students achieve greater progress in learning science is the role played by the science teacher in lowering the language barrier. With regards to this, Vine (1997) stresses that if content were to be made accessible to LEP students, teachers will need to move beyond leaving the language to take care of itself. As Kober (n.d.) notes, research confirms the importance of integrating language development with science learning. Shaw (2002) emphasizes the role of the content area teacher as a mediator. According to her, the science teacher must be cognizant of how to successfully mediate content knowledge and language instruction effectively to LEP students. This is in line with Vygotsky’s notion of zone of proximal development and Bruner’s concept of scaffolding whereby the teacher needs to adjust his / her instruction to support the learner’s existing capabilities so that the learner is able to beyond his / her current level of functioning.

Anstrom, Lynch and Dicerbo (1998) explain that by giving English Language learners more opportunities for using the language of science, science content is made more accessible to the learners. They propose that teachers identify linguistic structures or discourse patterns associated with a particular topic and then incorporate appropriate language learning activities into their science lessons.

Language development strategies appropriate for various concepts / principles in teaching science in English

Wholistic language development encompasses the development of listening, speaking, reading and writing skills. However, this paper only touches on the reading and writing components. The following paragraphs list some successful strategies as recommended in a review of related literature:

Shaw (2002) suggests that in order to help students read more, the science teacher could identify language demands (eg cause and effect, compare/contrast and sequencing) and teach specific strategies to help students understand each type of discourse through simple worksheets and graphic organizers.

Buxton (1999) adds that the success of LEP students in science classrooms may be enhanced by explicitly addressing vocabulary and technical terms, carefully integrating language functions such as summarizing, rephrasing, classifying and evaluating, and making explicit the different structures and features of the language of science.

According to Crawford (1995) "Students learn new terminology and word meanings best when they encounter them during purposeful activities and investigations. Therefore, teachers will want to teach vocabulary as part of their core instruction, not as a separate activity" (p. 16).

Henderson and Wellington (1998) record that Directed Activities related to Text (DARTS) have been successful in helping students be more focused on important parts of the text as well as involving them in reflecting on its content. The two broad categories involved are:

1. Reconstruction (or completion) DARTS – These are essentially problem-solving activities that use modified text. The text, table or diagram has parts missing (words, phrases or labels deleted), or alternatively, the text is broken into segments which have to be re-ordered into the 'correct' sequence according to logical order or time sequence.

2. Analysis DARTS – These use unmodified text and are more study-like. They are about finding targets in the text. The teacher decides what the 'information categories' of the text are and which of these to focus on. These are the targets which pupils are to search for, and involves the pupils in locating and categorising the information in the text. The teacher may also request pupils to construct diagrams or tables from information given.

According to Henderson and Wellington (1998), word games are also beneficial in exposing students to more active reading in a more sociable context. While this strategy may require the teacher to spend more time and effort in preparing the materials, the enjoyment experienced by students is certainly worth it. Examples of word games include matching pairs or trios and grouping words into groups. Cards may also be used to play the memory game called "Pelmanism" whereby all cards are placed face down and students are required to uncover the cards two at a time. If the cards form a pair, the student gets to keep the pair but replaces the cards (face down in the original position) if they don't.

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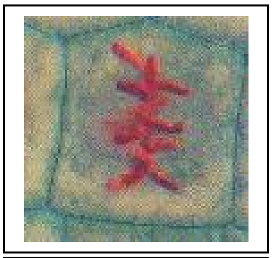
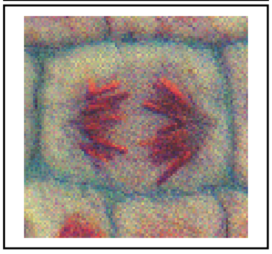
Appendix
Examples of completion DARTS

1. Sequencing the phases of cell division

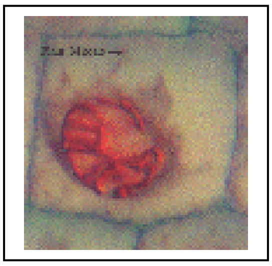


1. Interphase:
Chromosomes threadlike

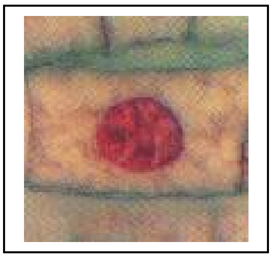


2. **Prophase**:
Chromosomes become shorter and fatter

3. **Metaphase**:
Chromosomes arrange themselves on the equator



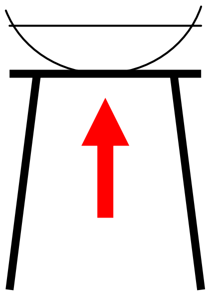
4. **Anaphase**:
Chromatids move to opposite poles



