Glasses Have Two Lenses

The Use of an Acronymous Metacognitive Learning Strategy to Improve Reading Comprehension on the Internet

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ABSTRACT

This exploratory study took place in a New Zealand Intermediate School and demonstrated the use of an acronymous metacognitive learning strategy designed to improve reading comprehension outcomes for student participants reading material directly sourced on the Internet (web-text). The strategy, WWW SSURF, was formulated by the researcher from the results of existing research into reading comprehension for print-based text and web-text. The research was conducted in two phases: the original study and a replication study. In the original study two class groups used the strategy; in the replication study one class group used the strategy while a second class group did not. The original study provided evidence that uptake of the strategy elements by participants was relatively quick and that participant increased use of strategy elements persisted over a six-month period without any further specific strategy instruction or scaffolding. The replication study groups were comparable with respect to their reading comprehension of print-based text, however the group using the strategy performed much better on the reading tasks in the study than the group that did not use the strategy (effect size = 1.08). A structural equation model (SEM) model for successful reading comprehension of web-text was tested from which it was determined that the use of a metacognitive strategy for processing cognitive strategies made a greater contribution than just possession of the cognitive strategies, while the usability features of web-text, such as navigability, discourse features, presence of multi-media elements and general appearance, made a negative contribution. This thesis provides details of the WWW SSURF strategy and its implementation and articulates practical implications for the classroom practitioner using the Internet as a source of authentic materials for their participants, and questions that merit future research.

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CHAPTER 1

RATIONALE AND OVERVIEW

Why is it that students who are normally regarded as being "good" readers of print-based text may not necessarily be good readers of web-text, that is, material sourced and accessed on the Internet? Why is there often a greater expectation on the part of students that teachers would come and help them out with answers to questions when reading material on the Internet, than when they are reading print-based text? Why is it that teachers themselves often seem to have difficulty "reading" when using this electronic medium? Personal observation gave rise to these questions which then became the stimulus for this research.

This study sought to demonstrate a pragmatic approach to the task of raising students' reading comprehension ability for web-text through the use of an acronymous metacognitive learning strategy, WWW SSURF, in which each letter of the acronym assists the user to recall a key word associated with each step of the strategy. This type of strategy has been used successfully to promote reading comprehension skills for print-based text. Its use as a strategy in connection with reading comprehension for text sourced on the Internet has not been reported in the research literature thus far. Simplicity of use is intrinsic to the design of the strategy, with teachers easily able to introduce and implement the strategy with their students.

The approach taken in this study is to draw together two disparate lines of research and to synthesise them into a cohesive model of successful reading comprehension for reading web-text. Looking through the lens of the "consumers" of web-text (the readers) the study addresses the preliminary research question, "Is the use of an acronymous metacognitive learning strategy a contributing factor to the ability to read web-text with understanding?" The study goes beyond a simple "yes" or "no" response and uncovers evidence of "what" and "how" the WWW SSURF strategy makes its contribution to the reading comprehension process. This, on its own however, is only part of the story. By combining the consumers' lens with that of the "producers" of web-text (the writers), the study then addresses the primary research question "What factors contribute to the ability to read web-text with understanding?"

The following section "Rationale" outlines the grounds for the research reported in this study. A general outline of the scope and impact of this research follows in a section titled "Overview". A brief "Summary" provides a bridge that orients the reader to the pathway through the thesis.

Rationale

Carol Weir returned to the classroom as a middle school reading teacher after an absence of twelve years. She realised that reading was a passive exercise for her students in the sense that they just "ran their eyes" over the print and hoped that they had understood it. Comprehension questions after they had finished reading showed that they had not understood (Weir, 1998). Maitland (2000) affirmed this is a well-known phenomenon, and also reported widespread observation by reading teachers of students who are disengaged and inattentive. Some of these students have little or no understanding of what they need to do in order to become better readers.

The construct of reading and *literacies* has been expanded to include electronic media, especially material resourced from the Internet (Hobbs, 2001). The Internet provides ready access to content relevant source material (i.e., authentic reading materials), and is intrinsically appealing for both students and teachers (Alexander, Kulikowhich & Jetton, 1994). The environment in which web-text is located brings additional complexities for the reader to deal with. Multimedia elements, for example, can be distracting, and the skills needed to *navigate* through the maze of information can prove to be significant obstacles for the reader (Coiro, 2003; Eagleton & Guinee, 2002; Stylianou, 2003). As web-based resources also include text, the *readability* of the text is also an issue (Johnson & Johnson, 2005; Zakaluk & Samuels, 1988). Successful reading comprehension of print text and web-text share some issues in common. Issues of readability, for example, for print-based text are seen to have their counterparts in web-text (Pope, 2005), as does *navigability*, the task of finding one's way around the material being read. Readability, essentially, the ease with which text can be read, and navigability, the ease with which users can find their way around web pages, can themselves be seen as dimensions within a broader construct, *usability*, the ease with which a Web user can complete a specified task (Arney, Jones & Blankenship, 2003; Lee, 1999; MacGregor, 2004), and can be examined within this framework.

Two related lines of research have developed historically which give insight into possibilities for helping students to improve their comprehension of print-based text: (a) the use of instructional strategies to help improve students' comprehension and (b) the understanding of the processes and strategies used by proficient readers (Asselin, 2002). Of particular interest to this study was that acronyms appear to help make strategies easier to remember (Katims & Harris, 1997).

The purpose of this study was to build on the foundation provided by previous research into the use of acronymous strategies to facilitate reading comprehension for print-based text, and to extend it into the relatively new domain of web-text. A further area of interest in this study was the nature of a strategy itself. Existing research tends to look at "whether" a particular intervention works, as opposed to “how” it works. Annemarie Palincsar’s multi dimensional instructional strategy for learning, “Reciprocal Teaching”, for example, consists of the use of the four cognitive strategies: predicting, questioning, clarification and summarizing (Duffy, 2002; Palincsar & Brown, 1984). This well known learning strategy, devised in the 1970’s, is still in use in schools today. While it is known that the strategy works as a whole and it is used with confidence in schools, there is no reported research into the individual contribution that each of the four component cognitive strategies makes, or whether these individual component strategies are used in the same way by different students.

Existing models of successful reading comprehension tend to focus on the effectiveness of a particular learning strategy, while models of web sites that can be “successfully read” tend to focus on the usability features of the web site. At this time there appears to be no published research that models successful reading comprehension of web-text in terms of these two dimensions, the cognitive strategy skills used by the consumer and the usability characteristics of the web site. It is also unclear as to the part that reading comprehension performance for print-based text plays in successful reading comprehension for web-text.

Strategies reported in the literature used to facilitate reading comprehension for print-based text, while in many ways encouraging, have been very restrictive in others. Some of the strategies employed were highly context-specific, while others were complicated in the sense that there was a relatively long period of time involved for transference to the students. In addition, the implementation of strategies has been found to be subverted, albeit unwittingly, by inadequate teacher understanding. Further, the subjects of the investigations have frequently been those groups of students who are known to show the most improvement when a strategy is tried.

From research into reading comprehension of print-based text, there is evidence that some strategies may be better than others. There is little hard evidence as to "how much" better or "why" any particular approach works at all. There seems to be just an underlying assumption that if struggling readers can be taught to do what fluent readers do, then their reading comprehension ability should improve. It is not clear in a number of studies whether any improvement in reading comprehension is due, entirely or in part, to factors such as: students getting more attention in class than they normally get; students' withdrawal from a normal classroom, to an atypical environment; or the person delivering the intervention not being a student's regular teacher, and the student is able to build a different relationship with that person.

The strategy used in this study, through its supporting materials, was designed to be "user friendly" for both the teacher and the students, in that it would be easily assimilated by students in its intended form in a realistic time frame. In order to try to gain some insight into the implementation of strategy instruction in a setting that the normal classroom teacher experiences, the original study was undertaken in a regular instructional setting characterised by: a learning situation that was not contrived, in the sense that the students' task was part of their regular classroom programme; source materials to be used by the students were not prepared/constructed especially for use in the study; a familiar instructional setting with the students working with their teachers in their usual class groups; and instruction that was to be given by the normal classroom teacher, the researcher not having contact with the participants during the course of the study. The replication study was altered to control for "teacher effect". The researcher, rather than the classroom teachers, introduced the strategy to the students and supervised them during the study while they were using the computers. This, however, introduced an added complication known as the "experimenter effect". This is discussed in Chapter 3 "Methods and Procedures".

Overview

The study was undertaken in two phases. In the initial phase two complete class groups took part, each group receiving instruction in the use of the WWW SSURF strategy. In the second phase, a replication study, one class received the strategy training, while a second class completed the same tasks, but without the benefit of the strategy. Classes were drawn from a New Zealand Intermediate school with students' ages in the range 11 through 13 years. The classes, overall, were different in terms of the participants' average reading comprehension ability for print-based text.

The data gathering tools used in the study included two Assessment Tools for Teaching and Learning (asTTle) reading comprehension tests in the first phase study and two Progressive Achievement Tests (PAT) reading comprehension tests in the second phase study. These nationally normed tests provided comparative information about the groups involved in the study, as well as those not in the study, and were undertaken as part of the school's scheduled testing programme. In order to gather baseline data about use of strategies prior to the study, but without providing foreknowledge of specific aspects of the WWW SSURF strategy to be used, an existing tool, the Motivated Strategies for Learning Questionnaire (MSLQ), was adapted with the permission of its creators, to meet the needs of this study. Only a selection of the questions in the original MSLQ questionnaire were needed for comparison with the results of the WWW SSURF strategy self-reflection questionnaire, and the questions had to be re-worded to be more age-appropriate. The self-reflection questionnaire was used to monitor the use of different strategy elements during and after the study. The data generated by these tools were screened for reliability by computation of Cronbach's alpha, and the tools themselves were validated through a process of Confirmatory Factor Analysis (CFA). The details of these validation processes are discussed in Chapter 4 "The Preliminary Research Question: results and discussion" (data reliability) and Chapter 5 “The Primary Research Question: results and discussion” (validation of tools) respectively.

The elements of the acronymous metacognitive strategy used in this study were derived from two sources: a survey of existing literature, through the lens of the consumers, dealing with reading comprehension of print-based text and, similarly, through the lens of the producers, with its focus on web-based text. This is extensively back-grounded in the following chapter, Chapter 2 “Literature Review". The letters of the acronym WWW SSURF key the user of the strategy into a selection of task oriented cognitive strategies and processes known to assist reading comprehension from these two perspectives. The first three letters “WWW”, for example, respectively refer to: “What do I already know?” (prior knowledge), “What am I looking for?” (key words and phrases) and “Where can I go to find it?” (locating appropriate websites and pages within those sites). The strategy is presented as a “package” consisting of the acronymous metacognitive learning strategy WWW SSURF, a workbook to keep the strategy in front of the participants throughout the study and a set of instructions for teachers to use to introduce participants to the strategy. The data tools and the WWW SSURF strategy are discussed in Chapter 3 “Methods and Procedures”.

The results obtained from the use of the WWW SSURF strategy are documented in Chapter 4. Evidence is presented, through the lens of the consumers, confirming the effectiveness of the WWW SSURF strategy. Patterns in the data are confirmed through the use of appropriate statistical tests. This chapter specifically deals with the preliminary research question “Is the use of an acronymous metacognitive learning strategy a contributing factor to the ability to read web-text with understanding?” Chapter 5 begins by investigating the reading age associated with the textual component of the web sites mainly used by participants in this study. Other aspects of “usability” are then quantified, using an appropriate rubric. Through the lens of the producers an understanding is arrived at concerning the essence of web sites and how this impacts on the process of reading comprehension. Combining the two lenses brings a fresh perspective to our understanding of what is involved in successfully reading web–text. This exploratory study allowed a conceptual structural equation model for reading comprehension of web-text to be tested. The validated model directly addresses the primary research question "What factors contribute to the ability to read web-text with understanding?"

Summary

This exploratory study addresses the task of improving reading comprehension outcomes for the reading of web-text. It breaks new ground in two important areas, one functional, the other theoretical. In implementing the acronymous metacognitive learning strategy WWW SSURF the study demonstrates a pragmatic approach to the task of raising reading comprehension ability for web-text and establishes that the use of a class of strategy known to provide results in the domain of print-based text can also apply in the realm of web-text. Intervention strategies that are easily understood and readily implemented are likely to find favour with classroom practitioners. The specification and validation of a structural equation model is a major step forward in being able to understand the scope of the problem of reading web-text successfully. The value of such a model lies in the messages that it has both for reading comprehension practice in the classroom and also for potentially "profitable" further lines of enquiry. The results reported in this thesis have both practical and theoretical significance.

The study is described in the following six chapters. Chapter 2 reviews the research relating to reading comprehension for print-based text, with particular attention being paid to cognitive and metacognitive strategies and the implementation of strategies in classrooms (the consumers' lens). It continues with a consideration of the nature of web sites themselves and reviews the research relating to reading web-text and the usability of web sites (the producers' lens). Chapter 3 details the methods and procedures followed in this study. The tools used to gather data are discussed, as are the details of the WWW SSURF acronymous metacognitive learning strategy and its implementation. Chapters 4 and 5 present the results of this study for the preliminary and primary research questions respectively, through analysis of the data and discussion in the context of contemporary research. Chapter 6 recaps the findings of the study and articulates suggestions for both future research and classroom practice.

CHAPTER 2

LITERATURE REVIEW: GLASSES HAVE TWO LENSES

Reading comprehension is a complex phenomenon. For more than 30 years, research into reading comprehension exclusively focused on print-based text. In the last decade, the focus has progressively broadened to include web-text; that is, materials sourced on the Internet. Research into both of the domains, print-based text and web-text, has been characterised by two *lenses* or perspectives: that of the *consumers* and the *producers*. The consumers are the readers, who typically focus on "how do I understand this?" while the producers are the writers, who typically focus on "how do I make this understandable". The readers want information; the producers want the readers to use *their* information.

This chapter examines the significant understandings that have emerged from research through the lens of the consumer and the lens of the producer. These understandings, in their turn, have informed the research questions and research processes which are embodied in this thesis.

The first major section, "Reading Comprehension and Print-based Text" begins by exploring our present understanding of both the readers (consumers) and also the reading process. Initially concerned with narrative print-based text, this discussion leads to a consideration of *cognitive strategies* and *metacognition*, and then shifts to how our understanding of reading comprehension is put to use to scaffold the process of learning 'how to read' through the use of *learning strategies*. A particular class of learning strategies, the *acronymous metacognitive learning strategy,* becomes the focus of our attention.

The discussion then shifts to the perspective of the writers (producers) with the focus now predominantly on expository text. Expository text becomes progressively more important as students move up through the school system. An overview of the developing interest in expository text leads to the deliberate first attempts by producers of print-based texts to match their products to the consumer – a consideration of the *readability* of text. We will see that from an initial focus on readability and *reading ages,* awareness of the problems associated with reading expository text has expanded to include the *structural* elements of content area texts.

In the second major section, "Reading Comprehension and Web-text", we see that there are parallels to be drawn between the print-based text and web-text scenarios, and that our understandings about reading comprehension in the case of print-based text are helpful in our dealings with web-text. This section begins with an overview of our developing insight into the nature of the web-based materials themselves – the products of the writers (producers). A discussion about the readability of web-text leads on to the wider consideration of the *usability* of web-text.

We then return to the perspective of the readers (consumers) and explore the understandings gleaned from research into the task of reading web-text with understanding. Further discussion on the use of cognitive strategies and early steps in putting strategy instruction to use in the web-text environment, leads us to consider the state of contemporary research in relation to the task of improving reading comprehension outcomes for the readers of web-text.

The final major section "Reading with a purpose, or reading purposefully?" resolves the links between the very substantial contribution of many others, and the contribution of this researcher, laying the ground work for the WWW SSURF acronymous metacognitive learning strategy that is fully described in the following chapter, "Methods and Procedures".

The Consumer's Lens: How do I Understand This?

Research into the needs of the consumers, or readers, of print-based text has largely focussed on *narrative* text. There have been distinct phases of research. A focus on the characteristics of skilled readers, especially when contrasted with the characteristics of those less skilled, first led to an understanding of the place of cognitive strategies in the successful reader's toolbox and, later, highlighted the importance of the metacognitive processing of those strategies. These themes are developed in the following three sections: "Reading comprehension and narrative text", "Strategy Instruction", and "Cognitive Strategies".

Reading Comprehension and Narrative Text

This section discusses insights arising from research into disengaged students, the nature of reading comprehension, and the use of instructional strategies and processes used by proficient readers. Some research into the reading of expository text, which contrasts unsuccessful and successful readers, is also relevant to this discussion. The significance of the research discussed for this study is that the difference between successful and unsuccessful reading lies in the use of comprehension strategies. The strategy used in this study makes use of a selection of cognitive strategies, informed by research, as being appropriate to the nature of the task of reading web-text.for the present study.

> We define reading comprehension as the process of simultaneously extracting and constructing meaning through interaction and involvement with written language. We use the words *extracting* and *constructing* to emphasise both the importance and the insufficiency of the text as a determinant of reading comprehension. Comprehension entails three elements: the *reader* who is doing the

> comprehending, the *text* that is to be comprehended and the *activity* in which comprehension is a part … These three dimensions define a phenomenon that occurs within a larger *socio-cultural* context that shapes and is shaped by the reader and that interacts with each of the three elements.
>
> (Snow, 2002a)

Comprehension is not just a matter of knowing the words. Carol Weir (1998) returned to the classroom as a middle school reading teacher after a twelve-year absence. She discovered during her years of 'information blackout', that a new idea about the reading process had emerged. This idea embodied the notion of readers' active engagement in the reading process; self-checking for understanding as they read. She realised that reading was a passive exercise for her students, in the sense that they did not monitor and redirect their activities during the reading process to reach a desired goal. They 'ran their eyes' over the print and hoped that they had understood it. Comprehension questions after they had finished reading showed that they had not! In this sense, her students did not take *ownership* of their reading. We will pick up this vignette in a later section "Scaffolding Learning" to see how Weir addressed this; Maitland (2000) affirms that this phenomenon is well known. Reading teachers, across all levels of schooling, encounter students 'staring into space', disengaged and inattentive. The students have little or no understanding of what they need to do in order to become better readers.

Comprehension is the process by which an understanding is arrived at through the construction of an internal representation of the text (or other material) that is being read. The process occurs at several levels, with the outputs of each level interacting with the others. The reader first encounters the words, sentences and paragraphs making up the text. This verbal representation is converted into chunks of text information that are stored in memory. These chunks, referred to as *text propositions*, are a representation of the original text in a form that, in turn, can be used to modify the reader's understanding of what is being read. The resulting modified world knowledge is a further level of representation that can be used to modify all previously constructed levels of understanding, or influence those levels yet to be constructed [through further reading] (Hacker, 1998b).

The years 1975 – 2000 produced two main strands of research into reading comprehension: (a) instructional strategies to improve students' comprehension, and (b) the processes used by proficient readers (Asselin, 2002). Early studies linked the depth and structure of a reader's background knowledge to their effective understanding of text read. A further development linked the construction of meaning to chunks of key ideas in the text and connected those chunks to a greater 'whole'. Asselin suggests that these two dimensions are combined when the reader is called upon to make an inference (the process of requiring readers to use their background knowledge to make connections between chunks of ideas).

The substantial body of published research into the problems of reading print-based text, and the processes used by expert readers, has literally "opened our eyes" to the enormity of the task of becoming a proficient reader. Students begin at school "learning to read", but it is not very long before the whole thing is turned around and they must "read to learn". The demands for successful performance in content related coursework increase sharply as students make the transition from primary to middle school and again on to secondary school and beyond. The major sources of information are text based, even when sourced electronically from the Internet. In the latter, 'hyperlinks' which enable the reader to 'jump' through cyberspace and the plethora of multi-media 'enhancements' may make the reading comprehension process more difficult, requiring additional skills and strategies (Spires & Estes, 2002). We will return to this point in the second major section "Reading Comprehension and Web-Based Text".

The structure of the material to be read is not the only aspect to cause difficulty for students. The language used may also be a barrier. Ogle and Blachowicz (2002) assert that much of the trouble students have with comprehending informational material relates to the specialised vocabulary that communicates major concepts. Much of the language of expository material is greco–roman based. Technical terms, with precise meanings, are frequently rooted in classical languages. These words are 'foreign', not readily integrated into the common language spoken in the world outside of school. They 'look' unfamiliar and 'sound' strange. In this type of material the vocabulary and the structure of the text is often more difficult to understand than that found in narrative material. A further difficulty is the context. The context is often beyond the reader's experience.

Students who appear to be reading but have difficulty with recall when asked questions about the content of the reading are passive readers. They are not able to readily use words as sources for information, and tend to rely more heavily on information from contextual sources to gain meaning (Bonds, Bonds, & Peach, 1992). They do not ask themselves whether what they are reading is 'making sense'. Poor readers fail to recognise that they do not understand. They just 'read'. Vaughn, Gersten and Chard (2000) assert that poor comprehension is largely due to students' failure to read strategically and spontaneously to monitor their understanding of what is being read. This has implications for classroom practice. Instruction relating to locating information is typically not very effective, unless attention is also given to cognitive issues. Dreher (2002), Simpson and Nist (2002) have observed that *successful* students identified concepts they understood, and those they did not, and then used that information to guide their reading – in contrast to *unsuccessful* students who just read to locate information or memorise details. Successful students also made mental or written plans that "forced" them to keep up their reading on a regular basis.

Unsuccessful readers are characterised in the literature as thinking that *understanding* comes from "getting the words right". They use low level strategies such as creating simple lists and using rote memory; they see success and failure as the result of luck or teacher bias (Knuth & Jones, 1991). Block and Pressley(2003) suggest that successful readers generally do all of the following when they tackle text: (a) generally read from the beginning to the end although they sometimes jump ahead in anticipation of information or look back to clarify an idea, (b) recognise information that is relevant, (c) anticipate what might be in the text based on their prior knowledge, (d) self-monitor their understanding as they read, and (e) reflect on what they read; how they might use the ideas in the text for example. More specifically, good readers make use of a variety of comprehension strategies. We will return to this point in a following section "Cognitive Strategies".

Strategy Instruction

This section briefly reviews three different historical pathways identified with research into reading comprehension and particularly considers research into teacher-directed strategy instruction. The significant of this research for the present study is that teachers can effectively model/scaffold learning strategies for students as they learn to become successful readers. The role of the teacher in this study is part of the strategy design.

Research into effective instructional strategies has evolved along at least three pathways: (a) the use of single instructional strategies, (b) the use of multi-dimensional strategies, and (c) the use of teacher-directed instruction to teach the strategies. Single instruction strategies found to be effective include activating background knowledge, asking questions during reading, and constructing pictures during reading and summarising. Multi-dimensional strategies combined two or more of the above strategies. Annemarie Palincsar's Reciprocal Teaching (Duffy, 2002b; Palincsar & Brown, 1984), for example, consists of predicting, questioning, clarification and summarising. These strategies are designed to encourage students to think strategically and they more accurately reflect the complexity of the nature of comprehension than do single instruction strategies. They also take more time to learn.

Teacher-directed instruction studies looked at the effect on students' reading abilities when teachers modelled reading strategies, such as 'thinking aloud'. After the teacher demonstrates a strategy in context, the students are guided to practise the new strategy with the teacher assessing their learning and continually modelling and explaining as necessary. The process ideally continues until the students are able to use the strategy independently. The approach was found to be so effective that the concept of teaching reading comprehension was broadened to encapsulate the mental and motivational processes used by proficient readers. This approach construes the teacher-student relationship as being one between expert and apprentice. Teachers use their own observation of expert performance to *scaffold* students' new knowledge and skills and to guide them through to independent application. These themes are developed in the following sections "Cognitive Strategies", "Metacognition", "The Use of Learning Strategies to Scaffold Comprehension Development", and "Acronymous Learning Strategies".

Cognitive strategies

This section considers examples of cognitive strategies reported in the research literature. Research suggests that cognitive strategies are often used in combination and that 'excellent reading' progresses through a sequence of phases. Some gaps in the research are also identified: application to different genres (text types), level of text difficulty, and influence of teacher characteristics, for example. The significance for this study is that a planned sequence is at the core of a successful strategy. In addition, this study investigates/addresses the identified gaps.

