Enhancing Secondary Science Students' Text Processing Skills

http://www.tki.org.nz/r/esol/esolonline/teachers/prof_read/murry_black/home_e.php

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ABSTRACT

This research focuses on the use of a common secondary science text book with ESOL (English for speakers of other languages) students. The aim was to evaluate a simple reading strategy introduced during a short unit of work in the students' regular science programme. The student group included year 10 ESOL students and two year 11 mixed ability classes. These two year 11 classes were from two different suburban secondary schools in Auckland. A sequence of lessons was prepared using readings taken directly from the chosen text book. The lessons included reading based activities with word analysis and content development being incorporated into the teaching programme for the topic. The feedback from selected members of the class was analysed. The lists of words extracted from the text book were also analysed. These results are discussed in relation to published literature about improving literacy outcomes by using pre-reading strategies.

The results show:

- that there are relatively simple pre-reading strategies that can be used effectively at a variety of levels within mixed ability classes;
- the need to incorporate more extensive word lists for ESOL students;
- the importance of assisting ESOL students to make the best use of text for effective learning;
- the need to develop students' questioning skills -and some approaches to questioning skills are explored.

This research is based on the premise that all teachers need to be using literacy strategies in their classrooms. The discussion suggests ways for science teachers to use their text books to produce more efficient literacy based teaching.

INTRODUCTION

Each year schools invest a lot of money in purchasing text books and written resources. Written material is a very helpful learning resource but there is a danger of placing too high an expectation on students to read text and understand it fully, especially when English is the second language of many students. Where there are high proportions of students with non- English speaking backgrounds (ESOL), not only is it important for schools to get value for money in their investment in textbooks and photocopying, but also it is important to help these students get the best possible information from the text they read.

Recent documents from the Ministry of Education (2002) emphasise that literacy is the responsibility of all teachers, not just the English teacher. The premise on which this research is based is that every teacher is a teacher of reading and therefore literacy strategies such as those investigated are an important part of science teaching. Students do not readily transfer reading skills between subjects (Heselden and Staples, 2002) and science teachers need to become more involved in actively teaching reading skills as well as using reading skills to help students learn, particularly where it can make a significant difference to ESOL students.

The Ministry of Education recognises that most students will become successful readers and writers if they experience high-quality teaching in their everyday classrooms (TKI, 2002). This research aimed therefore to find ways to help both teachers and students enhance text processing skills during the classroom use of a common New Zealand secondary school science text book.

AIM

The aim was to identify and evaluate the success of a selected classroom reading strategy. As the project developed the research focused on pre-reading strategies and the need to develop a simple approach that teachers could use with their classes and that students could apply to text reading without the teacher prompting. This required identifying activities for teachers to introduce and reinforce reading skills, trialing lessons and gathering data about the activities.

PROCEDURE

The Students. The students were in two groups selected from Year 10 and 11 classes. For the first group of students a sequence of six lessons was taught to introduce the Genetics topic to a Year 11 Science class studying NCEA at a decile 4 Auckland secondary school. Two other teachers then used the same units of work with their Year 11 class. These were mixed ability classes with a proportion of ESOL students in each. All the students in each class completed all the activities and a small number were selected for interviewing. The total number of students involved was 85. A change in jobs at the end of term three enabled the researcher to work with a science class of Year 10 students at a decile 7 Auckland secondary school. This was an ESOL science class and the context for the research was a three lesson introduction to Electricity. The same lesson structure was used with both groups and is detailed below. There were 24 students involved in this group.

Pre-reading strategies. A literature search resulted in the following pre- reading strategies being introduced as part of the teaching units:

- setting a goal for reading - the students writing this as a question or aim;
- identifying and using the visual aspects of the text by surveying the diagrams and headings;
- scanning the text for activating experiences prompted by the headings, word recognition and bold text to find out what is already known.

The lesson structure included some discussion about the learning advantages of activating prior knowledge and these are discussed below.