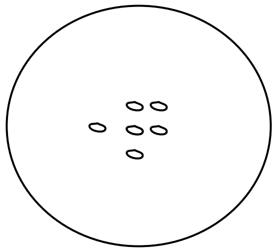
5. **Telophase**:
Chromatids have reached poles. Cell starts to divide into two

2. Sequencing the steps of an experiment on how to separate a mixture of sand and salt

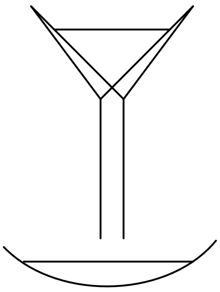
Sequence the following activity in the correct order to separate a mixture of sand and salt



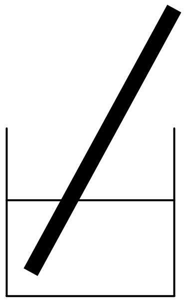
Boil filtrate to evaporate nearly all the water.



Leave content in evaporating dish to cool until crystals are formed.

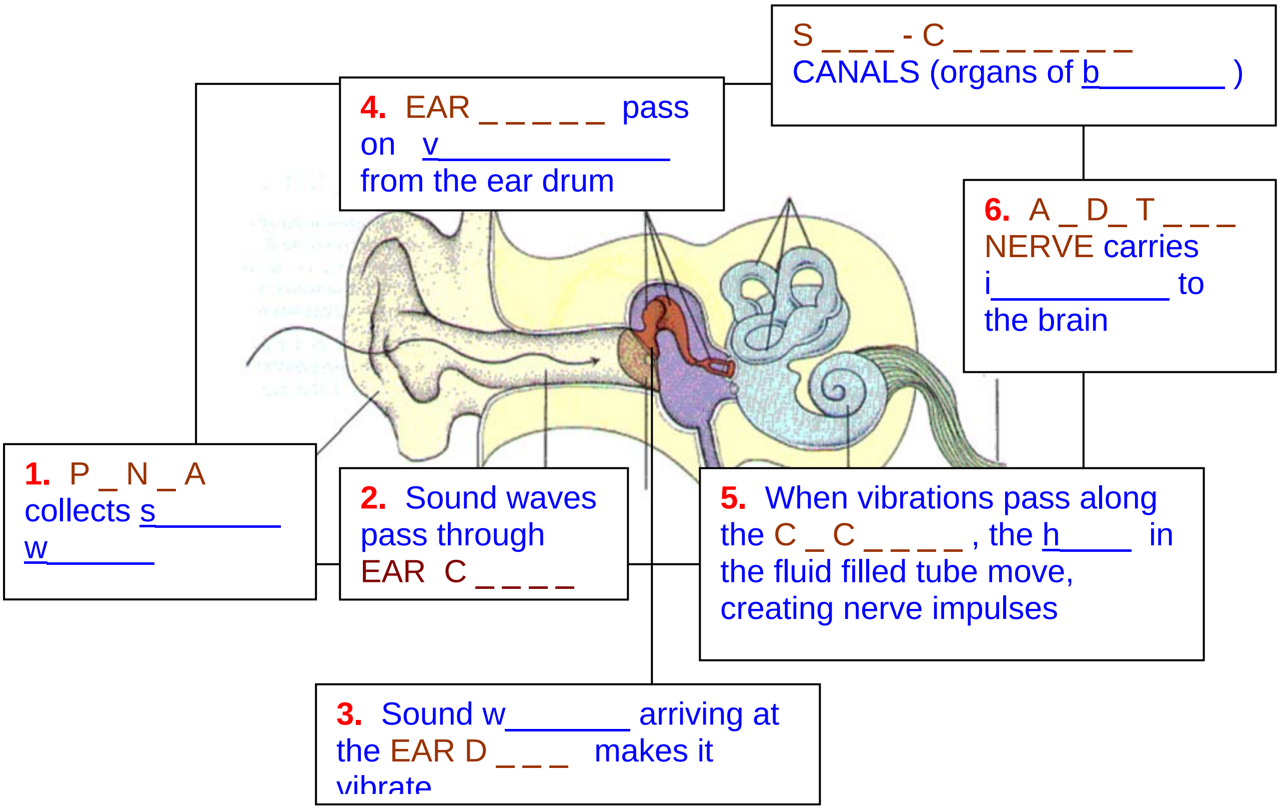


Filter mixture using filter paper and filter funnel.



Place mixture in beaker and stir in water.