Readers can acquire reading comprehension strategies informally, to some degree, but the direct teaching of comprehension strategies produces demonstrable results. Gerald Duffy (Feb 2006a) uses the term *explicit teaching* which he defines as (a) providing *how to* information, and (b) getting students consciously to use that information. A variety of cognitive strategies have been identified as being effective in promoting reading comprehension skills (National Reading Panel, 2000; Trabasso & Bouchard, 2002). Seven types of strategy thought to be most effective are:

1. Comprehension monitoring, where readers learn how to be aware of their understanding of the material they are reading
2. Co-operative learning, where students learn reading strategies together
3. Use of graphic organisers, where readers make graphic representations (maps) of the material
4. Question answering, where readers answer questions posed by the teacher and receive immediate feedback
5. Question generation, where readers ask themselves questions about the story they are reading
6. Story structure, where readers are taught to use the structure of the story as a means of helping them to recall story content
7. Summarisation, where readers are taught to integrate ideas and generalise information from the text

Students can learn these strategies and their use fosters active, competent and intentional reading. What this line of research did not disclose, however, was: (a) the extent to which the different strategies applied to different types of text genres, (b) whether the level of text difficulty mitigated the effectiveness of strategy use, and (c) the extent to which teacher characteristics influenced successful instruction (National Reading Panel, 2000, p. 15). In addition, successful acquisition of cognitive strategies pre-supposes that students could read the text fluently, thus freeing up cognitive capacity for understanding, and that they had good working vocabularies (Pressley, 2001). A different perspective on reading comprehension integrated the role of *prior knowledge, strategic processing* and *student interest* into a *model of domain learning* (MDL) (Alexander, 1997; Murphy & Alexander, 2002). Prior knowledge can be in the form of subject-matter knowledge or strategic knowledge. The latter refers to a form of procedural knowledge deliberately employed to overcome comprehension difficulties and involves both the use of cognitive strategies, such as those mentioned above, and metacognitive strategies to monitor and regulate one's learning.

Cognitive strategies are often used in combinations as the reader engages with the text, and "excellent reading" (Pressley, 1998, p. 51) progresses through a sequence of phases: (a) before reading, during which the reader determines the purpose for reading the text; (b) during reading, where the reader determines what to read first, begins to relate what they are reading to their prior knowledge and continues on, invoking a variety of cognitive strategies; and (c) after reading, where the reader may have decided to re-read parts that seem particularly important and may "lock in" their new knowledge through such devices as making a summary. Engaging with text has an emotional as well as a functional side. Readers express feelings as they read, consciously accepting or rejecting the text as well as the ideas expressed in the text (Pressley,1998). This is the student interest dimension of the MDL model.

Excellent reading is metacognition in action. In the following section "Metacognition" we explore the nature and role of metacognition. A selection of studies helps us to clarify our understanding of the distinction between "cognition" and "metacognition", and provides evidence that metacognitive strategies are effective in improving learning outcomes for students in the area of reading comprehension.

Metacognition

This section considers research related to the nature of metacognition, metacognitive strategies, and the importance of focussing on the processes involved. The significance of this research for this study is that the strategy used in this study is designed to scaffold students' thinking at the process level.

A study undertaken by Groller, Kender, and Honeyman (1991) compared the results of a reading comprehension exercise between three groups of students: one group read, a second group read using an "advance organiser" and a third group read using both an advance organiser and also a "metacognitive strategy". Forty-five eleventh grade students were selected at random from a group of 135 students in a High School in Pennsylvania. The school population was predominantly white with 'sizeable' numbers of students from African-American, Asian and Hispanic backgrounds. The students in the study were drawn from a population whose reading comprehension levels were above the 80th percentile on the test being used for their peer group, and randomly assigned into three groups of 15. One group was taught using advanced organisers and 'metacognitive' strategies. They were to be aware of their thinking processes as they read, to monitor their comprehension and their plan of action as they read, and to evaluate what they understand when they finish reading. A second group was taught to just use an advanced organiser while the third group studied the text without additional aid. The experiment was repeated three times over three months. Each phase involved activities over several days, culminating in a comprehension test. The comprehension tests required immediate short answer recall. No difference in achievement was found between the second and third groups, but there were significant differences between the three groups of students. The use of advance organisers *with* metacognitive instruction yielded significant gains and the benefits increased as students practised using the strategies.

Higher order processing skills become increasingly important as academic demands increase. Vaughn et al. (2000) examined intervention studies that used measures of higher order processing. The studies they analysed included adolescent participants with learning disorders (LD). Higher-order processes were represented in the studies surveyed by measures of metacognition, attributions, understanding, verbal problem solving, mathematical problem solving, and speed of processing.

With the focus on students with LD who were in middle or high school programmes, effect sizes were calculated for 58 studies. The instructional models represented in these studies were placed in four categories: (a) strategy instruction only, (b) direct instruction only, (c) a combined model that included components of both strategy and direct instruction, and (d) non-strategy/non-direct models (i.e., none of the previous categories). The average effect size of the 58 studies was 0.82, suggesting that the instructional approaches designed by the researchers to improve higher-order skills of students with LD were quite successful. Greatest gains were realised in the area of metacognition, with an effect size of 1.19. The smallest gains were on measures of attribution (teaching students to attribute their successes to their own skill, rather than to luck or someone else's assistance), with an effect size of 0.38.

This analysis does not argue that metacognitive strategies are the only types of strategy that are effective in leading to improved learning outcomes for students in the area of reading comprehension. There is, however, a demonstrable case for preferring metacognitive strategy instruction to the other alternatives.

Hofstadter's (1979) observation that metacognition was a process by which "one jumps out of the system to observe the system", deftly captures its essence. Others do not necessarily accept the definition. Hacker (1998a), for example, thought that metacognition was difficult to describe. He characterised the process of thinking about one's own thoughts, which are tied to the individual's internal representation of reality, as a "fuzzy" concept. Shimamura (2000) none-the-less affirms that knowing about 'what we know' is at the core of metacognition. But, the question remains: how *do* we 'know'?

Every student is unique. This poses a tremendous challenge for teachers. The realisation that no one learning strategy will work for every student has spawned a large amount of research. Green (1999) lists brain structure, multiple intelligence, learning styles, emotions and learning, music and cognitive development and brain-based learning in support of this contention. Gardner's (1993) theory of 'multiple intelligences argued that people have many different mental strengths and contrasting mental styles and other studies support the contention that the nature of intelligence is not genetically fixed, that intelligence can be taught. Perkins (1995) S*cience of Learnable Intelligence* holds that strategies for problem-solving, decision making, creative thinking and metacognition are significant in enhancing cognitive development and that ways of thinking are both teachable and learnable. Sylwester (December 1993/January 1994) examined other lines of research that have looked at 'thinking' as an integrated body/brain system and concluded that the search for meaning takes place by patterning, which may be modified through improved self-esteem and social interaction. Learning involves both conscious and unconscious processes, thus students need to reflect on *how* and *what* they learn in order for learning to develop personal meaning. Studies by Corcoran (1986), since replicated by others, revealed that within the nursing profession, for example, novices tended to use more cognitive structuring and little analytical processing when clinical information was complex. Further insight into metacognitive practice is provided by Kuiper (2002) who envisaged current metacognitive theories as having their roots in three diverse constructs: information processing (i.e., data processing in memory), behaviourism (i.e., response strengthening), and constructivism (i.e., learning from naturalistic settings). Using this "broad-brush canvas", Kuiper found that the promotion of reflective practices improved cognitive thinking abilities during problem solving and decision-making and, further, situated learning studies revealed that interpretation of experience, reflection and self-evaluation impacted on metacognitive gains.

A model of metacognition and cognitive modelling proposed by Flavell (1979), was developed from answers to research into questions about memory. In particular, Flavell studied how the processes of information storage and retrieval are controlled. According to this model, a person is able to control a 'wide variety of cognitive enterprises' through the actions and interaction of four classes of phenomena: metacognitive knowledge, experiences, goals (or tasks) and actions (or strategies).

Metacognitive knowledge is further categorised as knowledge of: (a) person variables, (b) task variables and (c) strategy variables. Knowledge of 'person' includes general knowledge about how humans learn and process information as well as individual knowledge of one's own learning processes. Livingston (1997), by way of example, notes that some people know that they work better in the morning, others in the evening. Some like to work in a quiet place, others like background music. Knowledge of 'task' includes knowledge about the nature of the task and the type of processing demands it will place on the individual. For example, one might anticipate that reading and understanding a novel may take less time than reading and understanding technical literature such as a psychology text. Reading and understanding material in print form may take less time than reading similar material in an electronic format, such as via the Internet. Knowledge about 'strategy' variables includes knowledge about both cognitive and metacognitive strategies, as well as conditional knowledge about when and where it is appropriate to use such strategies.

Metacognitive strategies are sequential processes that one uses to control cognitive activities to ensure that achieving a cognitive goal, such as understanding a piece of text, has been met. These processes help to regulate and oversee learning. They consist of planning and monitoring cognitive activities as well as checking the outcomes of those activities. Self-questioning is a metacognitive strategy that can be used to ensure that the cognitive goal of comprehension is met. Having just read the last few paragraphs of this literature review, for example, I might ask myself "What is the difference between cognitive and metacognitive knowledge?" I might decide that I already know the answer to the question, or I might re-read the text specifically looking for information to answer the question. Another option might be to set the text aside and look for other sources of information that might help my understanding, or, I might just decide to read-on. Maybe the answer to the question will be found further on in my reading. In fact, the answer to this particular question may be that cognitive and metacognitive knowledge are not different, the distinction lies in how the information is used. Self-questioning, for example, can be seen as a cognitive strategy when it is used as a means of obtaining knowledge, but as a metacognitive strategy when used to monitor ("Do I understand? "Have I completed my task?") goal completion.

A different line of thinking sees that a distinction can be made between cognitive and metacognitive levels. The former involves knowledge of the world and strategies for using that knowledge to solve problems. The latter concerns monitoring, controlling and understanding one's knowledge and strategies. Metacognition can therefore be understood as the monitoring and controlling of a lower-level thought process by a higher-level thought process (Hacker, 1998b) or as an executive or supervisory system that enables top-down control of information processing (Shimamura, 2000). Neither process occurs in isolation.

Much of the research into problem solving has confirmed that some kind of 'thinking aloud' is beneficial during both practice/learning and the transfer of learning to other tasks. Berardi-Coletta, Buyer, Dominowski, & Rellinger (1995) note that various explanations of why verbalisation works have the common theme that it focuses attention on and enhances problem-domain knowledge. In other words, problem-solvers are made to think more carefully about the relevant features of problems and the different steps (tasks) needed to find a solution when they articulate the material.

Asking for explanations, however, requires participants to bring into their short-term memory information, which is not normally stored there. To do this, intermediate (secondary) processes must be activated. A distinction can be made between procedures that articulate that which is stored in short-term memory and procedures that take stored data as their input and then perform some intermediate processes on the data to produce the information requested by verbalisation of instructions such as “state your reasons”. Ericcson and Simon (1984) conceive of a ‘central processor’ that controls and regulates all non-automatic processes. It can be envisaged as switching control from the on-going cognitive processes (which can verbalised in a think-aloud fashion) to the metacognitive processes directed at looking at the on-going processes. Several terms, in fact, are used interchangeably in the literature. ‘Self-regulation’, ‘executive control’, ‘meta memory’ or, simply, ‘thinking about thinking’ all share the concept of the role of executive processes in the overseeing and regulation of cognitive processes.

Berardi-Coletta et al. (1995) have documented three studies, which were performed to test the hypothesis that it is a metacognitive, process-level focus that is responsible for improved problem-solving performance. In the first study, 109 undergraduates were randomly organised into five nearly equal groups (four verbalisation and one silent control) and solved four practice versions of the ‘Tower of Hanoi’ problem (which involves restacking discs on spikes in the shortest number of moves, following certain rules). They then solved a fifth, more difficult transfer version of the problem. In the second study involving 64 undergraduates, two verbalisation groups and one silent control group served to replicate the findings from the first experiment and show that they could generalise to a quantitatively different type of problem (a ‘card problem’). The third study, in which 40 undergraduates were organised into two groups, also served to replicate the results of the first experiment. This time the participants were asked to think about but not verbalise their responses to the experimental prompts. The purpose of this study was to demonstrate that focusing the participants on the process level would produce the desired effect in the absence of verbalisation.

Results from the experiments demonstrated two basic findings with respect to problem-solving and solution transfer: (a) the participants did not spontaneously focus on the process by which they attain the problem solution, and (b) if the participants are forced to focus on this process, transfer effects are positive. When information regarding the problem solution is acquired/discovered by the participant via metacognitive processing, an understanding of the process by which a problem may be solved is attained and is transferable to other problems. The participants who were asked to focus on process-level information performed noticeably better in the experiments than other participants. Answering questions such as “why did you do that?” involved a shift in attention from focussing on aspects of the problem itself to a focus on what one was doing to solve the problem.

To return to our earlier story about Carol Weir: she began to think about metacognition, not as another skill, but as a fundamental understanding about literacy, which she expressed as enquiry questions: “How can we know that we understand what we read? What can we do to make sure we understand what we read?” In order to get her students starting to think during the reading process she decided on a strategy of “interrupting” their reading. Cutting and pasting, she created a series of stories with questions embedded in the text at a point she felt knowing the answers was important to understanding subsequent developments. Questions embedded at the beginning of a story, for example, drew reader’s attention to noticing details of setting and character to lay the foundation for understanding plot development. The students could thus build meaning incrementally as they worked their way through a story.

The questions were chosen to emulate the metacognitive strategies employed by skilful readers. Opportunities to summarise, self-question and predict, for example, were frequently provided. Talking about the stories was also considered important. Over a cycle of three stories, the first few pages of each story was read aloud, the students collaborated on answers to the embedded questions. As the students became more comfortable with the process, the dynamics changed from a teacher-led group to working with a partner, to working alone. Carol reported a ‘clear awareness’ of metacognitive strategies by her students after the intervention. Pre- and post-tests using the Stanford Diagnostic

Reading Test for Reading Comprehension realised a mean change in grade equivalent of 1.7 years, representing an even greater improvement than might have been anticipated.

Underwood (1997) contends that skilled readers make most reading process decisions below the threshold of consciousness, especially when the material is familiar and written in 'ordinary' language. The reading experience is automatic, until the reader comes across a word, phrase, or an idea that is no longer 'transparent'. At that moment of uncertainty, the reader needs to be able to do something to get back into a reading 'flow'. In order to do this the reader needs to have formative assessment skill, that is, the capacity to self-monitor, self-assess and self-evaluate in order to locate and then fix a difficulty. Reading theorists call this particular formative assessment skill 'metacognition'.

Scaffolding Learning: Putting our Understanding of Reading Comprehension to Use

How do learners *learn*? Research has provided some definite answers to this question. There is convincing evidence for the direct teaching of strategies to facilitate the development of reading comprehension skills, particularly with respect to the reading of print-based text. An exploration of the nature of strategy instruction, in this context, leads into a discussion of acronymous metacognitive learning strategies of which the WWW SSURF strategy used in this exploratory study, and detailed in the following chapter "Methods and Procedures", is an example. These themes are developed in the following two sections: "The use of learning strategies to scaffold comprehension development" develops our understanding of obstacles surrounding the teaching of learning strategies, the value of teaching learning strategies, and the variety of learning strategies available; "Acronymous learning strategies" discusses the strategic flexibility of this approach, as evidenced by a variety of example strategies; the value of using this type of learning strategy is established; and, the algorithm used to create the WWW SSURF acronymous metacognitive learning strategy used in this study is detailed.

The use of learning strategies to scaffold comprehension development.

Research discussed in this section focuses on: the importance of a metacognitive culture where people are comfortable to acknowledge what they need to learn, supporting diversity in a learning community, student engagement, teaching styles, the importance of making the reading processes explicit, effect of strategy instruction, and types of strategies. The insights from this research provide the rationale for the use of a learning strategy in this study. The strategy is based on the evidence from existing research that there are effective, identifiable, cognitive strategies which can be taught to most students. The rationale for the particular choice of strategy used in this study is presented in the next section.

> The goal of comprehension strategies instruction is to increase comprehension by encouraging readers to be active in the ways good comprehenders are active.
>
> (Duffy, Feb 2006b)

Learning, whatever form it takes, is a social artifact. Jacobsen (1998b) noted that the comprehension process is facilitated, or hindered, by the thinking processes that a learner has acquired. These processes are a product of the learner's environment. This is elaborated on by Nash (2003) who talks about a 'cognitive *habitus*', a kind of abstract problem solving capability exercised in language-based symbolic information processing. He claims that there is incontestable evidence for such a human capability, 'almost indisputable' evidence that it is developed differentially in family environments, and 'every reason to believe' that it is exercised in the performance of academic schoolwork. He further argues that all intellectual performances depend on cognitive dispositions (mental properties) that are closely allied with an individual's neural development. If Nash is correct, there is good reason to believe that individual performance in reading comprehension *will* be progressed through metacognitive strategy training embedded in a supportive social classroom environment.

Research in recent years has in fact begun to emphasise the creation of social environments to support metacognition, as well as the integration of strategy training into the context of everyday social activities. Xiaodong (2001) notes that attention is being given to such issues as:

(a) how to create a metacognitive culture where people feel comfortable to acknowledge what they do not know,

(b) how to use a systems approach to design metacognitive activities,

(c) what it means for everyone to take on a helpful and intelligent role in a community,

(d) what it takes to help students develop deep learning principles that can apply across different curricula and domains, and

(e) how to support diversity and metacognitive discourse in a community

We want to engage students effectively in reading comprehension. Engaged literacy learners are motivated - they *want* to read. When students read merely to complete an assignment, with no sense of involvement or curiosity, they are being compliant by conforming to the demands of the situation rather than their personal goals (Guthrie, 1996). They are not likely to become life-long readers. Educating for literacy engagement involves linking students' intrinsic motivations to classroom activities – through 'engaging classroom contexts'. Research affirms that strategy use increases self-regulation within the student which results in improved performance and enhanced self-concept (Jacobson, 1998a).

Concept Oriented Reading Instruction (CORI) is an example of a strategy, which aims to fuse literacy activities with real-world experiences and interdisciplinary content. The details of this particular strategy are not as important to this discussion as is its core philosophy, namely, that engaging classrooms are:

(a) observational, observing the real world – livings things, events, people

(b) conceptual, developing explanations for the observations

(c) self-directed, some latitude is given for students to choose pathways in learning activities

(d) strategic, explicit support provided for strategy learning

(e) collaborative, social construction of ideas and strategies within the classroom community

(f) self-expressive, students are able to represent their knowledge or imagination in ways they select, and

(g) coherent, instructional activities are integrated through a concept/theme

Strategy instruction holds much promise in the fight to improve reading comprehension standards. Working with students to encourage/help them take control of their own learning requires timely formative assessment, couched in language that that will encourage self-direction. Teachers must become patient coaches.

To accomplish this, Maitland (2000) asserts that a change in teacher mind-set is fundamental. Guthrie and Ozgungor (2002) who pioneered the CORI model concur with this. They assert that teachers need to think ‘a bit differently’ about reading comprehension instruction and how this might affect their teaching practice. Rather more bluntly, Flick and Lederman (2002) argue for instruction in reading comprehension, not just instruction in the ‘skills of learning to read’.

Research into classroom practice finds that teachers rarely make explicit the processes involved in reading. Hall, Myers, & Bowman (1999) suggest that by often emphasising the influence of time and practice, teachers may be contributing to children's beliefs that they are failing to read because they have not put in enough effort – regardless of the effort made. Maitland (2000) goes further than this by asserting that, with the best of intentions, it may be that teachers themselves are reinforcing a dependent role in which students react to teacher instructions, but cannot express any specific direction for themselves. Teachers' own lack of understanding of metacognition contributes to this problem. This can lead to the situation Baker (2002) cautions against, whereby metacognitive strategies are taught to students as a learning goal, rather than as a 'means to an end' in the process of improving their comprehension abilities.

A study undertaken by Hall et al. (1999) of children in the middle years of primary schooling in England and Ireland sought to evaluate children's opportunities for developing higher-order strategies in relation to reading with reference to three inter-related foci: (a) tasks, (b) texts, and (c) contexts. Lesson observations (N = 43), supplemented by teacher interviews, were conducted in 12 classrooms. The results of the study were notable more for what was gleaned about teacher practice than the original research questions. In classrooms identified by researchers as not promoting thinking skills, interaction was characterised by the children concentrating on what the teacher wanted to hear rather than thinking through their own ideas. The teachers were so busy seeking the 'correct' answer and the children were so busy chasing after it that there was no time to dwell on the 'error' that might give access to the learners' thinking and mental strategies. In these classrooms, the children already knew that their teachers knew the answers to the questions they were being asked. The teacher spoke and decided who else should talk, when they should talk and for how long. The teacher would then evaluate each response, sometimes modifying/translating it to fit the teacher's frame of reference to the point where it could no longer be recognisable as the child's original contribution.

The problem with such teacher-dominated and teacher-initiated interaction is that the learner is constrained to use the language of others and this undermines the constructive use of language as a powerful medium of learning. The attention is on what is in the teacher's mind rather than the learner's thought processes and mental strategies. This type of interaction does not constitute effective feedback. Interview data from Hall's (1999) study revealed that these teachers spoke more about and relied more upon organisational strategies, resources and materials, results of tests, remedial teachers, support staff and parents. They thought and behaved more like system managers, facilitators and providers of a stimulating environment. Even the teachers who attempted to promote the use of thinking skills were judged to be "more inclined to stress pedagogical and interventionist strategies". They saw themselves as the main resource in promoting their pupils' learning. They were instructional leaders and mediators of their pupils' learning. On the evidence in this study, the promotion of learning strategies and learning how to learn did not appear to be a predominant feature of classroom life. The teachers were found to be much more task- and product-driven than learning or process-oriented.

This phenomenon is not the exclusive domain of reading comprehension teaching. The Mathematical Thinking Skills Project, which involved 641 pupils in 12 pairs of classes drawn from six secondary schools located in England, provides interesting insight into teacher practice. The aim of this 'quasi-experiment' was to evaluate the effect of an intervention based on the higher-order thinking skills of planning, monitoring and evaluating. Over a period of twelve school weeks, half the classes received intervention lessons while the other half followed their usual programme. Tanner and Jones (1999) determined that the project's particular interest, unexpectedly so, was derived from ethnographic data that revealed significant differences in teaching styles between the project teachers; their styles were closely related to achievement outcomes for the students.

The teaching styles of the teachers involved in the project were retrospectively classified in terms of the degree of 'scaffolding' that they provided in their classrooms:

(a) *Taskers*, who focussed on the demands of the task. Characterised by an extreme form of constructivism, these teachers initially left the children to 'sink or swim'. Later they provided more structure, but their pupils' attention was not drawn to the underpinning strategies.

(b) *Rigid scaffolders*, who were far more directive in their approach to planning. Their emphasis was on demonstrating and sharing the teacher's own previously defined plan rather than helping their pupils to develop their own plans.

These first two groups were the least successful.

(c) *Dynamic scaffolders*, who made use of the 'start-stop-go' strategy (i.e., read a problem, think in silence for a few minutes, and then discuss possible solution plans before moving on to a teacher-led brainstorming session). They were very successful in accelerating the development of the higher-order skills of planning, monitoring and evaluating in the context of mathematical modelling.

(d) *Reflective scaffolders*, who also used the social structure of 'start-stop-go', but granted their pupils more autonomy. They encouraged several approaches to problems rather than producing a single 'class plan'. Pupils had to evaluate their own plans in comparison with other plans in the posing, planning and monitoring phases of the lessons.

The characteristic feature of the reflective scaffolders was their focus on evaluation and reflection. They were very successful in accelerating the development of active higher-order skills and, unlike the dynamic scaffolders, achieved short-term transfer of these skills in practical modelling situations (effect size 0.4). Unlike the other groups they also succeeded in accelerating development in the content domain of mathematics.

While teachers may believe that they are teaching comprehension, they are often found to be assessing instead of explaining how to comprehend. Dowhower (1999) noted that teachers in pre-service and in-service training programmes reportedly confuse the term 'strategy teaching' with 'instructional techniques' they might use, rather than strategies children might learn to use. Duffy (1993) asserted that if low achievers are to be strategic (i.e., if they are to be flexible adapters of strategies as needed to construct meaning), then their teachers must themselves be strategic (i.e., flexible adapters of professional knowledge in response to students' developing concepts). Furthermore, the teachers of teachers must also be strategic (i.e., adapting innovations and research findings to teachers' situations and involving them as co-constructors of knowledge rather than telling them what to do). Pressley (2002, p. 7) addresses the latter point in a different way: "if the goal is to develop elementary-age children into metacognitively skilled readers, their teachers must first possess some metacognition about reading". That is, teachers should know that comprehension strategies used by good comprehenders can be taught by the teacher explaining the strategy, modelling the strategy and then providing scaffolded student practice for the comprehension strategy during reading.

The teacher effect on student learning outcomes was signalled at least a decade earlier. Dweck (1989), for example, distinguished between two kinds of achievement goals and their corresponding learners:

> (a) *Learning goals* in which individuals strive to increase their competence, to understand or master something new. Learners with these goals would choose challenging tasks regardless of whether they think they have high or low ability relative to other children. They 'persist' and go more directly to generating possible strategies for mastering the task.
>
> (b) *Performance goals* in which individuals strive either to document or gain favourable judgements of their competence, or to avoid negative judgements of their competence. The learners with these goals avoid challenge when they have doubts about their ability compared with others. They tend to see ability as a stable entity, attribute difficulty to low ability and give up in the face of difficulty.