Lesson Sequence. Text was taken from the science textbook *Science Year 10* (Hook, 1998) and *Science Year 11* (Hook, 1999) from which are part of the New Zealand Pathfinder Series published by New House Publishers Ltd, Auckland. The publisher's approval was gained and a simple lesson plan for each lesson was developed to include reading of the text, a reading task, some teaching of the science concepts and an activity with a language base related to the text.

The initial focus in the research was on pre-reading strategies as a way to give students a literacy skill that would be transferable to any classroom setting. The production of a set of lesson outlines (Appendix 3) allowed other staff in the same department to participate in this literacy in science intervention collecting data and developing the reading skills of the students in their classes.

Text Processing Grid. The main research aspect of this study involved data collection using a Text Processing Grid (Appendix 1) developed by Helen Nicholls from a 4x3 Information Grid. Each student was given one of these to complete. Students recorded this information:

- a reading goal;
- three pieces of prior knowledge;
- three important ideas from the text;
- new words from the text;
- questions about the text;
- an evaluation of whether the reading goal had been achieved.

The students were encouraged particularly to use the title from the text to set a reading goal by forming a question. This added to the development of questioning skills discussed below. The completed grids were collected for analysis and all questions written into the question column were answered on the sheet to role model this skill. Any words included in the 'new words' column were recorded and their occurrence totalled.

Interviews

Following the analysis of the sheets, selected ESOL students were interviewed in small groups. They were asked about their own analysis of their reading skills, what they did before they started reading text and how they approached difficult words in the text they were reading. The interview questions are listed below:

1. *Did you read the whole of the text from start to finish?*
   If not, how far did you get? Why did you stop?
2. *How do you rate yourself as a reader? ... Do you think you are a good reader?*
3. *What do you do before you started reading?*
4. *What do you do when you find a new word in the text?*
5. *Do you ever guess what new words mean? How do you go about guessing what new words mean?*
6. *Do you ask yourself questions about new words?*
7. *Do you ask anyone else questions about new words?*

Word Lists
The list of new words collected from the grid sheets was compared against two other word lists - the *Academic Word List (AWL)* and the science topic word list from the school's science scheme.

Questioning Skills
The use of the text processing grid highlighted the need to investigate the development of *questioning skills*. A literature search was undertaken to find out more about questioning skills. As part of the teaching units the students were encouraged to set a reading goal by using the title of the section of text being read to formulate a question. The value of having both a pre-reading goal and the motivation to extend learning beyond the text became a focus. In addition, the class was introduced to a simple hierarchy of questioning. The lesson structure included some discussion about the learning advantages of asking good questions and these are discussed below. Modelling of questioning was built into the lesson sequences prepared.

The inclusion of data from three sources - the interviews, the written feedback from the text processing grid and the literature search - allowed triangulation to be undertaken during the interpretation of the results discussed below.

FINDINGS

Interviews
Students generally evaluated their own reading ability as "slow" and some felt it was "not good enough". The majority were reluctant to ask questions about new words in class - they would use a dictionary first, ask for help at home or use the internet at home. One student said "the teacher's explanation is too difficult to understand" and would rather ask the student sitting next to him or meet a friend after class to ask about the words. All the students were aware of ways to use the context of the new words to help them try and find meaning but few were able to describe a specific strategy that they used. One explained that he didn't guess new words because "there are lots". Using the pictures and diagrams were mentioned in general terms but not as something that was done before starting reading - most students said they read the title before they started reading the text. When the whole class was stopped and asked who had done anything before they started reading, less than a third indicated they were actually doing any pre-reading activity. The interviews revealed limited existing development of pre-reading strategies.

Lists of new words
Each new word identified from the student's completed grid sheets was added to a spreadsheet for the whole topic. The total number of times each word occurred was then entered on the spreadsheet. This allowed the total number of different new words to be compared to the number of words from the spreadsheet list that also occurred in the *Academic Word List (AWL)* and the school's Topic List (Table One).