3. Labelling a diagram of the human ear and completing the functions of various parts of the ear.



4. Completing a text on the boiling point of water using words from a word bank given

The boiling point of water. **Complete the text below using words from the word bank given.**
When a liquid is ____________, it eventually reaches a temperature at which bubbles form. This temperature is called the __________ point. The normal boiling point of ________ is 100^0 C. At this temperature water changes into __________.

steam	water	heated	boiling

Examples of analysis DARTS

1. Labelling paragraphs from a newspaper article on "Good bacteria" from The Star, according to information categories

Good bacteria

Can bacteria be good for you? Scientists have found that certain types of bacteria in the digestive system, such as lactic acid bacteria (*Lactobacillus acidophilus, Lactobacillus casei*) and *bifidobacteria*, are actually beneficial for digestion and health.

It is believed that good bacteria in the intestines can create an environment that deters bad bacteria from growing. The good bacteria also improve digestion and increase the body's ability to resist intestinal infection.

When these good bacteria are given as a supplement, or added into foods, they are called "probiotics". The most common foods that contain probiotics are yoghurt and certain fermented milk products.

Look for those that say "live culture" or "active culture" – but be warned that some products may claim to contain probiotics even though they contain only very small amounts.

Probiotics are also available as pills, tablets and powders, but there is no need to give these to your child if he is eating a well-balanced diet. Ask your paediatrician or dietitian for advice.

Label the paragraphs in the text given using the following:

1. Examples of good bacteria
2. How bacteria may benefit humans
3. Examples of foods that contain good bacteria

2. Completing a table based on an article on "Pollutants in tap water"

Read the passage below and then complete the table given

What's wrong with tap water?

Aluminium

Aluminium occurs naturally in some water supplies, and is also added during purification of some tap water. Most aluminium (from either source) is taken out before it gets into the main supply, since too much can discolour the water. There is growing evidence that high intakes of aluminium could be associated with Alzheimer's Disease (a form of senile dementia).

Lead

Large quantities of lead can damage the brain and nervous system, cause anaemia and affect the muscles. Lead gets into the drinking water mainly from lead pipes, which you may find inside pre-1976 houses.

Nitrate

High levels of nitrates in tap water can increase the risk of methaemoglobinaemia, a very rare blood disease which can affect bottle-fed babies whose feeds are made up with tap water (even if it is boiled first). There is also concern about the effect of nitrates on all age groups, because products which are formed when nitrates are broken down in the body have been shown to be carcinogenic in animals.

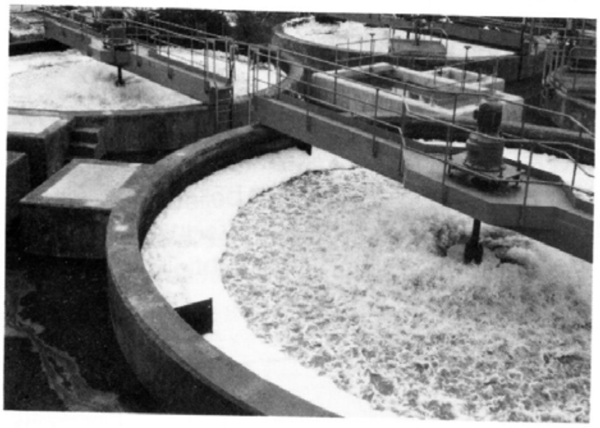
Concern about nitrates has grown in recent years because of an increase in nitrate levels in soil and water in some parts of the country. The main cause of higher nitrate levels in soil is likely to be more intensive farming which includes greater use of nitrogen fertilizers. Some of these nitrates get washed into rivers and underground water supplies and eventually find their way into tap water.

3. Sequencing the process of sewage treatment using a diagram

SEWAGE TREATMENT

The main methods of sewage treatment, used today, rely on the breakdown of the organic material in sewage by bacteria, in the presence of oxygen from the air.