Dweck's analysis was that the two types of goals are associated with different teaching approaches and that a tendency to adopt performance goals will not help the learner how to learn. An emphasis on learning goals rather than performance goals and identifying the causes of success and failure is more likely to promote learners' confidence in themselves as learners.

Findings such as those reported above should be looked at positively. They serve to illuminate aspects of strategy instruction design and implementation that can be used to inform further research. Comprehension instruction is complex and long term and, as Pressley and Block (2002b) have noted, teachers' own comprehension processing needs improving in order to improve that of students. This may be particularly salient where many primary school teachers, in New Zealand for example, have not had their own reading comprehension skills refined though the rigours of an appropriate tertiary education.

The teacher is "mission critical" to improving the reading comprehension learning outcomes for students. The challenges faced in teacher development, however, should not be underestimated. The case for teaching strategy instruction is compelling. Learners can be helped to guide their own learning processes and become independent decision makers by teaching them 'learning strategies' that can assist them in academic areas and social situations. Grounded in the principle that students should be taught how to maximise their cognitive ability rather than simply acquire pieces of information, strategy instruction leads them towards shifting the emphasis from 'how does my performance compare with others?' to 'how does my present performance compare with my earlier performance?' This does not come naturally to students.

Richard Vacca (May 2001), a *struggling reader* himself, noted that struggling readers frequently remain passive and disengaged rather than taking an active role in constructing meaning. These students perceive themselves as being unable to overcome failure, feeling that they cannot succeed at tasks that require reading. The mantle of *learned helplessness* sits comfortably as they actively alienate themselves from the world of print. Skilled readers, on the other hand, know what to do to get out of trouble. They have a variety of reading strategies that they can use to resolve their reading difficulty. What makes the difference? More importantly, knowing that this difference exists, what can be done about it? The missing link is not the teacher; rather it is the teacher's own comprehension practices. In order to effectively teach self-regulated use of comprehension strategies to students, teachers themselves need to become self-regulated strategy users. Becoming an effective comprehension strategies teacher can involve a significant time commitment, one that teachers do not readily subscribe to (Hilden & Pressley, 2007), which sheds light on the following observation: "It is strange that we expect students to learn yet seldom teach them about learning" (Luke & Hardy, 1999; Norman, 1980). Part of the dilemma is that just presenting students with knowledge of processes (strategies) is not sufficient. Students need a strategy for choosing strategies appropriately. The dilemma is confounded by the tension between the well substantiated fact that the direct teaching of strategies does benefit struggling readers, and the phenomenon of leaders in the field of reading inexplicably continuing to resist the benefits of directly explaining strategies (Duffy, 2002).

Strategies provide ways of lessening demands on working memory thereby facilitating information processing. This is especially important since cognitive capacity is limited. Pressley and Block (2002), for example, cite the original research of George Miller (1956) in which he postulates conscious thought as being limited to 7 ± 2 pieces of information at a time. The more automatic the processes required to carry out a cognitive act become, the more capacity there is to do all that skilled reading requires.

Strategies facilitate cognitive purposes such as comprehending and memorising and are conscious, controllable activities. Hacker (1998b) categorises them as: (a) monitoring strategies, and (b) control strategies. Monitoring strategies include re-reading a difficult passage of text, looking back to prior text, comparing two or more propositions. Their use is vital for triggering the use of "fix-up strategies" such as re-reading and looking-ahead for clarification when the reader is faced with comprehension difficulties (Baker, 2002). Control strategies include summarising text information and clarifying text information by using sources external to the text. The text base that serves as linguistic input to comprehension is external to the reader. The above processes allow the reader to modify the external text base. The whole process places self-regulated comprehension within a general theory of cognition.

At any point in time, different people have different degrees of cognitive ability. Livingston (1997) asserts that individuals can learn how to better regulate their cognitive activities through Cognitive Strategy Instruction (CSI) programmes, which emphasise the development of thinking skills as a means to enhance learning. Such programmes are based on the assumption that there are identifiable cognitive strategies, previously believed to be used by only the better students, which can be taught to most students. Snow (2002) associates the use of these strategies with successful learning. Substantial evidence in support of this assertion is found in two meta-analyses: in the first, Swanson and Sachse-Lee (2000) postulate that attempting to 'teach' students how to read with understanding will produce measurable results. The question is, then, is any one approach 'better'? A meta-analysis of 78 group-design studies published between 1967 and 1993, focussing on students in the 6 to 18 years of age range, reported a mean effect size of 0.85 across a variety of interventions. Direct and strategy instruction methods realised higher effect sizes. Mean effect size scores were: 0.91 for direct instruction, 1.07 for strategy instruction, 0.68 for remedial instruction (i.e., one-to-one tutoring), and 0.59 for approaches not directly related to academic skills. The effect sizes were similar across different domains of study (reading, social skills, mathematics and spelling), which suggests that strategy instruction is effectively content independent and that skills learned in one context would be transferable to another.

In a further study, a meta-analysis of 68 research studies of various strategies for improving reading comprehension conducted between 1976 and 1994, realised an overall effect size of 0.98. The focus was on children with learning difficulties (LD). The result suggested that, as a group, the set of reading comprehension interventions had improved the comprehension abilities of students with LD at all ages and ability levels. The largest effects were associated with those interventions that involved self-questioning or cognitive strategies. The mean effect size for these approaches was 1.33 (Vaughn Gersten & Chard, 2000). The researchers undertaking the meta-analysis found wide variability in the effectiveness of different interventions, an aspect that was dealt with in a subsequent meta-analysis. Effective interventions were categorised as either: (a) Comprehension Monitoring, in which students are taught to monitor their comprehension and to use 'repair strategies' when they begin to lose understanding of the text, or (b) Text Structuring, in which students are provided with a way to ask themselves questions about what they read.

Both types of intervention have subsequently become categorised as strategy instruction because students are taught to use some type of system to help them generate questions about the text they read. These studies highlight the importance of the teacher in strategy instruction, and the need for students to have multiple opportunities to practice the strategy under quality feedback conditions before they are expected to use the strategy on their own. Students' lack of metacognitive skill and awareness points to the need for instruction that teaches learners to plan, implement and evaluate strategies for learning and problem-solving. The need is for teachers to teach students how to create and maintain a plan of action over time.

Bonds et al. (1992) give examples of the variety of metacognitive strategies available:

> (a) Checking-back. Students can write questions while they are reading a selection of text. After the initial reading, they go back to the text to find the answers to those questions. In the section 'reading comprehension' that you read above, you might have jotted down the question "What is it that poor readers fail to recognise?" On re-reading you find the answer in the last paragraph of that section. This strategy helps to verify that what is being read makes sense.

(b) Self-questioning. Young children are naturally inquisitive; this process can be started at an early age with the use of such questions as:

What is the main idea here?

How many supporting details are there?

Are there examples to clarify the main idea?

What are the important dates, places, names or words (terms) that I need to know?

The check-back technique would be used to verify answers to the questions; class discussion could support the process.

(c) Visual representation. Concrete, visible, models are effective tools for teaching students about visualising relationships. A story map (Figure 1 for example) provides a visible means of helping children organise a story into understandable wholes. The core of the map is represented by the title of the story, with the two sub strands of ‘the characters’ and ‘the setting’.

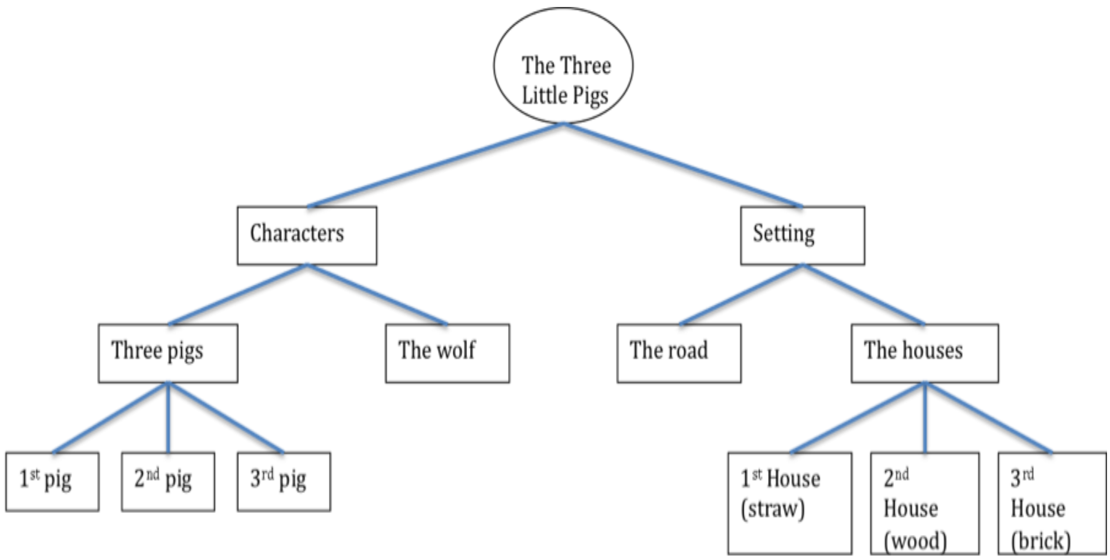

Figure 1. Story map for the "Three Little Pigs".

These story maps are derived from the integration of literal and implicit information, about the story's main characters, events and ideas.

(d) "Acronymous" metacognitive strategies. A metacognitive strategy represented by an acronym to make them easier to remember.

We explore acronymous metacognitive strategies in the following section.

Acronymous learning strategies.

Research discussed in this section focuses on the ease of use of strategies, their reflective nature, and a focus on process. Examples of acronymous metacognitive strategies: traditional, contemporary, compact, and extended, highlight the universality of this approach. An algorithm for designing an acronymous strategy is reviewed. This algorithm was used to design the strategy implemented in this study.

Of particular interest is the use of acronyms helps make the strategies easier to remember. They are taught to students to trigger or activate their inner, cognitive dialogues and to help them to think about and actively apply the steps in a particular strategy (Katims & Harris, 1997). The following examples illustrate that these types of strategy can be general or specific; simple or complex:

SQ3R (Robinson, 1970). Method for active elaboration of material being studied

Survey – get an overview of materials to be studied

Question – the student asks questions about the reading

Read – read to find the answers to the questions

Recite – the student recites the materials to him/herself

Review – review the materials to verify the answers to the questions

PARS (C. B. Smith & Ellot, 1979). A paraphrasing strategy.

Preview,

Ask questions before reading,

Read with a purpose,

Summarise

CAST (Lambert, 2000). A reading strategy used to help students determine the characters, their action, the setting and the ending of a story

Character – who is the main man?

Action – what is the action of the main man?

Setting – what is the setting of the story?

The end – how did the story end?

PROVE (Scanlon, 2002). An example of a strategy that can provide students with a procedure for naming a concept, providing evidence and defending it.

E.g., a student studying viruses to explore whether or not they are 'alive':

Present the knowledge I will prove.

Student statement: "Viruses are alive"

Reveal information to support my knowledge

Student statement: "something is living if …"

Offer evidence to support my knowledge (through examples or explanations)

Student statement: "viruses are alive because …"

It may be that the student does not have any direct evidence to support his/her rationale, in which case it must be obtained from an external source:

Verify my knowledge

Student statement: " In the book …. I found out that viruses …"

The last two steps are either/or, only one of them would be used. At this point in the process, the student should be prepared to defend their knowledge in the face of a challenge. This involves trying to find out if there is any reason to dispute the proposition. When students have confirmed their proposition by providing a rationale and supporting evidence, as well as thinking about how their proposition might be 'challenged', they are ready to:

Express my knowledge in summary form

Student statement: "Viruses meet the critical conditions for living …"

This final statement might confirm the original proposition, refute it or express facets of both the confirming and challenging perspectives.

Our confidence in these types of strategies is grounded in hard evidence. Salembier (1999) describes one study, for example, in which a school-based teaching team of seven general teachers (Eight Grade), two special education teachers and a university professor collaborated to design the SCAN and RUN strategy to teach reading in academically diverse classrooms in which students with reading disabilities were enrolled. The strategy was developed to illustrate to students that in order to read effectively for meaning, they needed a purpose and a plan for comprehending.

The SCAN and RUN mnemonic strategy consists of seven cues for strategies that assist students with actively planning and monitoring their comprehension before, during, and after reading expository text. Teaching the strategy consists of four steps: (a) introducing, modeling, and memorising the strategy, (b) previewing the chapter text before reading using the SCAN cues, (c) reading the text selection using the RUN cues, and (d) answering questions and discussing the text material after reading. The steps are taught using a combination of different activities including whole-class instruction, independent and peer-assisted reading, and co-operative groups.

The cues themselves are:

Survey headings and turn them into what, why or how questions that I will try to answer as I read

Capture the captions and visuals to find out more about the text to be read

Attack bold-faced words by looking them up in a glossary or dictionary and find out how to pronounce the words and learn what they mean

Note and read the chapter questions at the end of the chapter (if any) to help Me focus on important questions to answer when I read the text

In other words, learners should know what they want to know before they start reading.

Read and adjust speed – slow my reading down if I come to a section I do not understand

Use 'sounding it out skills' if I come to a word I can't pronounce

Notice and check parts I do not understand and reread or read on and go back to it after finishing reading the selection

Participants were drawn from a middle school and a secondary school in a northeastern state of the Unites States of America, representing a mixture of abilities and ethnicities.

After eight weeks of using the SCAN and RUN strategy the student's mean score on homework assignments increased from 65% to 84%; similarly mean scores on quizzes and tests increased from 72% to 86%. These gains were obtained for low, average and high achievers, as well as for those identified as learning or emotionally disabled. This reinforces the 'universal' applicability of metacognitive strategy instruction that surfaced from (Swanson & Sachse-Lee, 2000) analysis referred to previously and which is confirmed by (Snow, 2002) who affirms that acronymous metacognitive strategies are found to be particularly effective when combined with content area instruction.

Strategy instruction depends on teachers engaging students as active participants in their own learning and development. The approach emphasises explicit and direct instruction in how to use the strategy with authentic reading activities and assignments in content-area classrooms. An appealing aspect of strategy instruction is that complex ideas can be embedded in seemingly simple models, the ‘RAP’ model for example. It is a paraphrasing strategy:

Read a paragraph

Ask yourself questions about the main ideas and details, and

Put the main ideas and details into your own words using complete sentences

A study involving 207 seventh grade students from a low socioeconomic district, 93% of who were non-European, followed the progress of some groups of students who received instruction in this paraphrasing strategy. They also continued with the State mandated reading programme that all students undertook. The students exposed to the cognitive strategy and the control group achieved similar results on pre-tests. After a six week practice period, both groups showed a significant improvement in post-tests, with the cognitive strategy group achieving better gains in reading comprehension performance (effect size of 0.68) than the control group (effect size 0.53).

Mnemonic (or, *acronymous*) strategies, like the examples above, can be designed by teachers to meet the needs of their students. Lambert (2000) suggests an algorithm that is easy to use:

Step 1: select a learning outcome

Step 2: task-analyze the learning outcome (i.e., what steps lead to success?)

Step 3: rearrange the wording of the steps if possible

Step 4: ask yourself if you can create a word using the first letters of each step

Step 5: try to create a word that relates to the strategy (this will make it easier for students to remember the strategy)

Step 6: examine synonyms for key words in each step. This will help to create a word

Step 7: add lowercase letters to helps spell the word (these would not be steps of the strategy)

Step 8: you did it!

After the learning strategy has been designed, it needs to be taught using direct instruction (a recurring theme of all learning strategies). Describe the steps of the strategy and have students copy it down for future reference. Reinforce this with wall charts or similar. Next, model the strategy; give specific examples. Have the students try the strategy out with 'controlled' materials, materials with well-defined outcomes. Then help students to generalize the strategy to different settings and situations.

Metacognitive activities are *habits of mind,* rather than domain skills or ways of building knowledge about the self-as-learner (Xiaodong, 2001). This implies that engaging in such activities should be an integrated, natural part of the learning process rather than an add-on procedure. The WWW SSURF strategy used by students in this exploratory study is an example of an acronymous metacognitive learning strategy and its implementation mirrors Xiaodong's viewpoint. This strategy is introduced in the final section of this chapter, "Towards Evidence Based Practice", and described in detail in the following chapter "Methods and Procedures".

The Producer's Lens: How do I Make this Understandable?

Narrative text usually follows a linear pathway. That is, the reader starts at the beginning and reads the text sequentially until they reach the end. This is not necessarily true of expository text such as those encountered in science and the social sciences, where the reader may very likely "jump into" the middle of the text in order to access a subset of the information that the book contains. In addition, the language encountered in expository text is likely to be more difficult to access than that encountered in narrative text. These themes are developed in the following three sections: "Reading comprehension and expository text", introduces the nature of the reading comprehension difficulties associated with content area texts such as school science textbooks; "Textual readability, a first step in matching the product to the consumer", discusses the problem of the *reading age* of the text in content area textbooks; and "Other factors" broadens the discussion concerning the readability of content area textbooks into other areas such as visual elements, organisational features and structures for organising expository material.

Reading Comprehension and Expository Text

The research discussed in this section focuses on expository text: the need to build understanding, problems of structure and language, and suitability of texts for particular purposes. The significance for this study is that the first problem to receive a significant amount of attention for science textbooks was the 'reading age' of the text. This study investigates whether reading age is a potential difficulty for reading web-text.

The RAND Reading Study Group defines reading comprehension as "the process of simultaneously extracting and constructing meaning through interaction and involvement with written language" (Snow, 2002a, p.11). From this viewpoint, reading is a dynamic process in which the reader must actively interact with the text they are reading in order to make sense of the knowledge it contains. Comprehension is not just finding, answering or recognising (Walpole, 1999). It is about the reader building understanding through reading a particular text and integrating what is found there with what they already know, that is, their prior knowledge. Reading comprehension is both an active and a demanding process.

Paradoxes exist in relation to the use of textbooks in content area subjects such as science. In countries such as the USA and the UK, for example, text materials are seen as central to the process of reading and learning science in primary schools, yet there is little evidence of their effective use by children (Peacock, 1998). There is also a tension between the fact that difficult textbooks can overload children, decrease their confidence and hinder their development of thinking and the need to ensure that textbooks are not too easy for students (Mikk, 2002).

Science textbooks have long been generally regarded as being 'more difficult' for students to read than texts used in other areas of the curriculum (Carnine & Carnine, 2004; Holmes, 2000; Mastropieri, Scruggs, & Graetz, 2003). The expository prose encountered in science texts is different to narrative prose. It usually does not read like a story, with a typical story schema: a beginning, middle and an end (Bakken & Whedon, 2002). Its structure seems inconsistent and unpredictable to the reader, while the information it contains is generally unfamiliar. This is where students have to read to learn, as opposed to learn to read. Mastropieri et al. (2003) comment that printed science texts often pursue breadth over depth in content coverage. They contain large numbers of concepts, facts, and details, with insufficient explanation. In addition Mesmer (2005) notes that the frustration for struggling readers usually starts at the word level. Significant numbers of new vocabulary words are typically introduced, and these texts do not provide support for comprehension for the students that have to read them. Students who have prior subject related knowledge are better able to navigate through the text and process what they are reading. These students gain substantially more domain related knowledge as they progress through school. Other students remain unable to tackle the increasingly more demanding expository texts presented to them and continue to lose ground (Alexander, Kulikowhich, & Jetton, 1994). Part of the problem is that they do not connect with the text they are reading, often scanning the printed text without thinking about the ideas being presented (Dunn, 2000).

The statistics surrounding content area textbooks are sobering. “Unacceptable” proportions of middle school students struggle to read and understand content area textbooks (Carnine & Carnine, 2004). Studies in California have found that it is not uncommon, in some schools, to have significant numbers of classes in which 75-80% of students cannot successfully read textbooks. This group of struggling readers is made up both of students who simply cannot read (decode) text and of others who are able to read but who lack the necessary comprehension skills to reach grade level expectations in the content areas of science and social studies. The problem is not limited to schools with large numbers of at risk students.

Science material at middle school level (which starts at sixth grade in the USA) can have readabilities from sixth grade to eighth grade due to the high number of multisyllabic words required by content area information. These texts are particularly difficult for students whose reading skills are below grade level. Carnine and Carnine (2004) note that oral reading fluency is highly correlated with, and predictive of, reading comprehension. For students to read successfully and comprehend content area texts filled with multisyllabic, low probability vocabulary with considerable fluency and accuracy, they must be able to read narrative type passages involving higher probability vocabulary with considerable fluency and accuracy. They also contend that students at middle school level need to be able to read narrative passages of fifth-grade readability (USA), at minimally 150 words per minute with 98% accuracy, in order to successfully read and process expository material.

Ninety percent of teachers in the USA use textbooks 90% of the time for science teaching and these textbooks cover far too much material in one year (Holmes, 2000). The volume of factual material to be covered in expository texts leaves little time for the teacher to engage in instruction in reading comprehension. Eighth grade science texts in the USA, for example, may introduce 65 topics, compared with Japanese and German language textbooks which each introduce just five topics. This breadth of coverage compounds the problem for students of assimilating new knowledge, as teachers are frequently introducing the next set of concepts before the students have had time to understand the previously introduced ones (Mastropieri et al., 2003).

Difficult text decreases a student's motivation to read. The question is, "how can we know whether a particular text is appropriate for our students?" Bormuth (1968), for example, informs us that in the USA a text is regarded as: (i) being suitable for independent study when the student can comprehend 90% of its content, or (ii) a text can be studied with a teacher's help when the student can independently answer correctly 75% of the questions set on the content of the text. The problem a teacher has in choosing a science textbook is in determining which difficulty level is an optimal one for a particular group of students. In a mixed-ability class of 12 year olds, the reading ages would be expected to vary between 8 and 16 years (Johnson, 2000). Some students could well have reading ages even lower.

Methods of arriving at the appropriateness of a textbook range from asking teachers, parents or students about different aspects of textbook quality (easy to implement, but results can be of questionable utility) through to experimental evaluation (reliable but very time consuming and expensive). In between these extremes there are the *readability formulae*. These engage our attention in the following sections.

Textual Readability, a First Step in Matching the Product to the Consumer

Research discussed in this section focuses on contemporary 'readability' formulae, the algorithm for the Gunning 'FOG' index in particular. The significance for this study is the use of the FOG index to investigate the readability of the textual components of web sites.

The interest and motivation of the reader to engage with a text, the legibility of the print and any illustrations, and the complexity of words and sentences in relation to the reading ability of the reader, each feature in the readability of a text. This last factor has long engaged the interest of researchers. Readability formulae have been developed since the 1920s to help gauge the reading age needed to cope with print text (Johnson, 2000; Klare, 1985; Zakaluk & Samuels, 1988). Students in the United Kingdom can sit the General Studies Certificate of Education (GSCE) after a two-year course. These students are typically in the 14-16 year age range. The reading level for books available for students taking science courses are typically: GSCE Physics, 12+ to 15 ½ + years, GSCE Chemistry 13+ to 16 ½ + years, GSCE Biology 12+ to 16 ½ + years. These calculations were done for the introductory sections of a number of books in each category, so the rest of the material in each book is likely to require a higher reading level to cope. Contrast these figures with three books commonly used for GSCE English: 10 ½ to 11 ½ years, and we begin to understand why science texts are not used as primary sources of information in class, but rather as a basis for homework or revision (Johnson, 2000).

Contemporary readability formulas are usually based on one *semantic* factor (the difficulty of words) and one *syntactic* factor (the difficulty of sentences) and usually involve counting some characteristics of textbooks, such as numbers of words in a sentence and the number of syllables in each word, using strictly fixed rules. Studies confirm that including further factors involves a lot more effort with little or no gain (Klare, 1985).

Reading formulas typically predict the reading level (reading age) that an average reader needs in order to just cope with reading the text. In practical terms, this is the reading age at which an average reader would be at the limit of their comprehension ability, able to score only 50% on a test of comprehension of that text (Johnson & Johnson, 2005). This should be regarded as a minimal indication of textbook suitability, in the sense that one would hope that students would be able to understand considerably more than 50% of a text that they are asked to read. In order to be of real use a text needs to have a reading age, as predicted by readability formulae, some two years lower than the student's present reading age (Johnson, 2000). Of some 200 such formulae (Klare, 1985), three in contemporary use are:

1. The Gunning FOG index
2. The Flesch Reading Ease scale, and
3. The Flesch-Kincaid Grade

Words and sentences used by an author are easily quantifiable in terms of the length of sentences and the number of syllables in each word for example. These are the usual inputs for the readability formulae. The ‘FOG’ index is suitable for secondary and older primary age groups (that is, grades 6 and above, USA). The algorithm for computing the Gunning ‘FOG’ index is:

Select three samples of 100 words from the text. For each sample:

1. Calculate the average sentence length by dividing the number of words by the number of sentences. Calculate the average sentence length for the three samples (L), rounding to the nearest tenth. Next,
2. Count the number of words with three or more syllables. Find the average number of these words per sample, and then compute the average (N), over the three samples [Note: When counting syllables, it helps to say the word out aloud. Some examples are: universe (3), astronomy(4), fortunately (4), galaxy (3), area (3), passed (1), spiral (2)]
3. The grade level needed to understand the material is found by computing (L + N) x 0.4, and
4. The reading age, in years, by computing [(L + N) x 0.4] + 5.