TABLE ONE: Percentages of the new words which were also found in the Academic Word List or in the subject Topic List for two different science topics.

TOPIC	Total new words	AWL words	Topic List words
Genetics	51	8%	33%
Electricity	57	16%	16%

The low percentages show that most of the new words encountered in the science text were subject specific and therefore not in the Academic Word List. In addition, the low percentage of the new words matching the topic list shows that the text was more technical than teachers may have expected. A good example of this is the word "trait" used in the genetics units in the textbook but usually referred to as a "characteristic" in class. Neither word was included in the topic list.

Questioning skills
When students were first asked in class to complete the Text Processing Grid, they found it very difficult to complete the 'Questions' column and most left this part of the grid blank. This prompted the inclusion of questioning skills into the research. In the interviews, the majority of students said they would rather use their dictionary than ask questions about new words. The number of questions increased as the grid was used more regularly and the style of the questions developed: from word meaning, to some students asking about the application of genetics concepts in the text, to topical issues such as genetic modification and genetic disorders.

Pre-Reading Goals
The for writing down a reading goal entries in the line at the top of the Text Processing Grid (Appendix 1) also showed development as the grid was used more often during the sequence of lessons. The majority of goals began as general statements such as "learn something new" or understand text, but by the end of the unit almost half the students were writing specific goals such as "to find the difference between genotype and phenotype" or "how to use a punnet square to predict". These sorts of goals generally reflected the text headings as this was encouraged in the initial discussion about setting goals as a pre-reading strategy.

DISCUSSION

The information and data collected gave insights into three aspects of literacy development in the students who participated in this research:

1. **Pre-Reading Skills**
   The literature shows the effectiveness of pre-reading strategies in producing significantly higher comprehension scores (Norrish, 1994). In particular pre-reading strategies can help improve reading comprehension by activating a student's prior knowledge. McKnight says *Successful teaching strategies for reading comprehension must be based on assessing, activating and/or constructing a student's prior knowledge so that new information can become part of the reader's existing schemata. Pre-reading strategies can be used to*

reach this goal and usually work best when a student has some rather than no or much knowledge about a topic. (*McKnight,2000*).

Research on learning has shown that the more information is organised into meaningful parts and the more these parts are clearly perceived, the more easily the material can be learned (Maryland State Department of Education, 2002a). A structure that includes a goal for reading acts as an organisational aid that helps students process the text - teachers who prepared less able readers to read textbook assignments through the use of pre-reading strategies promoted learning because pre-reading strategies established a mind-set for reading and increased comprehension.

In terms of developing a pre-reading strategy for this project, the key ingredients in reading success were seen as

- **goal setting** (setting a purpose for reading as a question or aim),
- **visual aspects** (surveying for headings/diagrams/bold printed words)
- **activating experience** (finding out what is already known).

The suggested pre reading strategy emphasised setting a question as a reading goal and also encouraged the previewing of the text by looking for sub headings, bold printed words and diagrams. These activities all act to stimulate prior knowledge before a student reads the text.

Teachers need to teach, remind and model reading strategies - whether it is in science or any other subject. This study confirms the important role science teachers have in promoting literacy in science. The responses of ESOL students in this research show clearly that they need both help and encouragement with their reading - and that the teacher has both a responsibility and the opportunity to do this. The fact that student use of text books requires more than just giving page references is well documented. Wooldridge (1999) notes that students need to be taught how to make effective use of textbooks. The strategies trialled during this research provide teachers with effective methods for helping readers to enhance their text processing skills. These skills can easily be taught as part of a normal lesson.

The Text Processing Grid offers a structured tool that can be used to develop and reinforce reading skills and its use in this research confirmed the literature that states that reading strategies can be successfully taught (Carrell, 2002). The Maryland State Education Board (2002b) quotes research data that clearly demonstrates that teaching reading skills (including pre-reading strategies) improves the students' comprehension of text.