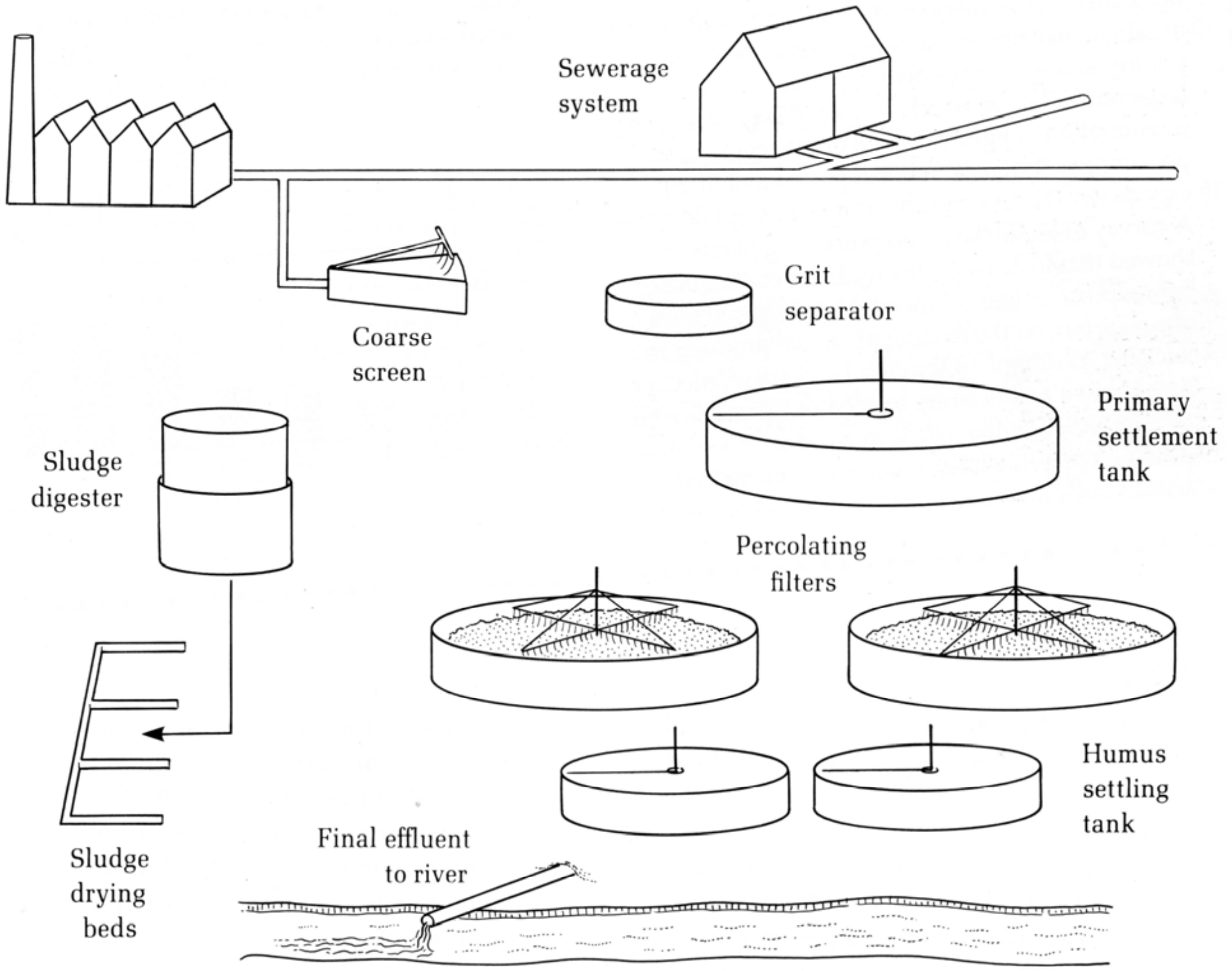
Before treatment, the sewage is first passed through a screen of iron bars, to prevent large objects entering the works. Grit and stones are allowed to settle in a grit separator and the sewage then flows into primary settlement tanks. The large particles of sewage settle to the bottom of the tanks and are removed as a sludge, while the liquid at the top flows on, for the biological oxidation step. In the percolating filter process, the liquid is sprayed by rotating radial arms over a large tank filled with stones which are about 5 cm in diameter. The stones are covered with a variety of biological life and can be regarded as a balanced ecosystem. There is a slime which consists chiefly of bacteria and these feed on the organic matter in the sewage. Insect larvae and worms are also present and feed on the bacterial slime. Some of the insect larvae metamorphose into flies and these are caught by birds.



The liquid which is collected at the base of the filter tank contains the breakdown products of the organic matter. These particles are allowed to settle in a final settling tank while the clean overflow water is discharged as effluent to the river. The diagram shows the flow of sewage through a percolating filter works with the connecting lines and arrows omitted.

Few pollution problems should result from a good quality sewage effluent discharge. The oxygen required for the oxidation of any organic matter remaining in the discharge, is removed from the river water by bacteria. This results in a slight decrease in the oxygen concentration of a river downstream of an effluent outfall. The results in the table show the effect, on clean river water, of a discharge of good quality sewage effluent.

Complete the diagram by means of connecting arrows, to show the flow of material through a percolating sewage works.



Source: Best & Ross 1977, 'River Pollution Studies'. Liverpool University Press

4. Answering True/False questions based on text about the various forms of energy available in the science textbook

Read pages 72 – 76 of the Form 2 science textbook and answer True or False

1. Energy that is stored in an object because of its position is called nuclear energy
2. Light energy is produced when an object vibrates
3. The burning of wood produces heat energy
4. We can get electrical energy from batteries

Example of word games

Matching labels with their meaning and examples





Corrosive: **Destroys living tissue**	chloroform
Radioactive: **Gives off radiation**	petrol
Toxic: **Dangerous to health and may cause death**	hydrogen
Flammable: **May easily catch fire**	uranium
Explosive: **May explode if heated, knocked or ignited**	concentrated acid