The Flesch-Kincaid Formula is a USA Department of Defence test, and is built into the readability statistics available through current versions of Microsoft Word. It predicts the grade level (USA) at which the average reader would just cope with the text. The Flesh Reading Ease is a score out of 100. The higher the score, the easier the text should be to read. Textbook publishers, particularly in science and social studies, strive to produce texts with Flesh Reading Ease scores in the range 70-80 out of 100 (Johnson, 2000).

Science textbooks, in particular, may contain a feature that mitigates the readability of the text. Cohen and Steinberg (1983) investigated a phenomenon in which technical words may be repeated so often that readability may be lower than readability formulas indicate. This was previously described by Finn (1978) as *extraordinary transfer feature support*. Word repetition, especially of important technical words, appears to be a necessary but not sufficient condition to enable science texts to be more comprehensible. Readability formulae do not tell us anything about how easy it will be for a student, for example, to understand (comprehend) what they are reading (Goldman & Wiley, 2004). Such formulae do help us to understand whether the text is accessible to the student in the first place.

Readability formulae help us to predict reading ease (Zakaluk & Samuels, 1988), but as we will see in the following section, there are other factors involved that impact on readability.

Other Features

Insights from research into other factors impacting on readability are discussed in this section: the interest of the reader in the content, layout of web pages (text, diagrams and tables for example), presence of multimedia elements, and the need for students to have a plan of action to deal with text structure. This study investigates the effects of these structural features of text with respect to web-text.

Factors such as the (a) interest and motivation of the reader to engage with the text content, (b) layout of the text, (c) inclusion of diagrams and tables, and (d) use of colour also impact on readability (Gambrell, 1996). In the case of science texts, the reading task is even more difficult since visual elements do not merely support the written text; they often carry meaning and information.

Comprehension of non-verbal aspects of text is an issue that may be given low priority in schools. Peacock (1998) notes that in the English National Literacy Strategy, for example, locating and identifying visual elements such as graphs is emphasised more than reading and comprehending them. Traditional textbooks use organisational features to guide learner's reading through devices such as the table of contents, chapter titles, section headings, and bold print. Newer texts exhibit a less linear structure. Peacock observes, with reference to a double page spread in "Pupil's Book on Electricity and Magnetism, pp 2-3" (Nuffield Primary Science Scheme), that the sequence in which the reader moves from words to graphics and back changes: sometimes across the page, sometimes down, without this being made explicit. The word *energy* appears four times in four different parts of the layout, but is not explained and does not appear in either the index or the glossary at the back of the book. The skill level required to make sense of this expository material is magnitudes above that needed for narrative text.

Walpole (1999) notes that in science textbooks that (a) subheadings are more like questions to be answered than lesson titles; for example "What are some parts of the skeleton?", rather than the more traditional "The Skeleton" (p. 363), (b) newer texts have more pages but fewer words of running text, (c) captions for illustrations extend the information in the running text, sometimes even providing new information, and (d) newer texts may not contain *signaling words*, such as "before", "after", or "next" which help the reader to make the connection between separate pieces of information in a sequence of events. She further notes that children do not naturally respond to illustrations, graphics and highlighted items, which suggests that they need instruction in how to make sense of these features.

In a comprehensive review of research into the teaching of reading comprehension strategies to students with learning difficulties Gersten, Fuchs, Williams, and Baker (Summer 2001) refer to seminal research by Meyer, Brandt, and Bluth (1980) who found that readers who are unaware of text structure do not approach text with any plan of action. Six major structures for organizing expository material, first identified by Anderson & Armbruster (1984), present a conundrum for readers and teachers alike. Identified by their traits, as (a) describing characteristics, properties or functions, (b) cataloguing a temporal sequence of events, (c) explaining concepts and/or terminology, (d) giving definitions and examples, (e) comparing – contrasting, and (f) problem – solution – effect, these structures rarely provide the template for any one text. Most chapters in content area texts would be considered to be a hybrid of several of these text structures (Armbuster, Anderson, & Meyer, 1991), which serves to make the situation all the more confusing for the weak reader.

It is probably pertinent to remember that "because textbook publishing is a commercially-driven endeavour, educators must always be vigilant in maintaining their knowledge of exactly how materials are constructed and influence people" (Mesmer, 2005, p. 3). This situation is paralleled when the source texts for content-based instruction are located on the Internet.

Reading Comprehension and Web-Based Text

In the following sections we address the research relating to reading comprehension for material sourced on the Internet and identify concerns that this exploratory study attempts to address. A consideration of the nature of web-text itself, with illustrations drawn from two particular web sites, is the concern of the section "The Producers' Lens: How Do I Make This Understandable?" A second major section, "The Consumers' Lens: How Do I Understand This?", returns to the problem the consumer faces when reading web-text and discusses how current knowledge of reading comprehension and the characteristics of web-text informed the design of the WWW SSURF acronymous metacognitive learning strategy used in this study. The section “Reading with a purpose, or reading purposefully?” looks at integrating strategy instruction with reading comprehension for material sourced on the Internet, and situates the WWW SSURF acronymous metacognitive learning strategy used in this study in that context. A final section, “Summary”, sets the research questions addressed in this study in the context of this literature review

The Producer’s Lens: How do I Make this Understandable?

Research into the difficulties of reading comprehension of materials directly sourced from the Internet, or *web-text*, has been driven from two perspectives, those of the producers of web content and the consumers who are looking for information. The understandings of what constitutes good web design, while not complete, have been comprehensively developed in recent years, and contemporary web sites have paid heed to this knowledge. An example is the US Environmental Protection Agency web site found at http://www.epa.gov/. It contains information about global warming, for example, and a purposefully developed *Kids’ Site* is embedded within the main site, which helps to make essential content accessible to young people.

The difficulty of dealing with *hypertext* was the first issue to capture educators’ attention. This single factor seemed to "raise the bar" when it came to helping students more readily read with understanding the material to be found on the Internet. Reading comprehension of web-text was perceived to be fraught with more difficulties than reading comprehension of print-based text. Contemporary research into improving reading comprehension of Internet sourced materials is slowly changing focus from "what do good reader’s do?" to "what strategies might help?" This parallels the evolution of our understanding of reading comprehension for print-based text. These themes are developed in the following three sections: “Reading comprehension and web-text”, Textual readability”, and “Usability of web-text, matching the product to the consumer" and liberally illustrated through reference to two web sites, "StarChild" and "Seuforum".

Reading Comprehension and Web-Text

In this section the research discussed suggests that defining literacy in the information age is problematic, that the nature of the web and associated technologies is still changing, and that ‘new literacies’ build on and do not replace ‘old literacies’. The strategy used in this study, essentially a compendium of cognitive strategies known to be effective in dealing with print-based text wrapped up in an acronymous metacognitive strategy that provides a ‘plan of attack’ for working through the additional difficulties faced by the reader of web-text, was conceived with these issues in mind.

The concept of literacy (including readability) has been expanded since the 1990s to include visual and electronic media (Hobbs & Frost, 2003). This increases the complexity of how to think about literacy in an information age. Television, video, radio and the Internet have replaced books and other print media for many students. For example: a student wanting to learn about history may watch a movie instead of reading an informational/history book; a student who wants to escape to an imaginary world may play a video game instead of reading a narrative book. Middle school students, for example, regard computer technologies as effortless and natural compared to processing traditional print text (Hobbs, 2001)

Students perceive web-text as being different to print-text (Sutherland-Smith, 2002). In a study involving primary school students in Melbourne, Australia, Sutherland-Smith found that there is an expectation that one needs to be *really quick* on the web to go lots of places, but one needs to *go slower* with books. Students expect almost immediate results from the web, that the information they are looking for will be found very quickly, but there is not the same expectation with print-based text. By the age of 12, many students have decided that the time, effort and patience needed to be a skilful reader just "isn't worth the effort" (Hobbs, 2001, p. 45). Immediacy is a central value of modern youth culture, and may run counter to the skills and processes needed to become literate.

In fact, the definition of literacy in the information age can be problematic (Loveless & Longman, 1997). Vacca (2005, p. 7) makes the point that "the more researchers inquire into literacy and what it means to be literate, the more complex and multidimensional the concept becomes. Literacy is situational." In addition, he notes that the speed at which the "world of the classroom is mutating" (p. 197) means that teachers need to re-examine their roles as electronic resources become integrated into the curriculum. Yet, curriculum documents in the UK, for example, refer to IT as little more than a tool for getting information. There is scant recognition as to how English is used, or might be different in the context of new kinds of language tool (Loveless & Longman, 1997, p. 5). As Sutherland-Smith (2002) notes in the Australian study, the Internet is having an impact on society that cannot be ignored. In addition to the use of Internet based materials as a teaching/learning resource for class-work, there has also been a noticeable shift in Australian schools from pen-and-paper writing to digital text production. Students' use of Microsoft PowerPoint™ presentations and the creation of web pages, instead of written essays, is an example. Web literacy, which encompasses both reading comprehension of web-based materials and web publishing, is a medium with which students and teachers alike must become comfortable and competent.

The problem for practitioners and researchers alike is that both are "aiming for a moving target" (Loveless & Longman, 1997, p. 10). This process continues to accelerate. The emergence of new IT technologies such as *blogs* and *wikis,* and their uptake by teachers and students as new learning environments, are a contemporary example of this phenomenon. The Internet is rapidly changing from a passive knowledge-providing environment to an active knowledge-creating environment.

Researchers such as Donald Leu talk about *new literacies*, encompassing the skills and strategies needed to successfully use these new technologies, while being careful to say that these new literacies build on and do not replace *old* literacies (Leu, 2002). This is a very important consideration when considering the question of *where to next?* for research into reading comprehension. The acronymous metacognitive strategy developed and trialed in this exploratory study embodies this philosophy. The construct "new literacies" means many things to many people, however four defining characteristics have been identified. In the case of the Internet: (a) new skills and strategies are needed for its effective use, (b) its use is morphing into the warp and the weft of contemporary society, (c) it regularly gives birth to new technologies that can be distributed universally and immediately to anyone who is on-line, and (d) the complexity of these technologies makes them harder to analyse and to prescribe for their use (Leu, Zawilinski, Castek, Banerjee et al, 2007). This may be why there is an acknowledged lack of theory and research into on-line reading comprehension. More recently, Leu and his colleagues have asserted that just using technology in classrooms, the software package Accelerated Reader designed to support the acquisition of foundational literacies for example, will not prepare students for the new literacies of the Internet, and that new instructional practices are needed that recognize the continuous change brought about by the emergence of new literacies (Leu, Kinzer, Coiro, & Cammack, 2004).

Early studies converged on the viewpoint that electronic reading environments could create difficulties for readers that may not have parallels in print materials: hypertext, one of the most easily accessible features of materials sourced on the Internet, for example. McEneaney (2003) undertook a small scale study which explored whether readers made more effective use of hypertext or traditional print-based text formats in a reading and question answering task. The subsequent analysis found that there was a difference in mean scores for those who used print-based text and those who used hypertext that was statistically significant (effect size = 0.43). The study was unable to answer the question *why* readers found hypertext material more difficult, but the absence of a significant correlation between general familiarity with technology and the hypertext reading results suggests that the problem is intrinsic to the nature of the electronic text itself.

Electronic text, such as that encountered on the Internet, is *non-linear* in the sense that readers can choose their own path to follow by clicking on *hyperlinks* that will take them to elsewhere on the web page they are reading or even to different web pages at different web sites. Contrast this with traditional print-based text where the reader is usually constrained to read the text sequentially. However, just as readers can fail to comprehend when they read print-based text at the sentence or paragraph level, this can conceivably be a contributing factor in readers becoming *lost* in hyperspace (Alexander et al., 1994). As we will see in the following section of this chapter, "Textual Readability", Leu's early efforts to conceptualize what was happening in practice, were very insightful. He predicted that the ability to read text would become more important as it allows us to access information more quickly than listening. Reading the text embedded in web pages has the same challenges as its print-based text cousin.

Textual Readability

The research discussed in this section suggests that the reading age of the textual component of web pages can be estimated using the readability formulae for print-based text, and that different pages within a web site are anything but homogeneous with respect to readability. This study investigates the effects of the readability of the textual component of web pages on the comprehension process.

Although they tend to be highly graphical in nature, web pages still contain text, and the issue of readability arises once more. Roger Azevedo puts the textual component of information extracted from a web site by students in search of knowledge at 90% (Azevedo, Chambliss, & Holliday, 2001). His contention that " The computer as a cognitive tool is only as valuable as the student's ability to comprehend text" (Azevedo et al., 2001, p.25) has the "ring of truth" for the classroom practitioner, although, as we will see in the next section of this chapter "Usability of web-text, matching the product to the consumer", the situation is complicated further by additional confounding factors. The need to investigate *reading levels* of textual information on the Internet was foreshadowed by Elizabeth Schmar who noted, as the result of her own research into strategy use by skilled fifth graders reading on the Internet, that:

> Because Internet readers potentially have unlimited access to web sites, readers could encounter text with varying reading levels. Further research should focus on the reading level of Internet text, and the connection between levels of difficulty in text and the strategies used by Internet readers.
>
> (Schmar, 2002, p. 215)

In 2005, the author was interested in evaluating the readability of some web sites with science content and chose two that had material flagged as being suitable for: (1) secondary and upper primary school students, and (2) for primary school students, respectively.

The first website, located at http://cfa-www.harvard.edu/seuforum/, provided material on "our place in space", "the big bang", "black holes" and "dark energy". These were contemporary topics at the time since 2005 was the 50th anniversary for Einstein's publication of three papers predicting these now substantiated phenomenon. The author made use of an on-line tool accessed via the URL http://www.juicystudio.com/fog, which allowed him to submit a web page, or local HTML document, for analysis. This tool returns statistics for the page including the Gunning Fog Index, the Flesh Reading Ease scale, and the Flesh-Kincaid Grade. The following discussion is derived from the published article "Can you judge an 'electronic book' by it's cover?" (Pope, 2005).

Table 1 presents the results of this on-line analysis of readability. The site contained 18 web pages, which provided information relating to Einstein's predictions. The average reading age of the pages, as determined from the Gunning FOG index, is 10.09 years. The results for the three measures of readability in the table are very highly correlated (Table 2). This consistency across the three different measures means, in practice, that any one measure would be sufficient to predict the readability of a particular text. Visual inspection of the results, however, reveals quite a lot of variability in the predicted reading ages of the individual web pages that ranges from approximately 7.5 through to 13 years. As a consequence, one danger a teacher faces in discerning the readability of a web site that they wish to use as a teaching resource, is to look simply at the 'first few' pages of a web site and gain an impression of readability that is lower than that actually needed for pages deeper into the site. Conversely, it is also possible to disregard a site because of an impression that the pages of the web site are too difficult to read.

Table 1
Readability of web pages at http://cfa-www.harvard.edu/seuforum

URL	Gunning FOG Index	Flesch Reading Ease	Flesch-Kincaid Grade
/opis_tour_earth.htm	7.69	82.82	4.78
/opis_tour_sun.htm	7.89	80.45	5.11
/opis_tour_nearby.htm	7.88	79.61	5.06
/opis_tour_starfield.htm	7.57	81.51	4.43
/opis_tour_galaxy.htm	11.67	69.92	7.28
/opis_tour_cluster.htm	12.59	63.01	8.06
/opis_tour_deepfield.htm	8.62	81.46	5.27
/opis_tour_dark.htm	10.47	76.53	6.37
/opis_tour_ancient.htm	9.81	71.85	6.11
/bb_whatwas.htm	10.80	66.37	6.69
/bb_whatpowered.htm	10.81	68.38	6.63
/bb_whycare.htm	12.33	60.92	8.46

Table 1 (Continued)

/bh_whatare.htm	8.85	73.60	6.27
/bh_reallyexist.htm	8.35	75.33	5.45
//bh_findout.htm	11.76	64.53	8.22
//de_speedingup.htm	12.37	62.99	7.92
//de_whatmight.htm	12.55	59.55	7.94
//de_whycare.htm	9.54	71.75	5.48
Average	10.09	71.70	6.42

Table 2
Correlation coefficients between the three measures of readability computed for the Seuforum website.

Gunning FOG Index/ Flesch Reading Ease	Gunning FOG Index/ Flesch-Kincaid Grade	Flesch Reading Ease/ Flesch-Kincaid Grade
-0.94	0.96	-0.94

.
This is an issue addressed by (Finn, 1978) who contends that unfamiliar words repeated often within a text take on “extraordinary transfer feature support” in that frequent exposure to the words in continuous passages of text helps the reader to comprehend the meaning of those words. This may mean that readability formulae over estimate the reading levels required, for science textbooks in particular. In order to determine if this assertion would be true in the case of web-text, the author investigated the Seuforum web page which had the highest computed reading age (12.55 years), http://cfa-www.harvard.edu/seuforum/de_whatmight.htm and aggregated multiple instances of words and similar words, counting them as one instance. Table 3 gives some examples of this. The result of

aggregating words in this way was to reduce the count of words with three or more syllables from 89 (12.4% of the text on the page) to 39 (5.54% of the text on the page). The formula for the Gunning FOG Index using this aggregated data realised a reduced value of 10.04 (compared with 12.55). This result is consistent with Cohen and Steinberg's (1983) contention that science texts may therefore not be as difficult to read as is commonly thought.

Table 3
Examples of multiple words with three or more syllables found in the text on the page http://cfa-www.harvard.edu/seuforum/de_whatmight.htm

Sample Words(s)	Individual Word Count	Aggregated Word Count
Universe	20	1
Astronomer/astronomers	6	1
Conclusion/conclusions	3	1
Scientists	3	1
Recently	1	1

Similar results were obtained from an analysis of text from the Level 1and Level 2 strands on the StarChild web site, a highly regarded site designed for use by primary school children that may be accessed at http://starchild.gsfc.nasa.gov/docs/StarChild/StarChild.html. Tables 4 and 5 present an analysis of a selection of parallel pages. The reading ages predicted by the Gunning FOG index, the Flesch Reading Ease scale and the Flesh-Kincaid grade are lower than for those predicted for the Seuforum web pages. In addition, the reading age required for the Level 1 web pages are lower than that required for the Level 2 pages. The results are consistent with the expected audiences for these sites, and strengthen confidence in the use of these formulae.

Table 4

Readability of sample web pages at http://starchild.gscf.nasa.govt/docs/StarChild/solar_system_level2/

URL	Gunning FOG Index	Flesch Reading Ease	Flesch-Kincaid Grade
/planets.htm	6.70	67.74	5.25
/Saturn.htm	8.36	68.17	5.79
/universe.htm	6.40	72.94	4.69
/Black_holes.htm	7.38	74.04	4.99
/darkmatter.htm	9.77	60.60	7.36
Average:	7.52	69.03	5.5

Table 5

Readability of sample web pages at http://starchild.gscf.nasa.govt/docs/StarChild/solar_system_level1/ .

URL	Gunning FOG Index	Flesch Reading Ease	Flesch-Kincaid Grade
/planets.htm	5.87	70.75	4.56
/Saturn.htm	6.34	76.88	3.95
/universe.htm	7.41	68.35	5.05
/Black_holes.htm	5.66	81.31	3.69
/darkmatter.htm	6.34	70.47	5.14

The preceding investigation suggested that teachers can make informed decisions about the suitability of potential web sites as resources for classroom programmes on the basis of their readability. In particular, readability formulae can be used to get a usable estimate of the minimum reading age students would need to be able to understand the text they would be reading on that site. This, however, does not address the question of a student's present ability to comprehend text, or whether this ability can be improved. Neither does it address other aspects of readability that arise in a web-based environment.

Usability of Web-Text, Matching the Product to the Consumer

Research discussed in this section considers the navigability of web sites, multimedia content, content presentation (structure of web sites), and the appearance of web sites. These factors are considered to have an impact on reading comprehension outcomes. This study investigates the effects of these 'usability' features of web sites on the comprehension process.

> Usability refers to the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of user [ISO 9241-11].

Usability measures the quality of a user's experience when interacting with a product or system, whether a web site or some other technology (U.S. Department of Health & Human Services, 2008).

Literacy and technology merge when students read on the Internet. The skills required to comprehend print text, especially expository text, are used when students are searching for information on the Internet. The question of readability of the associated embedded text aside, there are other demands with the Internet that make the task of accessing and understanding information more daunting for the reader. For example (Block & Pressley, 2003; Kuiper, Volman, & Terwel, 2005; Schmar-Dobler, 2003):

1. The sheer volume of text available
2. Distractions such as blinking graphics, vivid colours, scrolling banners and flash enabled 'moving' advertisements
3. The expository nature of the text which requires familiarity with its concepts, vocabulary and structure
4. Hypertext links which change the nature of text to be read from linear to non-linear
5. The need to scroll pages to access all the information, and
6. The problem of finding suitable sources of information [on the Internet] in the first place.

Lee (1999) described the task as "Finding desired information in a veritable ocean of unwanted information." We can add to all of this the difficulty of deciding which heading and/or sub-headings to take notice of and which link labels to follow. In the former case, a lack of the knowledge needed to interpret the vocabulary in the headings hinders the reader. In the latter, links and headings which are semantically similar, but reference different information, compete for the readers' attention and serve to confuse (Blackmon, Polson, Kitajima, & Lewis, 2002).

Digital texts are being used to support science learning. Students are provided with a more active role than is possible with textbooks. They are able to make decisions about what information to access and how this information is sequenced, yet the navigational aids provided with hypertext may not seem intuitive to middle school students (see, for example, Stylianou, 2003). Hinsley (2007) distinguishes between two kinds of applications found on the Internet: *hyperbases* which are freely explorable databases, and *hyperdocuments* which are highly structured with a more constrained access. The "free flowing exploration of the hyperbase" (2007, p. 263) is seen as best supporting the constructivist viewpoint of discovery learning while the hyperdocument is seen as being appropriate source material where developing deeper understanding and learning is required. In New Zealand at least, the penchant for promoting *constructivist* learning, a student-centred approach to learning that allows the learner to explore the world of learner at his/her own pace and his/her own way (Hinesley, 2007), is bound to run into difficulty when students are pointed to the Internet to source information. The evidence clearly suggests that navigation and comprehension of material in an unstructured hyperbase format can be difficult, especially for learners new to the material and or new to the hypertext medium (Nielsen, 1990). This can be mitigated, to a degree, if the web site designers pay close attention to their target audience. Oliver, Herrington and Omari (1996) classify hypermedia into three categories: (a) *linear*, where the learner is compelled to follow an instructional sequence, (b) *hierarchical*, where the learner has more freedom of choice of path moving through the materials, and (c) *referential* where very little structure is imposed and the learner is free to move anywhere. A linear hypermedia structure would support developing a student's initial knowledge of a topic, whereas if developing an understanding of concepts and principles were important, then hierarchical and referential structures would be more appropriate.

Learners can further be supported through other aspects of web design. *Chunking* content helps to make material more accessible with the learner having to deal with less content at any one time. This also can help alleviate the problem of *memory overload*, as can the use of *progressive levels of detail* where the learner is moved from the general to the specific and can stop when they have received sufficient information (Arney, Jones, & Blankenship, 2003; Troffer, 2002). Particularly useful is the provision of *navigational feedback* to allow the learner to remain *oriented*, that is, they are able to identify their current position in the system, know how they got there and know how to return to a previous position (Arney et al., 2003; Oliver et al., 1996). Without appropriate support, there is the danger that students might navigate multimedia environments extensively, but only superficially engage with the content of the material presented to them (Vacca & Vacca, 2005). Evidence for this arises from an investigation by Puntambeker and Stylianou (2003) who, from their investigation into the use of a hypertext system, “CoMPASS”, designed to support students’ navigation and learning through the use of *concept-mapping* and text, found that too much opportunity for exploration resulted in students floundering.