By using text books or photocopied handouts in their classrooms science teachers must take on the responsibilities for teaching reading skills as well as content. Leaving literacy up to the English teacher cannot suffice. Textbooks are one resource through which all teachers are able to adequately take responsibility for literacy development. (Wooldridge, 1999).

Often, however, science teachers, who may not have been specifically trained as 'reading' teachers, find it difficult to know where to start teaching reading in their classroom. The simple pre-strategy suggested here not only allows any teacher to teach reading skills but also correlates with current learning theory about metacognitive reading strategies (Maryland State Education Board, 2002b). Furthermore, pre-reading has been shown to be a strategy which is internalised to become part of students' own cognitive processes for reading (Brown and Palinscar (1982, as cited in Maryland State Education Board, 2002b).

2. **Word List Analysis and Vocabulary**
   The surprising lack of match between the new words and the words in the word lists shows that the majority of new words from the science text would not be explained or defined for these students outside their science classroom. This emphasises the need for science teachers to incorporate extra language based activity into their lesson structure and to use vocabulary activities as part of each topic development. The sorts of resources prepared during *Learning through Language* (Draft, Ministry of Education, 2002) professional development courses includes such activities as matching exercises, three level guides and structured overviews to cater for this requirement. Heselden and Staples (2002) describe the use of such activities as being part of *active reading*.

   A choice still has to be made about the number of new words to include in students' word lists. Separate research undertaken by others in the 'Secondary School Literacy Research Project' on pre-teaching vocabulary, (Lidbetter, 2002), and on the explicit instructional techniques for vocabulary expansion in science, (Pollock, 2002), reported a marked improvement in general literacy skills, increased metacognitive awareness of the place of vocabulary and an apparent increase in self-esteem among students involved in making vocabulary lists. In particular, Pollock pre-taught vocabulary from the science text book being used in class and included a key word list and a word list book as specific strategies to improve literacy levels.

   The teacher's role in selecting words that will help the students' understanding of the text, and therefore the topic being studied, is seen as critical. McKnight states that *Because it takes a high number of exposures or encounters with "rich" instruction to attain this [word understanding], it is very important that the teacher be able to choose wisely those words which warrant such instruction.* (McKnight, 2000).

   It is obvious from the results of this research that the majority of the new words need to be taught to students. This includes language that may be specific to NCEA assessment in science where the instructions in the questions are likely to include *describe* for achievement, *explain* for merit and *interpret* for excellence grades. Lambourne, Beale and McKay (2002), who were part of the same research team, found that the literacy aspect of the assessment tasks in Level 1 NCEA Physical Education assessment tasks is a barrier to student achievement. Their suggestion that the explicit teaching of language in the classroom is a useful aid to literacy development is supported in their study by

the student quote "The most useful things the teacher can do to help me with reading: helping me understand big words, talking about the ideas, giving me activities to do."

3. **Questioning Skills**
   The questioning skills of the students showed a concerning lack of development at the start of this project. Reading about the hierarchy of questioning emphasised the value of developing good questioning skills as part of pre-reading strategies (*literacyleaders.com*, 2002). Asking a question focuses readers on finding information that will answer the question (CASA IPFW, 2001). Isidore Rabi, Nobel Prize winner in Physics in 1944, tells the story of the inspiration he gained from his mother's encouragement during his early years of schooling. Rather than enquiring about what he had learned that day, he would be greeted on his arrival at home with, "Did you ask a good question today?" (Ciardiello, 1998).

   Theory about the various types of questions lists a hierarchy of questions which includes memory based questions such as naming, defining and identifying, convergent thinking questions such as explaining, comparing and contrasting, divergent thinking questions such as predicting, hypothesising and inferring and evaluative thinking questions such as valuing, judging and defending. (Ciardiello, 1998). However, the complexity of questioning makes it difficult to produce a simple method of learning how to question- rather it is best to provide opportunities for students to interact with models of effective questioning in real situations (literacyleaders.com, 2002). Teachers need to be role models of good questioning.

   After the introduction, teaching and modelling of questioning activities in the lesson sequences prepared there was an improvement shown in students' ability to formulate and write down questions. This revealed how easy it is to make significant developments if teachers are aware of strategies that focus on improving literacy levels and use them in their lesson plans.

CONCLUSIONS

This research clearly shows both the need for science teachers to teach reading and questioning skills, and the advantages of such classroom activities. If teachers are aware of the need to match topic word lists to the text being used, and the need to develop text activities that support literacy skills then ESOL students will show development of their reading skills. In particular, pre-reading strategies are shown to be simple, effective and transferable skills that enhance students' text processing skills.

WHERE TO NEXT? Recommendations from this research

- For teachers, the importance has been demonstrated of matching topic word lists to text, of using 'active reading' activities and of teaching and modelling reading and questioning skills.

- For students it has been shown that it is important to apply pre-reading strategies and to develop questioning skills.
- Pre-reading strategies could be implemented as a school-wide, cross-curricular approach to improving reading success.
- Professional Development opportunities need to made available for the production and sharing of active reading strategies.

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APPENDIX 1: Text Processing Grid

Name: _____

TEXT PROCESSING GRID

What is your reading goal for this text? _____

3 most important ideas	3 things I already knew	3 questions about this text	New words
			_____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____

How did you achieve your reading goal? _____

_____

APPENDIX 3: Lesson Outlines

YEAR 11 GENETICS TOPIC
Lesson sequence for six genetics topics taken from *Science Year 11* (The New Zealand Pathfinder Series).

Some lessons may take more than one period. Homework was set from the pathfinder exercises related to the text being studied. Each activity was reviewed and reinforced at the start of the next period.

1. ***Zygotes and Chromosomes*** page 16
    - Read the text and complete the Text Processing Grid
    - Students prepare a 'mind map' of all the statements about chromosomes in the text
    - Discuss mind maps and draw on board from student suggestions - fill in anything overlooked by students (sample given)
2. ***Chromosomes and Genes*** page 16 - 17
    - Read the text and complete the Text Processing Grid
    - Students use the 'ordering' activity sheet to place the eight words in order of size from smallest to largest items.
    - Discuss the order in relation to the meaning of the terms.
3. ***Copying Chromosomes*** page 17
    - Read the text and complete the homework
    - Students copy the 5 diagrams of Mitosis into separate boxes down the left hand side of a page in their notebook and beside each box write down what is happening in that box.
    - Show video of mitosis.
4. ***Passing on Chromosomes*** page 17
    - Read the text and complete the homework
    - Students complete a chart that lists the similarities and differences between meiosis and mitosis.
    - Discuss chart
    - Show video of meiosis
5. ***Phenotype and Genotype and Dominant and Recessive Genes*** page 20
    - Read the text and complete the homework
    - Complete the 'Genetics Model of a Monohybrid Cross' from *The Living World* (Level 6 Science) Computer Disk (New House Publishers, 1995).
6. ***Special Skills 1: Using a Punnet Square to Predict Phenotypes*** and ***Special Skills 2: Using a Pedigree Chart to Identify Genotypes*** page 21
    - Read the text and complete the homework
    - Complete punnet square problems

YEAR 10 ELECTRICITY TOPIC
Lesson sequence for three electricity topics taken from *Science Year 10* (The New Zealand Pathfinder Series).

Some lessons may take more than one period. Homework was set from the pathfinder exercises related to the text being studied. Each activity was reviewed and reinforced at the start of the next period.