Situated theories of learning, which require rich and unique learning environments, are well served in the web-based environment (Alexander et al., 1994). This environment can engage the transient interest of a student, or elicit an emotional response, particularly if the computer-based environment is perceived as an entertainment medium. Having captured a student’s interest, there still remains the problem of accessing the information. The USA National Research Council neatly discerns the problem:

> Hands-on activities, while essential, are not enough. Students must have minds-on experiences as well.
>
> (National Research Council, 1996, p. 2)

New purposes for reading, new ways to interact with information – the Internet provides new text formats (Coiro, 2003). These include multi-media texts with icons, animated symbols, photographs, cartoons, advertisements, audio and video clips, virtual reality environments, hypertext and conventional text. All these combine to create new ways of conveying meaning in an interactive environment which can be confusing, overwhelming and frustrating for people taught only to extract information from print-based text. Hypertext and interactive features can offer so many choices and so many animations, that otherwise strong readers may become distracted and disoriented (Eagleton & Guinee, 2002). These difficulties are present at more than one level. On the surface, many students see web graphics as a beautification process and miss the information they contain. At a deeper level, movements between links have been observed to make it increasingly difficult for primary age readers, for example, to predict results as more links appear (Sutherland-Smith, 2002). Low quality information, and difficult reading levels, compound the situation (Eagleton & Guinee, 2002).

Even adults find the web a difficult environment to cope with. A consumer research organisation, Roper Starch Worldwide, surveyed 566 adults in the USA by telephone about their use of the Internet to find information. They found that 71% of those surveyed felt frustrated from searching, whether they were successful or not, and that on the average it only takes 12 minutes of fruitless searching before “web rage” sets in ("The 'web rage' survey," 2000).

It has been noted that middle school students with little experience with Internet inquiry often make hasty, random choices (Coiro, 2003). Mayer (2004) suggests that some students fail to succeed in identifying main ideas and giving complete cohesive accounts of what they read because of how they read, rather than because they do not read. The additional features that web-text has (compared with print-based text) means that alternative reading strategies are needed such as non-linear thinking, visual literacy skills, and dealing with interactive tasks (Sutherland-Smith, 2002). In particular, hypertext environments appear to be handled more efficiently by users with high spatial ability (Stylianou, 2003). Users with the same level of cognitive abilities tend to perform better with simpler visual spatial interfaces (Chen & Yu, 2000).

One consequence of this is that students need support in understanding the structure of the system and relating navigating the system to their goals (Puntambekar & Stylianou, 2003). Coiro (2003) suggests that proficient readers need to plan to ask questions such as “how should I navigate this information?” and “how can I interact with this environment?” This is in addition to using print-based text processes to extract meaning.

The Seuforum website makes some effort to help the reader navigate the site to find the information they need. The homepage (Figure 2) has a clean layout and the reader can easily identify links to topics

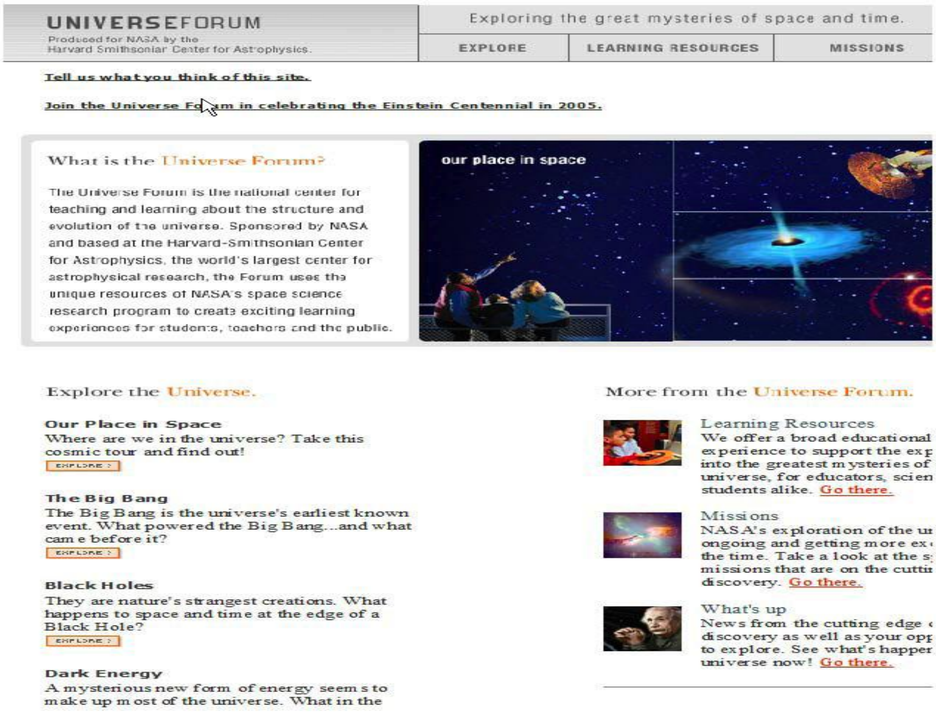

Figure 2. Seuforum, homepage. The reader is presented with a clear indication of what can be found on this site, and where to find it.

of interest such as Black Holes. The use of explicit headings such as "Learning Resources", for example, clearly signposts where a teacher can find supporting resources. This clarity persists as the reader advances further into the site. The introductory page to the topic Black Holes (Figure 3), for example, clearly indicates the scope of the discussion through annotated links at the bottom of the page,

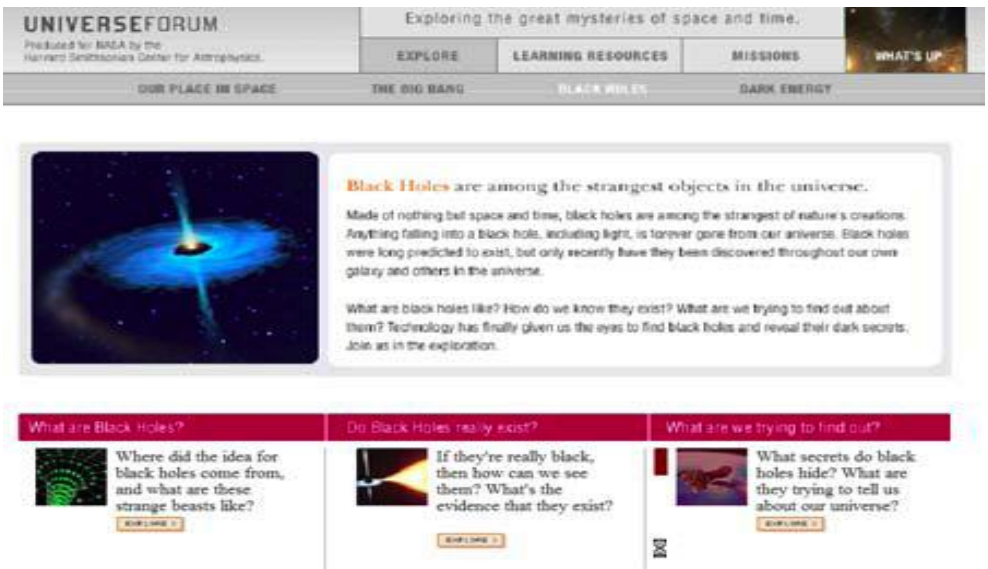

Figure 3. Seuforum, Black Holes, Introductory page. Preliminary information and clear pathways to find out "What are Black Holes?", "Do Black Holes really Exist?", and "What are we trying to find out?"

and offers the reader an easy path to opt out of this topic and go to another part of the web site through clearly labeled links at the top of the page. Even when the web pages contain a greater level of content (Figure 4), there is separation of different sub-topics in the text and links to additional pages that elaborate on the content of the text.

The home page for the StarChild site (Figure 5) has no clear links to such topics as Black Holes. The reader needs to make choices between the four topics solar system, universe, space stuff, and glossary, and also must make sense of the choice between Level 1 and Level 2. It is up to the reader to make these decisions. Selecting Universe in the Level 1 menu brings up a page that provides a link to the desired topic Black Holes (Figure 6). The information on the Black Holes page (Figure 7) is loosely structured. Some text in the centre of the page contains highlighted words that the reader can click on. These are hyper-links to an on-line glossary. To get to the Black Holes link, the reader might first be tempted to click on a speaker icon in the top left-hand corner, or to follow the link about the black hole in our Milky way, before actually finding out about black holes themselves. Then there is the picture on the right-hand side. Does the reader click it? What is it about? Unlike the graphics on the Seuforum site, there is no caption to help cue the reader as to its significance.

The Seuforum site, which has the harder text in terms of reading age requirements, is easier to navigate than the StarChild web site. Its structure helps the reader to make decisions about which links to follow. The StarChild site, while striving to ensure that the content is age appropriate in terms of readability, does not assist the reader to navigate the site to the same degree. Each of these sites presents different advantages and different difficulties. The degree to which a reader would cope with either site depends on their *web literacy*. We meet this term again shortly.

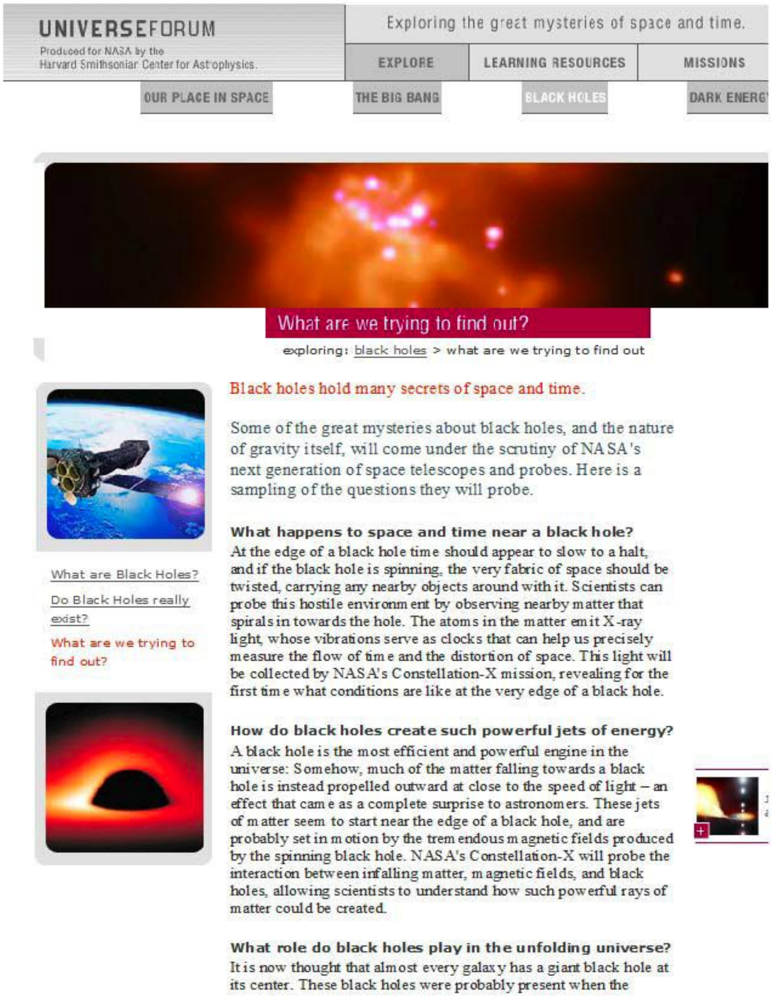

Figure 4. Seuforum, Black Holes: "What are we trying to find out?" Information is conveniently chunked in the form of questions and answers.

Figure 5. StarChild homepage. Appealing graphics for the younger student. Clear links to broad topics such as "Solar System", "Universe" and "Space Stuff", but requires some prior knowledge in order to select the link(s) that will take the reader directly to information about Black Holes.

Figure 6. StarChild, The Universe (Level 1). Some ‘scene-setting’ information. Hyperlinks take the reader to definitions of technical words. A convenient table provides links to topics of interest, including Black Holes.

Figure 7. StarChild, Black Holes (Level 1). Information is provided about Black Holes but the reader needs to know to explore several further leads, via hyperlinks, to get all the information.

The dialogue surrounding reading comprehension in the first section "Web literacy" moves forward to a consideration of the role that cognitive strategies might play in reading comprehension for web-text in "Cognitive strategies, matching the product to the consumer". How student learning using Internet sourced materials might be supported is the focus of "Scaffolding learning: putting our understanding of reading comprehension to use".

Web Literacy

Research discussed in this section suggests that a range of cognitive strategies used by strategic readers of web-text are the same strategies used for reading print-based text, and that additional strategies that seem to be web specific can be seen to have their parallels for reading print-based text. The teacher effect and the ability for different readers to construct different texts are also considered. The strategy used in this study uses cognitive strategies known to work for both print-based and web-text and is designed to be flexible, allowing the strategy to be used independently of the pathway the reader follows.

Sutherland-Smith (2002) describes *web literacy* as a term for finding, scanning, digesting and storing Internet information. Students (and others) who are web literate are strategic readers of this electronic text type – web-text. They characteristically carry out many of the following activities:

- Make use of prior content knowledge to formulate a strategy
- Monitor their own comprehension by skim reading a web page for specific information
- Work from 'big picture' ideas to small details (for example, read headings first then text)
- Repair comprehension by re-reading more carefully if there is a suggestion that a page or

passage may contain the answer to a question

• Pause during reading and re-phrase text in own words

• Ask self questions to check on understanding of text being read

• Use keywords/phrases to both search for sites and locate relevant information at a site

• Make decisions about continuing with a web page or moving on

• Use the above strategies in conjunction with their knowledge of how to navigate the internet (Coiro, 2003; Sutherland-Smith, 2002).

The first six strategies in this list feature prominently in strategies for dealing with print text (Block & Pressley, 2003). While the remaining strategies seem to be web-specific, they can still be seen to parallel print based text strategies. For example Pearson, Roehler, Dole and Duffy (1992) note that:

• Using key words/phrases to search a library catalogue for book titles, or the index in a book to find relevant chapters compared with using a search engine on the Internet, and

• Making a decision about whether to move on to another chapter in a book, or even to another book compared with deciding which links to follow on a web site or which web sites reported by a search engine to investigate, and

• Strategies needed in order to make effective decisions about what to look for? where to go to find it?, and when to know that you have found it? are pertinent in either domain.

The most powerful strategies are termed metacognitive. They involve both "monitoring" and "fixing" on the part of the reader. Monitoring involves self-checking whether what is being read is being understood, and whether the information contained is relevant or not. Fixing involves using a strategy to do something about it if the monitoring process reveals a difficulty. Teacher-directed instruction of when, where and why to apply fix-it strategies has been shown in many studies to be the most effective way to teach cognitive skills (Holmes, 2000). Smith (2002), however, contends that students will not be able to move beyond teacher-dependence, that is, direct instruction, unless they learn to apply comprehension strategies for themselves. Reading comprehension of print-based text has been researched for more than 30 years. Electronic text has only started receiving attention in the last decade. While many approaches to teaching reading comprehension have been trialed, there is no one clearly preferred approach. There are some promising contenders, acronymous metacognitive learning strategies for example, but not a lot is known about why and under what circumstances particular strategies are effective (Snow, 2002a). The nature of the holy grail in this quest has been succinctly captured by Smith. Her criterion for the definitive strategy is one that is potent, easily acquired and easily executed. The difficulty is that, with respect to reading electronic text in particular, research has not yet established what is pivotal in making the necessary decisions about: What to read? How much to read? and when to read? (Parr, 2002).

The teacher remains the most important instructional resource available to students (Alexander et al., 1994). Teachers enrich interactions with the learning environment, in this case by providing students with relevant experiences and the necessary scaffolding that allows them to construct meaningful interpretations and assimilate new understandings, yet, a great deal of the available material on the web is going to need teacher mediation most of the time (Peacock, 1998). Learning needs to be a partnership between students and teachers. Students need persistence, flexibility, to take responsibility for their own learning (be self-regulating) and a belief in themselves to be able to undertake successfully challenging tasks (self-efficacy). They also need to be supported, and provided with specific cognitive models of text comprehension in comprehension instruction (Walpole, 1999). Teachers of content area subjects however, usually focus on low-level, literal comprehension questions designed to elicit the single right answer, rather than higher level inferential questions based on students' prior experiences (Holmes, 2000). As well as being knowledgeable in the content areas they are teaching, teachers also need to be aware of the strategies needed when students navigate within the web-based environment (Alexander et al., 1994; Eagleton & Guinee, 2002).
An Australian study has provided evidence that Internet technology has had sufficient impact on

teachers for them to rethink their classroom reading practice (Sutherland-Smith, 2002). Language teachers, for example, need to focus on the demands of the inquiry process. This initiative will support the overarching goal of teaching students reading strategies they can use in multiple contexts (Eagleton & Guinee, 2002). In addition, all teachers should be teachers of language, and should know what strategies and skills students will need for successful online inquiry. Teachers are likely to need help with not only the substantive and syntactic content of text, but also with the evaluation and use of specific text materials that they are likely to need to use (Peacock, 1998). This is particularly pertinent to the selection of web-texts to be used in teaching programmes. It is desirable that teachers investigate web sites with regard to their readability before using them with their students. It would be undesirable for teachers only to select text that they themselves can understand. This is a very real danger in the primary school system where teachers are, for the most part, not specialist teachers of content area subjects. It is particularly important for teachers to be clear about the instructional objectives, before undertaking Internet-based inquiry projects (Eagleton & Guinee, 2002). They need to be comfortable with possibly knowing less than their students about the technology, and able to take advantage of the distributed knowledge that is necessary for success in the digital world. It is still unclear what strategies are actually involved while reading non-linear information (Stylianou, 2003). Studies have not detected a strong relationship between metacognitive awareness of reading strategies and the navigation decisions made, which suggests that digital texts might demand new reading comprehension strategies. What is clear is that children who read at 3rd grade level in grade 3, for example, will not necessarily become proficient comprehenders in later grades. Teachers must teach comprehension explicitly, and this is a continuous process that must continue through into High School (Snow, 2002a).

Arguably, the significant difference between reading web-text and print-based text is that, in the case of web-text, it would be very unlikely for any two readers to read the same text, as each constructs their own text through their choices of pathways to follow and information to assimilate (Leu, 2007). This suggests that any support provided for learners must be sufficiently flexible to minimize potential frustrations generated by learners being constrained in how they approach the task. This is a design feature of the WWW SSURF strategy employed in this exploratory study.

Cognitive Strategies, Matching the Consumer to the Product

The research discussed in this section concerns the question "How can cognitive strategies be used with web-text?", and the concepts of coherence and cognitive overhead. These factors appear to be significant with respect to reading comprehension outcomes for web-text. The ability of a suitable metacognitive strategy, such as the strategy used in this study, to mitigate the effects of poor web design is investigated in this study.

Roger Avezedo (2005) postulates the emergence of a new paradigm – using computers as metacognitive tools for enhancing student learning. He defines a computer environment as "one that is designed for instructional purposes and uses technology to support the learner in achieving the goals of instruction" (pp. 193-194). Using the metaphor of computers as metacognitive tools, he catalogues a number of associated characteristics including: (a) learners are required to make instructional decisions regarding instructional goals, (b) the computer environment models, prompts and supports a learner's self-regulatory processes, (c) the computer environment models, prompts and supports learners to engage in task-, domain- or activity-specific learning skills, (d) a specific learning context where peers and tutors, human or artificial, serve as external regulating agents, and (e) the learner's use and deployment of key metacognitive and self-regulatory processes are critical for success. Azevedo codifies self-regulatory processes as: (a) cognitive (e.g., activating prior knowledge), (b) metacognitive (e.g., evaluating emerging understanding), (c) motivational (e.g., self-efficacy), and (d) behavioural (e.g., seeking help). The examples given here are indicative only. These cognitive processes are readily recognised as the same ones as are employed in reading comprehension for print-based text.

The unanswered question is “How can these strategies be utilised in a hypermedia environment such as the Internet? Reading comprehension on the Internet is strategic in nature. A recent study by Leu, Castek, Hartman, Coiro and Henry (2005) invoked the use of Annemarie Palincsar’s Reciprocal Teaching strategy, a proven strategy from the print-based text domain, in the hypermedia environment. However, research such as that arising out of a meta-analysis of interventions aimed at enhancing student learning by improving student use of one or a combination of learning or study skills, produced the recommendation that “effective strategy training becomes embedded in the teaching context itself”. (Hattie, Biggs, & Purdie, 1996, p. 131). That is, strategy training ought to take place in the teaching of content, and be taught with understanding of the conditions under which the strategy works. The inference from this, and other research previously discussed in this chapter (see “The use of learning strategies to scaffold comprehension development” for example) that it is axiomatic that metacognitive strategies are designed for a specific context and/or purpose. It logically follows that a metacognitive strategy to be used to facilitate reading comprehension for web-text should be research driven and accommodate the best of what is known about successful reading comprehension for text and the additional elements peculiar to hypermedia such as that encountered on the Internet. The WWW SSURF strategy employed in this exploratory study is such a strategy.

Web design has for some time been based on the designers’ intuition and commonsense. A major problem has been a lack of cognitive guidelines for web design (Dalal, Quible & Wyatt, 2000). Two critical factors are seen to either assist or inhibit the reader. The first of these, *coherence,* is contained within the text itself (e.g., use of headings and sub-headings) and also within the reader (e.g., the strategies and mental models of the reader). While not a lot can be done about the coherence of web pages, the reader can be helped through the use of a strategy to tackle web pages in a systematic manner and to help them make helpful decisions about where to look and what to look for. The WWW SSURF strategy used in this exploratory study provides this type of support. The second factor *cognitive overhead* addresses the additional effort and concentration needed to cope with navigation, orientation and other usability aspects such as *multimedia overkill* (for example, the excessive use of graphics, animation, colour, video etc). These factors reduce the cognitive resources the reader has available for the task of reading comprehension (Dalal et al., 2000).

The effects of cognitive overheads, due to the usability features of a web site, are explored in the context of this exploratory study. A structural equation model will be developed to picture the relative importance of such factors as prior comprehension ability for print-based text, the possession of cognitive skills, the use of a metacognitive strategy (the WWW SURF strategy) and the usability features of a web site in the task of reading web-text with understanding. Scaffolding student learning in a hypermedia environment, specifically the Internet, is the focus of the next section in this chapter.

Scaffolding Learning: Putting our Understanding of Reading Comprehension to Use

The research discussed in this section outlines a 'software' approach to scaffolding learning using Internet sourced materials, the advantages and disadvantages of this approach, and the time needed to implement a strategy. The strategy used in this study offers tangible advantages for classrooms compared with the software approach – portability (students are not tied to a computer to complete their classroom tasks), and a short timeframe for implementation (the study investigates the uptake over a relatively short timeframe and its medium term retention).

White and Frederiksen (2005) used a software tool "Enquiry Island" to scaffold student learning using Internet sourced materials. The software contains places for students to record prior knowledge, the research question that they are setting out to answer and a series of click-selectable "advisors" that attempt to provide them with on-demand guidance for such task elements as forming a hypothesis, planning the inquiry process, recording and analyzing the data. The purpose of the software is to model and teach students the metacognitive knowledge and skills that will enable them successfully to pursue inquiry learning in a hypermedia domain. The article reports success in student engagement and evidence of fostering the acquisition of metacognitive skills by students. Unfortunately, the question of the time given over to working with the students is not mentioned. The practicality of any intervention in a classroom situation must necessarily be bounded by constraints of time and access to facilities. This was a consideration in the design and implementation of the WWW SSURF strategy used in this exploratory study. There are other examples of the use of software to scaffold inquiry learning on the Internet. The problem of reading comprehension is central to each of these. Quintana, Zhang and Krajcik (2005) briefly discuss three of these: Artemis, Symphony and The Digital IdeaKeeper.

Artemis was designed to support middle and high school age students with searching a science-oriented digital library, organizing the information they found and sharing different questions and web sites with others. Although later versions of this software included the ability for students to take notes as they read web sites, this software did not help students to analyse/evaluate the information they were reading. The Digital IdeaKeeper extended the Artemis note pad approach to provide a structured "skim-read-summarise" area with note taking spaces and prompts informed by general reading strategies used in the classroom. This constitutes a *process visualisation* scaffolding strategy in which information analysis is decomposed into its constituent tasks (Quintana et al., 2005, p. 239). Learners also need support for planning. The software programme Symphony addresses this by including a specific planning workspace that includes an *inquiry map*. Quintana et al., also consider the importance of supporting *mindful reflection* during the reading/comprehension process; student reflection on the quality of their research questions and also on what they have learned after reading a text.

The use of purpose-written software to scaffold student learning as they grapple with web-text and seek to understand what they are reading is a novel idea, and consistent with the latter-day drive by educationalists to "make use" of computers and Internet technology. At the moment it has some limitations. The most significant one would be access to the necessary technology and access in a convenient location. While schools are generally able to provide some sort of Internet access for their students, it is not the norm that students have ready access to this technology where they do most of their work – at their desks in their classroom. Present computer based technology has the disadvantage of not being very *portable*. Students must go to where the technology is to access and make use of information, especially if the information is held within a computer programme. Sometimes they may even need to use the same computer in order to access their information. The WWW SSURF strategy used in this exploratory study has the advantage of portability. Being paper-based, students can use the materials with any computer and then take the results of their efforts back to their normal workspace. The WWW SSURF strategy not only builds in the reflection process for choosing pages of web-text to read, and evaluating the worth of information being read, it also incorporates a process for reflecting on the use of the strategy elements at the end of each session on the computer. This seems to be an integral part of the process of helping students to learn how to use the strategy effectively.

The use of computer software to scaffold student inquiry learning on the Internet may also relieve teachers of some of the burden involved in implementing strategy instruction (Sung, Chang, & Huang, 2007 and the previous discussion in "Use of learning strategies to scaffold comprehension development"). In one study a multi-strategy based system named CASTLE (Computer Assisted Strategy Teaching and Learning Environment) was used with sixth-grade students from an elementary school in Taoyuan County, Taiwan. Using a quasi-experimental design with some students using the strategy embedded in the computer software and a control group who used the same strategy elements without the benefit of the computer software, the researchers found that the CASTLE software did indeed effectively enhance students' ability to apply strategies. The timeframe for the intervention was significant, with students receiving strategy training in 22, 50 minute sessions, over a period of 11 weeks. The control group operated in a self-study mode. They were given, in printed form, the same reading materials to read as the CASTLE group, but did not have access to either the strategy demonstrations or the feedback provided by the computer software. One is left wondering if the control group had received instruction and feedback by a teacher whether the resulting differences would have been as significant. Nevertheless, the point about taking the load off the teacher should not be lost. The WWW SSURF strategy used in this exploratory study was designed to have minimal teacher input and was designed to be assimilated by students in a minimal time frame.

Reading With a Purpose, or Reading Purposefully?

In this final section, "Towards Evidence Based Practice", we bring together the research base that informs this exploratory study and the use of the acronymous metacognitive strategy WWW SSURF. We particularly look at the question of integrating strategy instruction into content area domains, a dominant characteristic of the Internet. The importance of placing emphasis on *process* rather than *product* is featured in this section and the question of *how* a particular intervention works, rather than *does* the intervention work is also considered briefly. These considerations underpin the research questions embedded in this exploratory study.

Towards Evidence Based Practice

The research discussed in this section addresses 'conscious' comprehension, reviews elements involved in successful reading comprehension, suggests the need to undertake research in as "natural" as setting as possible, and considers research constraints. Specific cognitive elements were identified to be used in the acronymous metacognitive strategy used in this study, and, the study itself, allowed investigation of questions such as "how the intervention works" as well as "does it work?".

> Conscious comprehension involves actively thinking about the ideas being presented in a text while reading. The reader needs to connect with the text information in order to fully understand it.
>
> (Dunn, 2000)

The big-picture question was first posed by Snow (2002a): "How can excellent, direct comprehension instruction be embedded in content instruction that uses inquiry-based methods and authentic reading materials?". Existing research helps us to begin to unpack this question. In a study of reading pedagogy and metacognition in six classroom in Leeds and six classrooms in Dublin, Hall and Myers (1999) found that teachers were much more task- and product driven than learning- or process driven. This parallels a finding by Berardi-Coletta et al (1995), who noted in their investigations into the use of metacognitive strategies in problem solving, that students did not focus on the process by which they attained a problem solution. An implication arising from their study is that problem-solving, in general, has to be viewed in terms of processing skills. The discussion on this point is advanced further by Eagleton and Guinee (2002) who observe that "while it is tempting to focus on content acquisition or the final products of online research, it is imperative that [language-arts] teachers direct their attention to the process instead." The WWW SSURF strategy is a process for tackling the task of reading comprehension of web-text. It allows the student to locate potentially suitable material but is flexible enough to let the student make decisions about going on or retracing their steps at any stage in the process.

Duke and Pearson (2002) argue that much of the considerable research into reading comprehension for print-based text is not reflected in classroom practice. There could be a variety of reasons for this. It may well be that pragmatism determines whether a particular strategy is too unwieldy to use in a particular classroom scenario. While Duke and Pearson advocate the use of multiple strategies so that students are not constrained by single strategy models that may not meet all the their needs, they also infer that multiple element strategies should focus on a "few well-taught, well-learned strategies"

(2002, p. 236). A comment from Xiaodong (2001) in the conclusion to an article summing up the task of designing metacognitive activities is particularly pertinent: "… engaging in such [metacognitive] activities should be an integrated, natural part of the learning process rather than an add-on procedure." This suggests that any metacognitive strategy should be heavily integrated with knowledge and skills that students already possess, and that any scaffolding should be *familiar* in nature rather than *exotic*. In the context of the exploratory study reported in this thesis, the WWW SSURF strategy employs a selection of cognitive strategies that are foundational for reading comprehension success with print-based text and combines them into a process which will enable the reader strategically to tackle the web-text interface purposefully rather than just with a purpose.

A question posed by Collins, Dickson, Simmons and Kameenui (2004, p. 4) asks "whether effective, long-lasting benefits of metacognitive instruction are a results of direct instruction or instruction that induces metacognition indirectly", that is should a teacher teach a cognitive strategy such as summarising (for example) and then the student works out how this can be used in different situations, or, should the teacher also teach where and when to use the strategy and how to self-monitor its use. The role of the teacher is quite clear. Students need to have direction when it comes to problem-solving (Fuentes, 1998), and what is reading comprehension of material sourced on the Internet if it is not primarily an exercise in problem-solving? The teacher should take initial control of a student's learning of a strategy and help them to assimilate the use of strategy into their own practice through explicit instruction. In the case of print-based text it is known that positive outcomes are obtained when instructional procedures that are logically related to specific processes of reading comprehension are implemented (Mastropieri & Scruggs, 1997). There is no reason why this should not also be the case for reading comprehension of web-based text. Use of the strategy becomes embedded in student practice as the teacher guides them through feedback and a process of self-reflection.

> A thinker-learner will be created if educators consistently emphasise the activation of thought processes by the learners. (Lidor, Winter 2000)

The WWW SSURF strategy used in this exploratory study is introduced by the teacher, but the scaffolding provided by the booklet that the students use is designed to facilitate the transfer control of the strategy to the student. The emphasis is on thinking and making decisions (choices) about what to do next and the relevance of the material being read.

The most effective strategy instruction involves providing the learner with both knowledge of cognitive process strategies (used as metacognitive knowledge) and experience, or practice, in using both cognitive and metacognitive strategies and evaluating the outcomes of their efforts (which develops metacognitive regulation). Only providing knowledge without experience or vice versa does not seem to be sufficient for the development of metacognitive control (Livingston, 1997). The WWW SSURF strategy used in this exploratory study addresses both of these dimensions. Of the cognitive strategies selected for use in this study, activation of prior knowledge is singled out as being especially important. In a study reviewing 183 articles, books, papers and research reports into prior knowledge and its role in student performance, Dochy, Segers and Buehl (1999) found that there was a strong relationship; prior knowledge generally explained between 30% and 60% of the variance in student cognitive performance. Prior knowledge has also been found to improve comprehension monitoring. This is known as the "facilitative hypothesis" (Nietfeld & Schraw, 2002). The axiomatic importance of prior knowledge is captured by Patricia Alexander et al. (1994, p. 215) in their description of the "Matthew effect", attributable to Tyler and Voss (1982):

> Thus, those with more subject-matter knowledge are better able to process or navigate through text and are, therefore, able to gain substantially more domain-related information as they progress through school. However, those who lack such knowledge remain unable to tackle the increasingly more demanding exposition presented to them and continue to lose ground. To compound this situation, those with more domain knowledge continue to read and gain even more relevant subject-matter knowledge, while those without a satisfactory knowledge base fall farther and farther behind.

Reading comprehension is a process, underpinned by a purpose, and strategies for understanding play a part before, during and after the act of reading some text (Lee, 1995). Successful reading comprehension is dependent on multiple elements (Mason, 2004). Four such elements: (a) searching for relevant information, (b) navigating in a hypermedia environment, (c) critically evaluating the information being found, and (d) Synthesising information, have been identified as *challenges* facing students as they use Internet technologies (Coiro, 2005). These elements are addressed in this exploratory study through the cognitive strategies and the metacognitive processes incorporated into the WWW SSURF strategy. The use of *key words* (Eagleton & Guinee, 2002) and *key phrases* is an important factor in tackling these challenges. They may be derived from the wording of the tasks that students have been set, and also prior knowledge of the content area. These words and phrases may be refined and added to in the light of new knowledge gained as the investigation proceeds. Since web-text involves a substantial amount of reading, it seems appropriate to incorporate reading strategies for understanding print-based text into a strategy for online reading. *Skim* reading to gain an overview of text and to identify possible chunks of text as candidates for *systematic* reading are preliminary strategies to help the reader to process the material strategically.

Successful reading comprehension involves the construction of a coherent memory representation of the text being read (Van den Broek, 1995). Van den Broek premises that, during reading, the ideas and concepts associated with the text fluctuate in their activation. At any point during reading the following concepts are most likely to be activated: "information described in or associated to the current sentence, information retained from previous reading, and information that is reinstated from prior text or drawn from background knowledge in order to maintain coherence." The key point here is that once readers *understand* what they are currently reading, they then need to *relate* what they have been reading back to what they already know, and then make a *decision* as to whether this new information is relevant and useful or not. By making this conscious decision the reader is then *integrating* the *new knowledge* with the prior knowledge and expanding their memory representation of the text. These cognitive elements are not new, see Pressley (1998) for example, however this reflective process, a design feature of the WWW SSURF strategy used in this exploratory study, has had little attention in the literature with regard to reading web-text. There is a recently reported study in which the 'Reciprocal Teaching' strategy for print-based text was adapted for use in an Internet environment (Coiro, 2005), but at the time of writing, the WWW SSURF strategy is the first attempt to synthesise a strategy from the considerable amount of research into reading comprehension of print-based text and the lesser amount of research into reading comprehension of web-text (Figure 8).

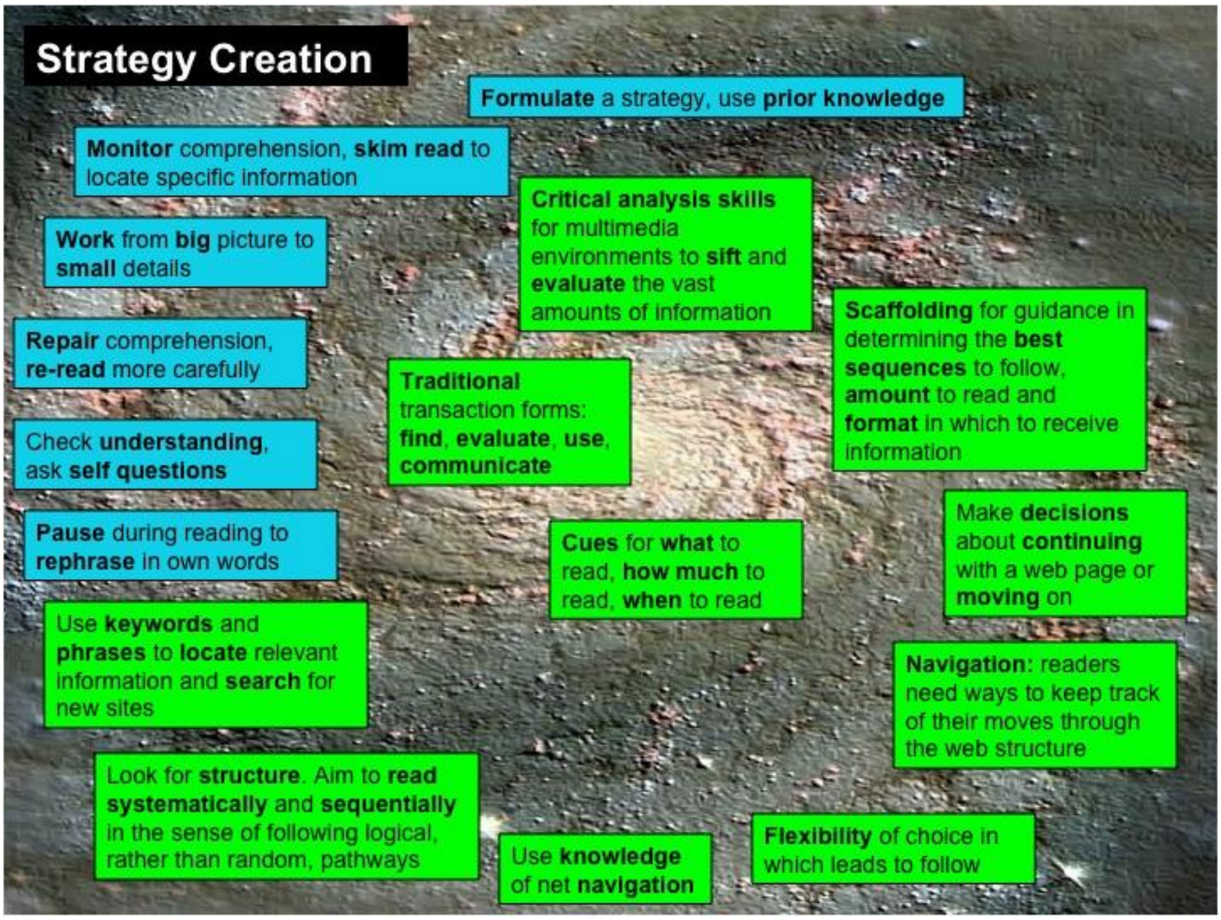

Figure 8 . Selection of effective cognitive and metacognitive strategies suggested by existing research into reading comprehension for print-based text (blue boxes) and web-text (green boxes) considered in the design of the WWW SSURF acronymous metacognitive strategy.

The *setting* for the research task is significant. The need for research tasks to be "undertaken in as naturalistic a setting as possible as possible" was flagged many years ago by Wagoner (1983, p. 344), yet most of the studies reported in the literature have imposed constraints on the research. The constraints range from artificial groupings of the student participants in the studies (e.g., participants either have learning difficulties, or, have high skill levels) through to artificial settings used with the students (e.g., small groups are withdrawn from normal classroom settings, and/or, the reading materials used in the study are specially prepared). We can include in the setting the class teacher. Some strategies may require too much teaching time (Rich & Pressley, 1990) to be pragmatically viable, and the teacher may take shortcuts to compensate, in other cases the teacher may not understand the strategy sufficiently to enable them to operationalise it in their students in the way that was intended. These factors impact on the *external validity* of the study. Pressley consistently argues for measures of process to be incorporated into studies of reading comprehension, contending that such measures can provide more insight into how instruction affects the reading processes more directly than standardised test data can (Lysynchuk, Pressley, d'Ailly, Smith, & Cake, 1989; Pressley, 2003). Process measures can also inform the question posed by Swanson & Sachse-Lee (2000):

> Thus, the question is not whether a particular intervention works, but how it works and how it can work much better.

All of these considerations were incorporated into the design of the WWW SSURF acronymous metacognitive learning strategy and its implementation, which we will read about in the following chapter: “Methods and Procedures”.

Summary

The exploratory study reported in this thesis addresses two research questions. Research into reading comprehension for print-based text strongly supports the use of purposefully designed metacognitive learning strategies, yet at the time of writing this thesis, there is no reported use in the literature of such a strategy in connection with web-based text. In addition, there is little mention in the literature of *how* a particular strategy works. These issues are the concern of the preliminary research question:

> "Is the use of an acronymous metacognitive learning strategy a contributing factor to the ability to read web-text with understanding?"

This literature review further reveals that attempts to facilitate the reading and understanding of web-text, that is material directly sourced from the Internet, and to make web-text more readable have been pursued from two different perspectives, those of the consumers (or readers) and those of the producers (or writers). These two lenses (perspectives) converge to a point, with the same end-point in mind. To what degree this is successful is the concern of the primary research question explored in this study:

> "What factors contribute to the ability to read web-text with understanding?"

This question puts the use of the acronymous metacognitive strategy WWW SSURF alongside other possible variables such as prior ability to comprehend print-based text, possession of general cognitive strategies, and the usability factors of websites themselves. The details of the WWW SSURF acronymous metacognitive strategy and its implementation are discussed in the following chapter "Methods and Procedures". The results of the study are reported and discussed in subsequent chapters.

CHAPTER 3

METHODS AND PROCEDURES

The preliminary question “Is the use of an acronymous metacognitive learning strategy a contributing factor to the ability to read web-text with understanding?” was approached in this study in several different ways. By collecting data about student use of the individual elements of the WWW SSURF acronymous metacognitive learning strategy prior, during and post-study, information was obtained about the uptake of the strategy by students and insight gained into the use of the individual strategy elements. Comparing the task performance between students who had access to the strategy, and the students who did not, provided tangible evidence of the value of employing such a strategy with the goal of improving reading comprehension outcomes for electronic text. In this context, *electronic text* refers to reading material sourced and read on the Internet, and the term *reading comprehension* encompasses the construction of meaning from text and other elements incorporated into web pages such as captioned diagrams, animations, hyperlinks and video segments. An *acronymous metacognitive strategy* is a metacognitive learning strategy associated with a convenient acronym, which helps the learner to recall the steps associated with the strategy.

The primary question “What factors contribute to the ability to read web-text with understanding?” refines the first question, providing a greater degree of focus. This question puts the use of the acronymous metacognitive strategy WWW SSURF alongside other possible variables such as prior ability to comprehend print-based text, possession of general cognitive strategies, and the usability factors of websites themselves. At the heart of any web page is print text which contains the core information. Data from the study provided information that allowed the conjecture “that an improvement in reading comprehension for electronic text will be paralleled by an improvement in reading comprehension for print-based text” to also be tested.

The study was undertaken in two phases. In the original study two classes each used the WWW SSURF strategy. In a replication study conducted some 18 months later, one class received the strategy, whereas the other did not. In the following discussion, the conditions under which the research was conducted were identical for each phase, unless otherwise noted.

The predominant methodology employed in the study is quasi-experimental. It makes use of repeated measurements and multiple groups of participants. In this chapter the research design is outlined in the sections "Research Context", "Procedures", "Instrumentation", "Data Analysis", and "Validity". A final section, "Summary" provides the bridge to take us from a discussion of the intentions to an examination of the outcomes of this study in chapters four and five of this thesis.

Research Context

Location

The setting for the study was a semi-rural school, catering for students predominantly in the 11 to 13year old age range.   Class sizes for the school were typically in the range 30 to 35 students, with the school student population approximately equally apportioned between two year levels, Year 7 and Year 8 in the New Zealand Education System.

Participants

Original study

Two teachers and their classes were approached as potential participants from the lower year level cohort. Both teachers were experienced, and achieved good outcomes from their classes, especially (but not exclusively) in the area of literacy. Each class, referred to as Group 1 and Group 2 respectively in the study, consisted of 33 students with boy/girl ratios of 39% / 61 % and 48% / 52 % respectively. Both groups had a mixture of ethnicities (Table 6). The average chronological age for the students Group 1 was 2.4 months higher than the average chronological age for the students in Group 2. All students involved in the year group cohort that the participants were drawn from were familiar with using the school computers and had some degree of experience of using the Internet to find required information.

Table 6
Ethnic composition of groups in original study

Ethnicity	Group 1	Group 2
NZ European	59%	64%
NZ Maori	7%	21%
Pasifika	0%	4%
Other	34%	11%

Replication study

The second study also involved two classes, again referred to as Group 1 and Group 2 respectively. Group 1 consisted of 32 students with a boy/girl ratio of 55% / 45 % and Group 2 consisted of 29 students with a boy/girl ratio of 45% / 55 %. Both groups had a mixture of ethnicities (Table 7). The average chronological age for the students Group 1 was 0.1 months higher than the average chronological age for the students in Group 2. As in the first study, all students involved in the year group cohort that the participants were drawn from were familiar with using the school computers and had some degree of experience of using the Internet to find required information.

Table 7
Ethnic composition of groups in replication study

Ethnicity	Group 1	Group 2
NZ European	41%	52%
NZ Maori	24%	38%
Pasifika	3%	0%
Other	31%	10%

Curriculum

The study was integrated with the normal classroom programme. Both classes were studying "global warming" as part of a unit of work. The two teachers collaborated to organise the questions that they wanted their students to answer using the Internet as their information source. The questions they chose for their students to research were:

1. What is global warming and what effect does it have on our planet?
2. Who or what causes global warming and what is being done to stop the situation getting worse?
3. What is acid rain? How does acid rain affect the environment? Is there a relationship between global warming and acid rain?

The cognitive level of this task was determined by the instruction to "explain", e.g., "Explain what is global warming?" This placed the level of higher order thinking skills required at the lower end of deep cognitive understanding, "Analysis" in the case of Blooms Taxonomy (Anderson et al, 2000) and "Relational" in the SOLO Model (Biggs & Collis, 1982).

Procedures

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Ethics Permission was granted for the study by the University of Auckland Human Participants Ethics Committee [Reference 2006/268]. Permission was obtained for the study from the school's Board of Trustees. The prospective teachers were approached and the project was explained to them. They were provided with a printed information sheet about the nature of the research, and their role in the study. Both teachers subsequently indicated their consent to being part of the study and completed the requisite consent forms. The two teachers then explained the project to their students and provided them with printed explanatory materials and consent forms, for themselves, and also to take home for their parents or caregivers. Separate consent forms from both the participants and their caregivers were received by the teachers and passed on to the researcher.

The Original Study

Prior to the study, all Year 7 participants in the school were tested using an asTTle reading comprehension test. AsTTle was developed for the New Zealand Ministry of Education by a team from Education Faculty of the University of Auckland headed up by the project director Professor John

Hattie. The "Assessment Tools for Teaching and Learning" are used by teachers to facilitate student learning in a large number of New Zealand schools. Further information about this unique tool can be accessed from http://www.tki.org.nz/r/asttle/. The participants in the two groups taking part in the study also completed a questionnaire based on the Motivated Strategies for Learning Questionnaire (MSQL) (Pintrich, Smith, Garcia & McKeachie, 1991) developed at the University of Michigan. The researcher discussed with the two teachers the process that the participants would be asked to follow during the period of the study. The discussion made use of printed materials provided by the researcher that modelled this process. The teachers then used this information as a model when they, in turn, explained the process to their students. Once the questions that the teachers wanted their students to investigate had been decided, the researcher identified two web sites that the participants would be asked to use as a primary resource. The researcher then created and printed the materials, in the form of a booklet, which the participants would be given to use during the study. The booklet was designed to keep the acronymous metacognitive strategy (WWW SSURF) that the researcher had designed in front of the participants and also to scaffold their use of the strategy with prompts. At the suggestion of the teachers, it was also agreed that the participants would not be given a knowledge based test at the end of the study. It was thought to be more appropriate, in the context of the classroom programme in which this study was situated, that the participants used the notes that they would record while using the computers to write answers to the questions in paragraph form.

The study made use of five sessions in a computer lab towards the end of the fourth school term. The teachers and the researcher discussed the availability of the lab and possible time constraints due to other aspects of their school programmes. It was agreed that each group would make use of the computers for one 45 minute session weekly over a period of five weeks. A list of times that the computer lab was available was provided for the teachers and the lab was booked for their use after they made their selections. The first session was to be a familiarisation session. The participants were given a copy of the booklet that they would be using and the teacher took them through the process to be followed. They then completed the first phase of the process, identifying their prior knowledge and selecting key words and phrases to be used as they undertook their research. The booklets were retrieved by the teachers and returned to the researcher at the end of each session. The participants undertook their research over the following four sessions, making use of their booklets to guide them in their use of the strategy, and to record the information that they would make use of in answering the questions set by the teachers. The booklets were also used to record participants' reflections on their use of the elements of the strategy during each session. Following the four sessions with the computers, the participants had one more session in class where they used the information they had recorded in their booklets to write answers to the questions.

Midway through term two of the following year, the Year 7 cohort, now in Year 8, had a follow-up asTTle Reading Comprehension test with a similar emphasis on reading skills to the test administered the previous year. Later in the same school term the researcher followed through with the participants who had participated in the study in the previous year. Data were gathered on the participants' continuing use of elements of the WWW SSURF strategy when using computers to access information from the Internet for class work and also to gain insight into possible use of the strategy elements by participants when they sat the second asTTle test.

The researcher also computed the reading ages of individual web pages using the Gunning FOG index, and a "Usability Index" for the web pages or sites made use of in the study.

The Replication Study

The second study involved Year 8 participants. Apart from the several variations noted here, the details of the study were as for the original study. This second study was carried out over the end of the first term/start of the second term instead of at the end of the year. The school did not give an asTTle reading comprehension at the start of this year, but a PAT reading comprehension test was given in the first term to all year 8 students. This was followed up with a second PAT reading comprehension test in the middle of the fourth term. The Progressive Achievement Tests (PAT), developed by the New Zealand Council for Educational Research (NZCER) for use in New Zealand Schools, are primarily designed to help classroom teachers determine achievement levels and help them to make informed decisions about the kinds of teaching materials, methods, and programmes that are most suitable for their students. Further information can be accessed from the NZCER website, http://www.nzcer.org.nz/. The most significant variation was that the researcher introduced the task to the students and supervised them in the computer lab instead of their class teachers. This was designed to control for a possible "teacher effect" when comparing outcomes for the two classes in the study.