1. ***Atoms and Charged Particles*** page 52
    - Read the text and complete the Text Processing Grid
    - Define 'conductors' and 'insulators'
    - Discover materials that are conductors and insulators using conductivity testers
    - Make lists on board of conductors and insulators and make predictions of materials not available inn classroom.
2. ***Static Electricity*** page 53
    - Read the text and complete the Text Processing Grid
    - Define 'attraction' and 'repulsion'
    - Investigate static electricity and attraction and repulsion using rods, plastic strips balanced on watch glasses and different types of materials.
    - Draw diagrams of results to illustrate and explain attraction and repulsion.
3. ***Current Electricity*** page 53
    - Read the text and complete the Text Processing Grid
    - Introduce 'circuit diagrams' and establish 3 requirements for circuit (energy supply, conductors, continuous pathway).
    - Investigate circuits using electricity equipment available
    - Draw circuit diagrams of different circuits.

Chromosome ordering activity sheet

homologous chromosomes

base

genome

chromosome

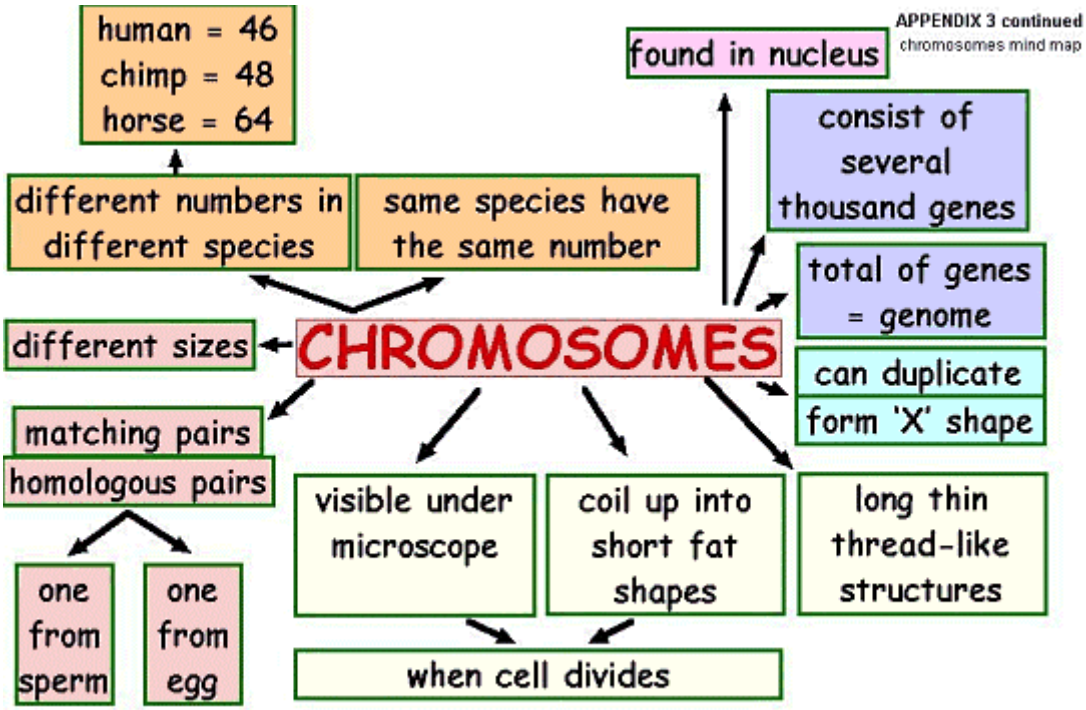
base pair

DNA

triplet

gene

Mind Map


APPENDIX 3 continued
chromosomes mind map
human = 46
chimp = 48
horse = 64
different numbers in different species
same species have the same number
found in nucleus
consist of several thousand genes
total of genes = genome
can duplicate
form 'X' shape
different sizes
CHROMOSOMES
matching pairs
homologous pairs
one from sperm
one from egg
visible under microscope
coil up into short fat shapes
long thin thread-like structures
when cell divides