Instrumentation

Reading Comprehension Tests for Print-Based Text

The original study: AsTTle reading comprehension test

The Assessment Tools for Teaching and Learning (asTTle) are a "bank" of closed and open-ended items intended to provide high-quality information to help teachers' identify participants' strengths and weaknesses in numeracy and literacy (Meagher-Lundberg, 2000), together with management software that allow the tests to be constructed, the participants results are inputted into a database and a range of reports produced. When a reading comprehension test is constructed, up to three *content areas* are selected from a total of six. The first five choices are derived from the SOLO taxonomy (Biggs & Collis, 1982) and relate to the concept of *deep* cognitive understanding. In the SOLO model, and hence in the asTTle model, surface cognitive understanding involves the use of one (unistructural) or more (multistructural) piece(s) of given information, or idea(s) obtained directly from the problem used separately without any integration of the ideas. Deep cognitive understanding involves the integration of at least two separate pieces of given information, or ideas (relational) or requires the learner to generalise beyond the given information, or ideas (extended abstract). The sixth asTTle content area choice, similarly, relates to the concept of *surface* understanding (Note: the examples given are indicative).

Finding information. Skim reading for information; note-taking; use of dictionary and/or thesaurus; distinguishing between fiction and non-fiction text types; find, select and retrieve accurate information

Knowledge. Vocabulary knowledge; knowledge of poetic and figurative language; knowledge of strategies to solve unknown words and gain meaning; knowledge of publishing conventions to identify and understand main ideas, details in factual text

Understanding. Read for meaning; understanding/identification of main ideas and details; analyse and discuss the effect of a range of language features (e.g., grammatical choices, vocabulary choices, literary devices) found in texts; question to clarify meaning; understand differences between text types in terms of structure and language features

Connections. Make links between aspects of text; make use of prior knowledge; understand and organise or sequence material; empathise with characters and situations; identify and comment on links between verbal and visual information; make use of multiple texts to respond, understand and formulate a view on a topic

Inference. Make inferences; explore author's purpose and question intent; identify and discuss purposes of text; predict possible outcomes; read critically for bias, stereotyping and propaganda; make judgements about events, characters, motivations in literary text

Surface. Grammar (identify word classes, use grammatically correct structure, identify features or characteristics of a text); punctuation; correct spelling

The first asTTle reading comprehension test was created using version 4 of the asTTle software. Preference was given to the content areas understanding, inference and connections. The selection was made by the teacher in charge of literacy in the school, and reflected a school focus for Year 7 participants on critical thinking. The test contained 28

Read Savages and Thieves, from Judith Wright's story Holidays, to answer questions 9 to 14.

SAVAGES AND THIEVES

Toby ran down the steep, guttered road from the shop, half-blind with tears. He was crying so much that he caught his foot in a root that ran out into the road from Ferguson's fig-tree and **barked** a knee and his chin on the hot gravel. As it was impossible for him to cry louder than he had been, he now fell silent, and limping home, only sobbed. But the tears fell in a flood.

10. What does the first paragraph mainly describe?

- what Toby's street looks like
- the Savage Gang's attack on Toby
- Toby's journey back from the shop
- Eleanor and John in the garden

11. Why did Eleanor offer Toby a sugar lump?

Figure 9. Sample asTTle reading comprehension test questions. Question 10 is an example of a "closed" question, while question 11 is an example of an "open" question.

open and 8 closed items (Figure 9), and included a scoring guide for the teachers' use. The test information was entered into the asTTle database by teachers after they had finished marking.

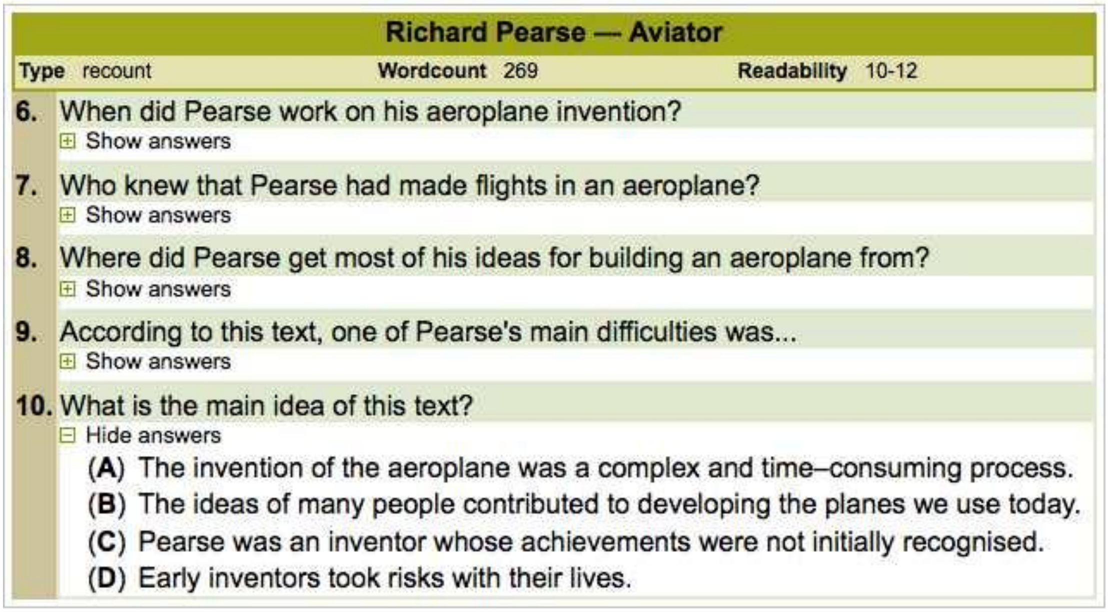
Relevant data were able to be exported into a spreadsheet by the researcher where it was accessible for analysis. At present the asTTle tests are administered as pencil and paper tests. They are designed to take 40 minutes of actual testing time, with overheads such as setting up the class, filling in the front of the test booklet and completing the practice questions requiring additional time. Deviations from the 40 minute recommended time can have the potential to invalidate the norming information from which comparisons of how participants are doing compared with peers in other schools is derived. The teachers marked their own class tests and the results were entered into a central database from which the asTTle software can produce a variety of reports.

The second asTTle Reading Comprehension Test was constructed similarly, with the emphasis again being on the content areas understanding, inference and connections. The second test questions were mainly at the level 4 difficulty (New Zealand Curriculum Levels), whereas the questions in the first test were mainly set at Level 3. This was in line with the expectation that the overall achievement levels of the Year 8 cohort would have increased over their achievement levels when in Year 7. Data from the asTTle tests are discussed in Chapter 4 in the sections "Group Comparison: The Original Study" and "Strategy Use and asTTle". A CFA of the asTTle results is discussed in Chapter 5 in the section 'Measurement Model for "Reading Comprehension for Print Text"'.

The replication study: PAT reading comprehension test

The Progressive Achievement Test (PAT) for reading comprehension is produced by the New Zealand Council for Educational Research (NZCER). Information about this tool can be accessed via their web site http://www.nzcer.org.nz. The content is fixed, and schools select from a range of test levels to match the groups of students they are testing. The results of each test are reported on scales which allow comparison of results across tests of different levels. All the questions are multi-choice (Figure

10) and consist of: (a) retrieval questions, where the reader matches the wording of the question to the wording in the text, (b) local inference questions, requiring the reader to comprehend implied information from within a relatively small section of text, and (c) global inference questions, where the reader is required to comprehend implied information from across larger sections of text. The test allows teachers to gain insight into students' ability to use abstract information, separated information, multiple pieces of information, implies information, vocabulary and grammatical structures. The later is possible due to a smorgasbord of narrative, poetic, persuasive, explanation, report and recount text types being used in each test.


Richard Pearse — Aviator

Type recount **Wordcount** 269 **Readability** 10-12

6. When did Pearse work on his aeroplane invention?
⊞ Show answers

7. Who knew that Pearse had made flights in an aeroplane?
⊞ Show answers

8. Where did Pearse get most of his ideas for building an aeroplane from?
⊞ Show answers

9. According to this text, one of Pearse's main difficulties was...
⊞ Show answers

10. What is the main idea of this text?
⊟ Hide answers
(A) The invention of the aeroplane was a complex and time–consuming process.
(B) The ideas of many people contributed to developing the planes we use today.
(C) Pearse was an inventor whose achievements were not initially recognised.
(D) Early inventors took risks with their lives.

Figure 10. Sample questions for a reading passage in a PAT reading comprehension test. Questions 6 – 9 are classified as local inference questions, while question 10 is classified as a global inference question.

The test was carried out as a 45 minute pencil and paper test. Classroom teachers were able to enter the students' raw results on-line and then view, or download, a variety of reports. Data from the PAT Tests are discussed in Chapter 4 in the section "Group Comparisons: The Replication Study"

Modified MSLQ Questionnaire

The Motivated Strategies for Learning Questionnaire (MSLQ) is a self-report instrument that was developed by a team of researchers from the National Centre for Research to Improve Postsecondary Teaching and Learning (NCRIPTAL) and the School of Education at the University of Michigan. Based on a general cognitive view of motivation and learning strategies, the questionnaire contains 81 questions, divided into two sections. A "motivation" section contains 31 items that assess participants' goals and value beliefs about a course of instruction. A "learning strategy" section contains 31 items that asses participants' use of different cognitive and metacognitive strategies, and a further 19 items concerning participant management of different resources. The present version of the MSLQ (1991) is the result of three previous "waves" of testing and re-designing. Up to 150 questions were rigorously scrutinised in its development.

The researcher, with permission from the University of Michigan School of Education, adapted 32 questions from the learning strategy section of the MSLQ, incorporating them into a modified version of the MSLQ questionnaire called "How I Make Sense of what I am Reading". The questions encompassed seven dimensions (Pintrich, Smith, Garcia & McKeachie, 1999):

Rehearsal. Rehearsal strategies involve reciting or naming items from a list to be learned. They appear to be best used for simple tasks and activation of information in working memory, rather than the acquisition of new information in long-term memory.

Elaboration. Elaboration strategies help participants store information into long-term memory by building internal connections between items to be learned. Paraphrasing, summarising and generative note-taking, for example, help the learner integrate and connect new information with prior knowledge.

Organisation. Organisation strategies help the learner select appropriate information and also to construct connections among the information to be learned. Selecting the main idea in a reading passage and creating an outline are examples of this type of strategy. Organising activities result in the learner becoming actively involved with the task.

Critical thinking. Critical thinking refers to the degree to which participants report applying previous knowledge to new situations in order to solve problems, reach decisions, or make critical evaluations with respect to standards of excellence.

Metacognitive self-regulation. Metacognition refers to the awareness, knowledge, and control of cognition. The questions in the MSLQ only address the control and self-regulation aspects. Three general processes are involved: planning, monitoring and regulating. Planning activities, such as goal-setting and task analysis, help to activate relevant aspects of prior knowledge that make organising and understanding the material easier. Monitoring activities include tracking one's attention as one reads, and self-testing and questioning. These activities assist the learner in understanding the material and integrating it with prior knowledge. Regulating refers to the fine-tuning and adjustment of one's cognitive activities in order to improve performance through checking and correcting behaviour while undertaking a task.

Effort regulation. Effort regulation is about self-management and the participants' ability to control their effort and attention in the face of distractions and uninteresting tasks. It is important to academic success because of its direct relationship with goal commitment and the continued use of learning strategies.

Help seeking. Participants must also learn to manage the support of others, both peers and teachers. Good participants know when they do not know something and are able to identify someone to provide them with some assistance. A large body of research indicates that peer help, peer tutoring and individual teacher assistance facilitate participant achievement.

Modification of the MSLQ questionnaire was not confined to just question selection. As the questionnaire had been developed for use with much older participants than the participants in this study, the researcher re-worded the questions to be used so that they were more age appropriate (Table 8) and the focus was kept on the act of reading comprehension. The wording of the questions was vetted by the two teachers of the classes involved in the study and also an independent scrutineer, an experienced teacher of English and English as a Second Language.

Table 8
Some examples of questions from the original MSLQ questionnaire, and their modified counterparts as used in this study

Original Question	Modified Question
When reading for this class, I try to relate the material to what I already know	I try to make sense of what I am reading by thinking about what I already know or have already read
Even when course materials are dull and uninteresting, I manage to keep working until I finish	Even if the material I am reading is boring, I manage to keep working until I have finished
When reading for this course, I make up questions to help focus my reading	Before I start to read, I think up questions I would like to know the answers to

The scoring for the questionnaire was also modified. The original instrument made use of a seven point Likert scale with descriptors for only the scale end-points (Figure 11), whereas the modified instrument made use of a 6 point Likert scale with descriptors for each point on the scale (Figure 12). A six point scale was chosen to avoid “fence sitting” where choosing the middle value can represent a neutral choice. Some of the questions in the questionnaire were “reversed coded” in that they were negatively worded. This has implications for rating participant answers for those questions in that it was necessary to record the "complementary" score for consistency. For example, a raw score "2" would be recorded as "4" (since 6 – 2 = 4).

not at all true of me						very true of me
1	2	3	4	5	6	7

Figure 11. The Likert scale used in the original MSQL questionnaire.

Never	*Not very Often*	*Often*	*Quite Often*	*Most of the Time*	*All the Time*

Figure 12. The Likert scale for the modified MSLQ scale used in this study.

The modified MSLQ questionnaire was appended with a cover page which recorded the participant's name and group. Brief instructions were included which explained to participants the procedure to be followed in completing the questionnaire (Figure 13).

The following questions ask about how you try to understand/make sense of things you have to read. **There are no right or wrong answers, just answer as carefully as possible.** For each question, put a tick (√) in the box under the heading that best describes what you do.

	Never	*Not very Often*	*Often*	*Quite Often*	*Most of the Time*	*All the Time*
When I am reading I first of all look at section headings, and labels for diagrams, to get an idea						

Figure 13. Instructions for participants on how to complete the modified MSLQ questionnaire.

Data from the MSLQ questionnaire are discussed in Chapter 4 in the section “Prior Study Strategy Use: the MSLQ questionnaire” and a CFA for the MSLQ questionnaire results is discussed in Chapter 5 in the section “Measurement Model for ‘Existing Cognitive Strategies’”

WWW SSURF Acronymous Metacognitive Learning Strategy

Several studies in recent times have attempted to address the question of how to improve reading comprehension outcomes when students are accessing information directly from the Internet. These studies employ a common device, namely the use of specialised computer software to scaffold the students’ learning process (Graesser, McNamara & VanLehn, 2005; Quintana, Zhang, Krajcik, 2005; White & Frederiksen, 2005). These approaches make non-sequential use of multilevel instructional processes. Research into self-regulation, however, informs us that sequential multilevel training enhances metacognitive competence and also students’ motivational self-beliefs (Zimmerman & Tsikalas, 2005). A more recent study, which also makes use of specialised computer software, comes closer to the ideal of sequential multilevel training (Sung, Chang & Hauang, 2007). Its focus, however, is still on the training of cognitive strategies (selecting, organising, integrating and monitoring, for example) rather than on the process for efficiently integrating these strategies in a metacognitive sense. In addition, with 22 training sessions over 11 weeks, the overheads required to establish competent use of the software and its processes, seem excessive.

The scaffolding provided by the acronymous metacognitive strategy WWW SSURF developed for this study adopts a different philosophy to these Computer Based Learning Environment (CBLE) solutions (Azvedo, 2005). WWW SSURF does not start with the assumption that students need to learn, or re-learn, multiple cognitive strategies, but rather serves to activate strategies appropriately that they are already in possession of, but do not necessarily readily transfer to new or different situations. The WWW SSURF strategy does not require the significant amount of training often required for teachers to become familiar with using a strategy and being able to teach it to their students (Duffy, 1993). In addition, the WWW SSURF strategy has one further advantage which sets it apart from recent approaches, it is portable. The CBLE solutions require access to a computer and also the specialised software which scaffolds the process. The results of students' efforts are stored electronically. The WWW SSURF strategy makes use of a simple booklet which scaffolds the strategy and allows students to record information of their choice. The booklet can then be taken away from the computer environment and the information is readily available for the student to make use of in their classroom. On-going use of the strategy is independent of a particular computer and its specialised software. In addition, the WWW SSURF strategy can also be effectively used in a regular print-text based environment.

The learning outcome for the participants in this study was to be able to locate and choose relevant information from a selection of web pages that would enable them to write answers to the questions that their teachers had posed. From the literature search a number of factors associated with successful comprehension of print-based text were identified which might be woven into the strategy:

- Formulate a strategy using prior knowledge
- Repair comprehension by re-reading more carefully
- Monitor comprehension using skim reading to locate specific information
- Check understanding by asking self questions
- Foster understanding by pausing during reading and rephrasing a passage in own words
- Work from the big picture to the small details

Additional factors were identified associated with reading comprehension of web-text:

- Navigation: readers need ways to keep track of their moves through the web structure
- Look for structure. Aim to read systematically and sequentially in the sense of following logical, rather than random, pathways
- Use of critical analysis skills for multimedia environments to sift and evaluate the vast amounts of information available
- Make use of cues for what to read, when to read and how much to read
- Make use of traditional transaction forms: find, evaluate, use and communicate
- Scaffolding for guidance in determining the best sequences to follow, the amount to read and the format in which to receive information
- Use knowledge of net navigation
- Make decisions about continuing with a web page or moving on
- Flexibility of choice in which leads to follow
- Use keywords and phrases to locate relevant information and search for new sites

The acronymous metacognitive learning strategy, WWW SSURF, was constructed following the algorithm for constructing acronymous learning strategies mooted by Lambert (2000) which, for the reader's convenience, is repeated here:

Step 1 Select a learning outcome.

Step 2 Task analyses the learning outcome (i.e., identify what steps leads to success).

Step 3 Rearrange the wording of the steps if possible.

Step 4 Ask yourself if you can create a word using the first letters of each step.

Step 5 Try to create a word that relates to the strategy (this will make it easier for students to remember the strategy).

Step 6 Examine synonyms for key words in each step. This will help create a word.

Step 7 Add lower case letters to help spell the word (these would not be steps of the strategy).

Step 8 You did it!

The first part of the strategy, “WWW”, sets up cues for a logical approach to interrogating web sites and the pages of information that they contain. The second part of the strategy, “SSURF”, sets up the processes for finding and evaluating the relevance of embedded information. Users of the strategy starts at the “top” by skim reading pages to gain a first impression, then “drill down” into the pages using a selection of cognitive strategies to arrive at a personal final choice of information to use. The acronym itself is designed to help the participants recall the elements of this strategy. It is designed to be readily remembered as the participants in the study were cognisant of the terminology the “World Wide Web (WWW)” and the concept of “surfing the Web”. The elements of the strategy may be explained in this way:

What do I already know? Before I start, I will think about what I already know.

What do I need to find out? I will make use of key words and/or phrases to help me find useful information.

Where can I find what I need to know? I will choose new pages or new web sites to go to, to find the information I am looking for.

Skim read pages. I will skim read through each new page, including headings and labels of diagrams, looking for my key words/phrases to get an idea if the page might have useful information.

Systematically start reading pages. I will read carefully through the pages that look to have useful information, a paragraph or section at a time.

Understanding what I am reading. I will use my classroom strategies for reading print-text to help me understand what I am reading on the Internet.

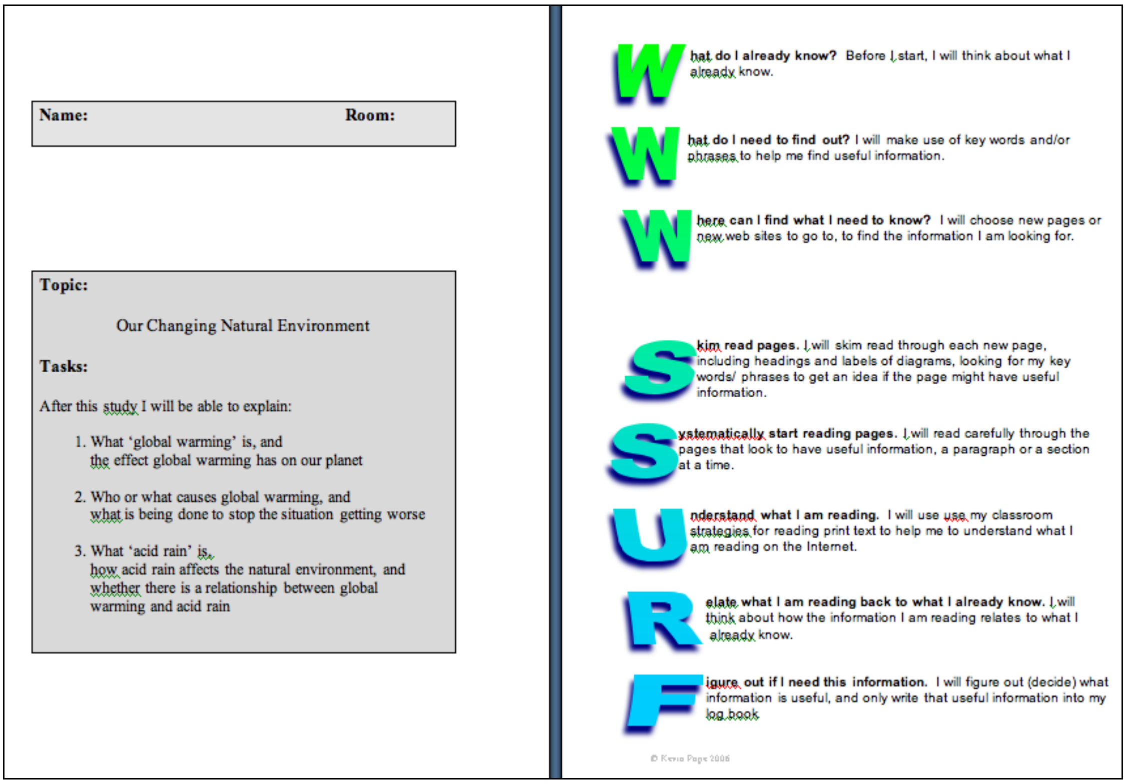
Relate what I am reading back to what I already know. I will think about how the information I am reading relates to what I already know.

Figure out if I need this information. I will figure out (decide) what information is useful, and only write that useful information into my log book.

Log Books and Answers to Questions Set by Teachers

The Original Study

Integral to the use of the WWW SSURF strategy is the participant workbook which serves to scaffold the strategy use for the participants, and records their findings in a format that is portable, allowing them to take their information away from the computers back into their class rooms where that information could then be readily accessed. The first part of the booklet set up the process, and was designed to keep important information readily accessible to the participants. The first page identified the booklet with an individual participant and recorded the academic goals for the study, expressed as learning intentions, and the second page contained a statement of the elements of the WWW SSURF strategy (Figure 14).



Name: **Room:**

Topic:

Our Changing Natural Environment

Tasks:

After this study I will be able to explain:

1. What 'global warming' is, and the effect global warming has on our planet
2. Who or what causes global warming, and what is being done to stop the situation getting worse
3. What 'acid rain' is, how acid rain affects the natural environment, and whether there is a relationship between global warming and acid rain

What do I already know? Before I start, I will think about what I already know.

What do I need to find out? I will make use of key words and/or phrases to help me find useful information.

Where can I find what I need to know? I will choose new pages or new web sites to go to, to find the information I am looking for.

Skim read pages. I will skim read through each new page, including headings and labels of diagrams, looking for my key words/ phrases to get an idea if the page might have useful information.

Systematically start reading pages. I will read carefully through the pages that look to have useful information, a paragraph or a section at a time.

Understand what I am reading. I will use use my classroom strategies for reading print text to help me to understand what I am reading on the Internet.

Relate what I am reading back to what I already know. I will think about how the information I am reading relates to what I already know.

Figure out if I need this information. I will figure out (decide) what information is useful, and only write that useful information into my log book

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Figure14. The first page of the participant booklet detailed the questions participants were seeking to find answers to. The second page provided an explanation of the elements of the WWW SSURF strategy.

The following two pages were where the participants recorded their prior knowledge and choice of key words and phrases (Figure 15). Information acquired in one session of the study can become prior knowledge for later sessions. Similarly, additional key words and phrases can become helpful as the study progresses and the "My key words and phrases" page contains space to record these if there is the need.

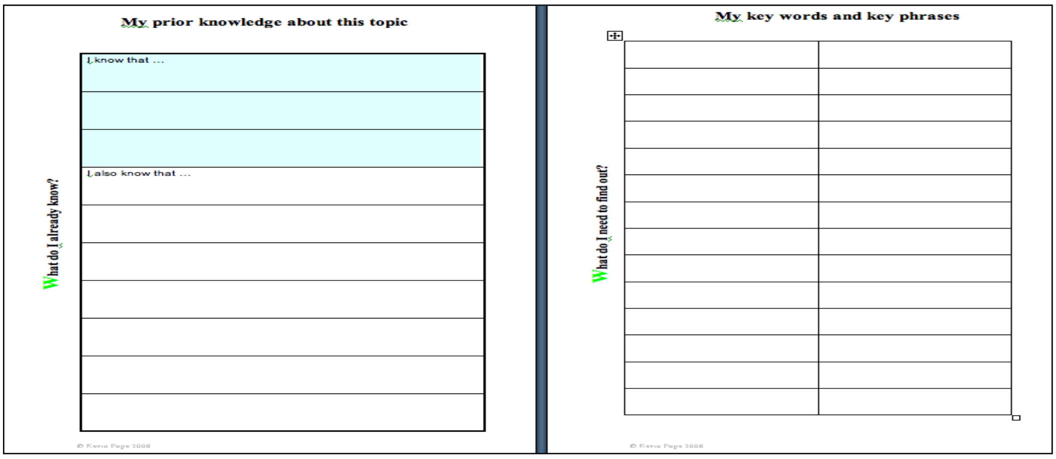

Figure 15. The third page is used to record prior knowledge and the fourth page the key words and phrases chosen to be used by the participant.

The second part of the booklet contains four sets of four pages, corresponding to the four sessions when participants would use the Internet to research the questions set by the teachers (Figure 16). Three pages provided space for the participants to record information that they thought they might subsequently use in writing answer to the questions. These pages were divided into segments to

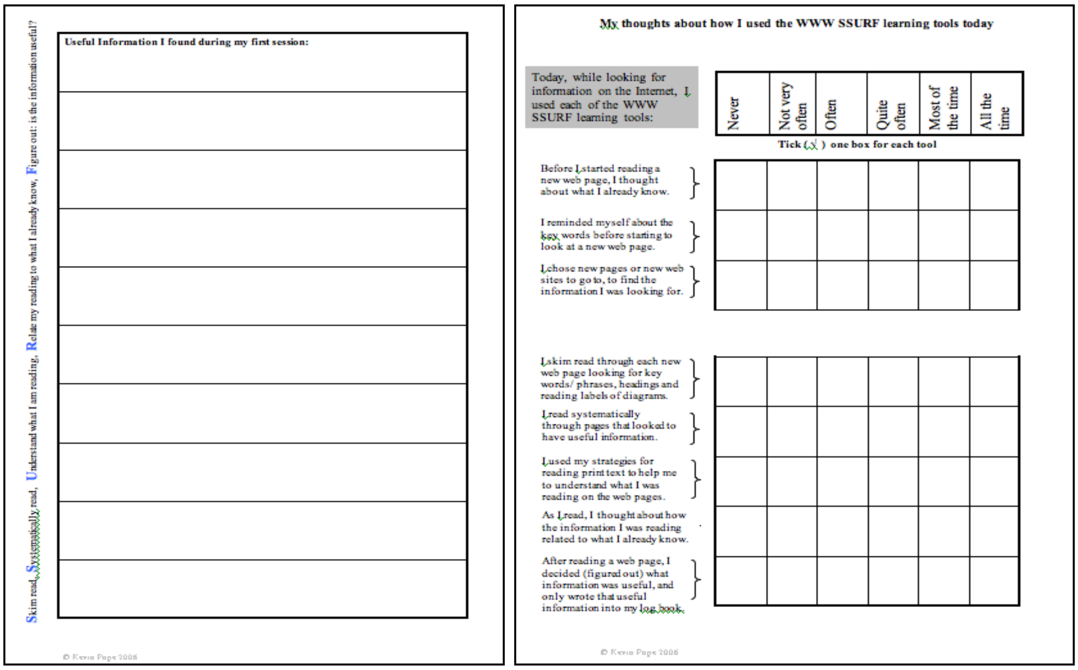

Figure 16. A sample page for recording information and the page used for the end-of-session reflection on the use of the strategy elements.

remind students that they would only be recording information in list form; they were not encouraged to write paragraphs. How they were to use the spaces in the booklet was not prescribed.

The elements of the second part of the strategy were kept in front of the participants, being restated in the left hand page margins, while the wording of the strategy elements was altered in the questionnaire on the fourth page (Table 9) to foster reflection on their use in the session that the participants had just completed. At the completion of the study the participants were asked to provide written answers, in paragraph form, to the questions set by the teachers. The notes that they had recorded in their log books provided the source data for this task.

Table 9
Some strategy elements and their re-worded counterparts in the reflective questionnaire

Statement of Strategy Element	Statement in Reflective Questionnaire
What do I already know? Before I start, I will think about what I already know	Before I started reading a new web page, I thought about what I already know
What do I need to find out? I will make use of key words and/or phrases to help me find useful information.	I reminded myself about the key words before starting to look at a new web page
Relate what I am reading back to what I already know. I will think about how the information I am reading relates to what I already know.	As I read, I thought about how the information I was reading related to what I already knew.

Data from the participants' log books relating to information the study participants recorded to make use of in answering the questions set by their teachers are discussed in Chapter 4 in the section "The WWW SSURF Strategy" and, also, in Chapter 5 in the section "Relationship between Reading Age and Information Obtained". Data from the Reflective Questionnaire completed by participants at the end of each session are discussed in Chapter 4 in the section "Strategy Use". A CFA for the Reflective Questionnaire is discussed in Chapter 5 in the section "Measurement model for 'Metacognitive Strategy Use'".

The Replication Study

In this second study the experimental group (Group 1) received the same materials and undertook their tasks under almost the same conditions as the groups in the original study. In this second study the researcher introduced the use of the WWW SSURF strategy to the experimental group and also supervised the experimental and comparison groups during their sessions with the computers. This change was made to eliminate the "teacher effect" when comparing the outcomes for the two groups; it did, however, introduce a potentially serious complication referred to as the "experimenter effect". Researchers have attitudes, values, biases and needs that may contaminate a study deliberately or unintentionally, biasing the results in the direction of the experimenter's expectations. This may occur in the experimenter-participant interactions by way of using a more positive voice tone, displaying different attitudes, or being more reassuring with the experimental group (McMillan, 2007). These effects are most probable in studies where the researcher gathers the data, administers the instrument and/or carries out the intervention. Specific procedures can be included in the study to limit the experimenter effect. The researcher can, for example, develop a specific protocol for gathering data and administering the intervention. In the present study, implementation of the intervention was carefully scripted (refer to "Teacher demonstration materials" later in this chapter) and specific, supervision-independent, protocols put in place to gather the necessary data (refer to the previous section in this chapter ”Logbooks and Answers to Questions Set by Teachers; The Original Study).

Another approach to this problem is adopt double-blind procedures which guard against the expectancy of both subjects and investigators. A typical biochemical experiment, for example, involving a test sample and a control would be carried out by two groups of participants, one of which does the experiment “blind” (that is they do not know which sample is which) and the other does the experiment with full knowledge of the samples (Sheldrake, 1998). This present study is quasi-experimental, not experimental, and the groups of participants themselves are the “samples”. If there was significant experimenter influence with the researcher supervising the groups in the replication study, this would be expected to show up in the form of one or more unanticipated anomalies when the results of the intervention group of the replication study are compared with the results of the groups in the original study, for example. In a sense this situation resembles a double-blind experimental situation, and the results, discussed in the following chapter “The Preliminary research Question; results and discussion” provide strong evidence for the absence of any significant experimenter effect.

The comparison group (Group 2) differed in the nature of the materials that they received. They also made use of a booklet, but apart from the cover which detailed the topic and tasks, and pages to record their findings, their booklets made no mention of the WWW SSURF strategy nor were they asked to complete a reflective questionnaire at the conclusion of each session. Group 2 students undertook their task without the benefit of the WWW SSURF, or any other prescribed strategy. They were expected to draw on such skills as they had learned from their previous experiences. Neither group in the replication study were asked to provide answers to the questions in paragraph form for reasons outlined in the following chapter: “The Preliminary Research Question: results and discussion”.

Gunning FOG Index

The Gunning FOG Index is a tool used to calculate the reading age associated with print-based text. The algorithm for computing the Gunning FOG index manually is as follows:

Select three samples of 100 words from the text. For each sample

(a) Calculate the average sentence length by dividing the number of words by the number of sentences. Calculate the average sentence length for the three sample (L), rounding to the nearest tenth. Next,

(b) Count the number of words with three or more syllables. Find the average number of these words per sample, and then compute the average (N) over the three samples.

Note: When counting syllables it is helpful to say the word out aloud. Some examples are:

u-ni-verse (3), as-tron-o-my (4), for-tu-nate-ly (4), gal-ax-y (3), ar-e-a (3), passed (1), spi-ral (2)

(c) The grade level needed to understand the material is found by computing (L + N) x 0.4, and

(d) The reading age, in years, by computing [(L + N) x 0.4] + 5

A convenient alternative for text embedded in web pages is to compute the Gunning FOG index for each of the pages used by submitting its Uniform Resource Locator (URL), or web address, to http://juicystudio.com/services/readability.php. Data from the FOG index are discussed in Chapter 5 in the section “Reading Ages of Web Pages”.

The following rubric for evaluating the "usability" of web sites (Figure 17) is based on two different rubrics; one developed by Arney, Jones and Blankenship (2003) and, to a lesser degree, another developed by MacGregor and Lou (2004). It allows five dimensions of web site construction to be evaluated: ease of navigation, the degree to which relevant information is present, the amount and usefulness of visual and audio support, discourse quality, and general appearance.

Navigation		
Links are easy to use (e.g., it is unambiguous where the links will take the user to and information is generally no more than one click away). [0 = No, 1 = Yes]		
A mechanism is provided that lets the user keep track of where they are and readily return to previous pages [0 = No, 1 = Yes]		
Content Presentation		
The site offers sufficient information for the user's needs [0 = None, 1 = information for one aspect being researched, …, 4 = information for 4 (or more) aspects being researched]		
Multimedia Contribution		

Figure 17. Part of the rubric for assessing the "usability" of web sites.

Navigation. Navigation is facilitated through a limited uses of layers of menus and submenus. In general, it is desirable that useful information is literally accessed with only one mouse click. Navigation is enhanced with the presence of site and section locators which allow the user to determine their position in a document and return to an earlier page.

Content presentation. The adequacy of the information provided in a web site is determined by its relevance to the task objectives and breadth of coverage. It is helpful if it is presented in "chunks", and provides progressive levels of detail. This allows the user to stop whenever sufficient information has been retrieved.

Multimedia. Video clips and other animations can be helpful in demonstrating concepts, and still graphics can help to make text elements more explicit, for example. Their usefulness depends on relevance to the text and their clarity.

Discourse features. The web pages should 'speak the users' language'. Vocabulary should be at an appropriate level for the user, and it is helpful if the content is signposted with appropriate headings.

General appearance. Visually pleasing displays and the absence of irrelevant or distracting material enhance accessibility for the user. Pages covered in text, or 'busy' space filled with lots of text, photographs and/or diagrams detract for the sites usability.

Data from the Usability Rubric are discussed in Chapter 5 in the section "Usability of Web Pages". A CFA for the rubric is discussed in the section "Measurement Model for 'Usability of a Web Site'" of the same chapter.

Teacher Demonstration Materials

The following materials were developed to explain the use of the WWW SSURF strategy and the participant workbook to the staff involved, and to provide them with material that they could use to explain the process to the students in their turn:

Using the WWW SSURF Strategy

The strategy involves the student use of a booklet to aid their research when using the Internet as a source of information. The booklet serves both as a research logbook in which students record in note form information that they would like to make use of in a project, and as a memory aid to help them to use cognitive strategies to make sense of what they are reading. The overall process is metacognitive as students are continually encouraged to think about which cognitive strategies are currently appropriate. They are also asked briefly to reflect on their use of the cognitive strategies at the end of each session, and use the results of previous sessions on the Internet to guide them in their next session.

The process starts with a short teacher-led demonstration, using the sample topic "Balanced and Unbalanced Forces", following these steps:

(a) Help the students to quickly establish their prior knowledge, the **W**hat they already know.

Note:

Before reading, it is important that students know why they are going to be reading the text and have a clear idea about what they want from it. In other words, a project should have clear objectives with specific content tasks for the students to complete.

If the topic was "Forces" for example, rather than asking students to "Find out about Forces", set them specific tasks: e.g., Find out about balanced and unbalanced forces and use this to explain why a boat floats, why a plane stays up in the air, why a jet engine moves a plane forward or why we can move along the ground by walking or running, for example. In this way, students can gain knowledge about facts, and develop understanding of concepts.

a. Organise the students into small groups of about 4. Designate a leader to report back for the group. Introduce the task (printed on front of student research logbooks):

Topic:

Balanced and Unbalanced Forces

Tasks:

1. Find out what forces are involved in a "tug of war" match and then explain what is happening when the rope is not moving.

2. Find out what forces are involved when a space shuttle takes off and then explain why the shuttle can leave the ground.

3. Find out what forces are acting on a motor vehicle as it travels along the road at a steady speed. Explain why the forces are balanced or unbalanced.

4. Isaac Newton investigated balanced and unbalanced forces and described them in his "Laws of Motion". Which particular "Law of Motion" applies to each of the situations that you investigated in Tasks 1, 2 and 3 above?

Give the groups approximately three minutes for individuals to write in their booklets under the heading "I know that" on the "My prior knowledge" page, then approximately another 5 for the group to brainstorm the topic and record group knowledge on some A3 paper. The A3 paper should have the group members' names written on it and be collected in and returned to the researcher at the end of the first session.

b. Have the group leaders report back and record their responses on the board for all to see

c. Allow a couple more minutes and invite further, individual, contributions.

d. Have the class determine (vote by show of hands?) the six or so “more important/useful” known facts

e. Allow three to four minutes for the students to record the chosen facts on the “My prior knowledge about this topic” page of their booklet under the heading “I also know that”.

(b) The next step is to determine **W**hat do I need to find out?

a. Either use the same small group/whole group structure as before and give a short time to brainstorm some ‘key words’ and or phrases (vocab that relates to the topic), or, suggest a couple of key words/phrases yourself, then ask the students to contribute.

b. Again, write all suggestions up on the board then engage the students in some process for choosing six or so words and/or phrases to use as search terms. In this project they will be mainly used to help locate useful information when reading web pages. In a larger project, they could also be used as search terms in search engines to find further, relevant, web sites.

c. Allow approximately three minutes for the students to record the chosen key words and/or phrases on the “My key words and key phrases” page of their booklet.

(c) Next, the students need to know **W**here they can find the information they will be looking for.

   a. Have the students record on the “Web sites I can explore” page of their booklet the url of the web site(s) that you have chosen for them to explore in this project.

      http://www.bbc.co.uk/scotland/education/bitesize/standard/physics/forces_and_motion/newtons_laws_rev1.shtml

   b. You can mention that later, if there is time to do a search using a search engine, they can record the addresses of any further web sites that they will be exploring. In a larger project, they would in fact do this. Allow a couple more minutes and invite further, individual, contributions.

(d) The next step is to go to the web site and start **S**kim reading the pages.

   a. Students need to look for the key words and phrases to pick out passages that may have relevant information

   b. Any headings used in the text and captions (labels) for diagrams and tables may also give clues to useful information.

(e) Talk through several pages/passages with students reminding them how to use their normal classroom reading strategies.

Note:

In the following, make sure that you particularly remind students to use specific reading comprehension strategies that you have been using with print-based material in class. Many of your classroom strategies are made use of in the WWW SSURF strategy. This strategy should therefore reinforce/support your other work with students in class. **Teachers should not give specific answers to students questions (unless clarifying the meaning of a word for example) but should freely give help of the "feed-back and feed-forward" kind**, making specific use of the steps of the WWW SSURF strategy to reinforce this process with students.

a. **S**ystematically (carefully) read the passages identified as possibly having something useful in the skim-reading phase. This is sometimes called "overviewing" a text.

b. Actively try to **U**nderstand what is being read by making sure that all words are understood (use dictionary/thesaurus, ask the teacher), asking questions, creating mental images or visualising, identifying the writers purpose and point of view, identifying the main idea or theme. Pause to think about what has just been said. Try to restate important ideas. Seek clarification when confused.

c. Work out how this new information helps us by **R**elating what is being read back to things that we already know (try to fill in information gaps in the text, make connections with other bits of knowledge, analysing and synthesising ideas, information, structures, features in the text).

d. **F**igure out what information is particularly going to be useful by evaluating the information and ideas in terms of the "What do I need to find out?" Only record useful information on the "Useful information I found out during my first (etc) session" pages.

(f) Have students complete a brief self-evaluation of their use of the elements of the strategy during the session. Spend 45 to 60 seconds (no more) having them tick <u>one</u> box for each descriptor on the "My thoughts about how I used the WWW SSURF learning tools today" following the "Useful information …" pages used during the session. Do not advertise the fact, but ticking on the lines between boxes will be quite acceptable. During this time, complete the "WWW SSURF learning tools that my students needed to use today" form.

(g) The booklets and teacher's feedback are collected in and returned to the researcher straight after the session. They will be returned to the teacher in time for the following session.

Note:

The above steps are repeated for <u>every new web page</u> that the student visits. It is not a case of using them "once each time". Cognitive strategies need to be used frequently. Following the above steps should be helpful the first time a web page is encountered, then parts of the above may be used multiple times as a student chooses what text they are going to be engaged with and struggles to make sense of it.

The students then start into their own research. They will have four sessions undertaking initial instruction in using the WWW SSURF strategy and undertaking the research:

Session 1 First: administer the "How I make sense of what I am Reading" questionnaire (approximately three minutes)

Next: Demonstrate using the strategy with the topic "Balanced and Unbalanced Forces".

Then: Introduce the class topic and tasks, then lead the students in their groups through steps (a) through (c), before students individually continue on using steps (d) through (g).

Sessions 2 to 5 Give students three to five minutes to read through all the information recorded in their booklets from the previous time. Then repeat steps (d) through (g) as before.

At the end of the project, students will be asked to provide written answers to the questions that they have been asked to research.

Data Analysis

All measured data are assessed for consistency through computation of Cronbach's alpha. Measured data for the two class groups are compared and any significant relationships reported in terms of effect size (Cohen's d). The rationale for this approach is that effect size provides more information than statistical significance; it provides information about the degree of significance. In this study effect size is reported in relation to differences between means and also in relation to differences in variation. Correlation is used to establish relationships between data elements and regression to establish the extent of these relationships. Graphs are made use of in order to visualise patterns.

In this project the dependent variables are the asTTle and PAT test scores, the modified MSLQ questionnaire data, the WWW SSURF data, the follow-up questionnaire data, and the scores derived from the students' log books and written answers to the questions set. The independent variables are the reading ages and usability scores associated with the web pages, and demographic data such as class group, ethnicity and gender.

Student Log Books and Answers to Questions Set by Teachers

The questions set by the teachers asked for a recount of factual information, and as such they engaged participants at the lower levels of higher order thinking. A count was made of items of information recovered by individual participants. The totals reflect participants' reading comprehension ability in so far as reading comprehension is a measure of the extent to which the participants were able to both understand the material they were reading and also the nature of the task that they had been set.

Reading Comprehension Test Data

The original study: asTTle data

The overall scores from the asTTle reading comprehension tests, aRs, provide comparative performance information for the two class groups in the study, and between the groups in the study and the rest of the year level cohort. Differences between the groups were assessed for both the test administered to the year group cohort prior to the study involving the use of the acronymous metacognitive learning strategy, and the second test administered at a later time following the study.

The replication study: PAT reading comprehension data

The overall scale scores from the PAT reading comprehension tests provide comparative information for the two class groups in the second study, and between the experimental group and the rest of the year level cohort. Differences between the groups were assessed for both the test administered to the year group cohort prior to the study involving the use of the acronymous metacognitive learning strategy, and the second test administered at a later time following the study.

Modified MSLQ Data

The data from the modified MSLQ questionnaire were derived from a Likert-type scale with values ranging from 1 (= never) through to 6 (= all the time). The elements from the modified MSLQ questionnaire were mapped onto corresponding elements of the WWW SSURF strategy which allowed for a comparison of the use of strategy elements prior to the study with strategy use at other times. The accuracy of the mapping was assessed by three raters and expressed as an inter-rater coefficient.

WWW SSURF Data

The data from the WWW SSURF study were derived from a Likert-type scale using the same scale of the modified MSLQ questionnaire. The data were obtained from repeated measures over four sessions. A comparison was made of the use of strategy elements between the two class groups of the original study, over the period of the study. Further comparisons of patterns in the relative use of strategy elements were also made between groupings which crossed group boundaries; participants who made use of the most information from the web sites with participants who made use of a lesser amount of information for example.

Reading Age Data

The reading age data are obtained by submitting each web page to an engine hosted by a web site which applies the algorithm for the Gunning FOG index to report the American grade level required in order to successfully understand the material on the web page. These data were then translated into reading ages for the New Zealand situation. A comparison was made between reading ages of pages and retrieval rates of information from those pages.

Usability Data

A comparison was made between the data relating to the five factors in the usability rubric, the reading age of web pages and retrieval rates of information by participants in the study.

Follow-Up Questionnaire Data

The data from the follow-up questionnaire parallel the data from the WWW SSURF strategy. The questionnaire used the same elements asking students about their on-going use of strategy elements when using computers to access information on the Internet together with an extra dimension which asked students about their use of strategy elements during the second asTTle reading test. Comparisons in patterns of relative usage of elements of the strategy since the study were made. Comparisons of the relative on-going use of strategy elements, and their use in connection with the second asTTle test, were made with strategy use during and prior to the study.

The software package “Statistical Packages for the Social Sciences” (SPSS) was used to test all of the data arising from this study for reliability. The software package “Analysis of Moment Structures” (AMOS) was used to carry out CFA to valid the measuring instruments used in this study, and also to validate a conceptual structural equation model (SEM) of the factors involved in successful reading comprehension for electronic text sourced from the Internet. The latent variables explored included: print-based text comprehension skills, cognitive skills, use of a metacognitive strategy, the usability of web sites.

Validity

The design for this study considered questions of internal and external validity.

Internal Validity

A preliminary evaluation of threats to internal validity (Wallen & Fraenkal, 2001, pp. 154-202)

suggests a strategy to mitigate adverse effects (Table 10). While “initial ability” rates as a high risk factor, meaningful differences between the two groups under study were able to be established by means of the first asTTle test. “Gender differences” were known prior to the study to not be an issue (section “Participants” above), nor was “location” as all students had equal access to the necessary computer equipment in a location that they had previously used in connection with their class programmes.

Table 10
Threats to internal validity

Possible Internal Validity Factor	Risk Level	Suggested Researcher's Response
Initial ability	High	Implement a control strategy
Gender	Moderate	Implement a control strategy
Loss of participants	Moderate	Examine effect if any
Location	High	Implement a control strategy
Instrument decay	Low	Not significant
Data collector characteristics	Moderate	Implement a control strategy
Data collector bias	High	Implement a control strategy
Testing	Low	Not significant
Extraneous events	Low	Examine effect if any
Maturation	Low	Not significant, but can be controlled for
Attitude of subjects	Low	Not significant
Regression	Low	Not significant but can be controlled for
Implementation	High	Implement a control strategy

.

"Data collector characteristics" and "Data collector bias" were not potential threats in this study as the means of collecting data were standardised and carried out independently of the researcher and the class teachers. "Implementation" was standardised and involved minimal external input (from class teachers, for example). The students use of log books and reflection sheets, and written notes from the teachers following each session, provided evidence for the reliability of the implementation of the strategy.

External Validity

The research design also addressed the issues of external validity. Four key factors are identified by Campbell & Stanley (1966):

(a) Participants' demographic characteristics may bias their performance in a manner that is not representative of the wider population.

This is able to be assessed through the asTTle testing which allows comparisons with national norms

(b) Pre-testing could serve as an unintentional variable.

While there were pre-study tests, these were not comparable with the final students' outputs, i.e., their written answers to questions, and so the participants did not have the opportunity to practice and were not given "clues" as to what they would need to know. In addition, the final output was a piece of written work with no 'right' or 'wrong' answers, based on the students' own notes rather than a test, which helped remove the motivation to try and learn the answers.

(c) The performance of participants can be more a product of, or reaction to, the experimental setting.

For example, access to certain resources (e.g., greater number of computers), an atypical setting (e.g., smaller group size, less noisy environment) or just being aware that being observed as participants in a study could have implications for generalisability. All participants in the study had equal access to the computer facilities. They were familiar with using these facilities from previous class work. The nature of the study, the participants using computers to gain information to be used in class, and no overt treatment in terms of special pre- and post- to expose their performance (which would be an abnormal situation) addressed these concerns.

(d) A study that uses multiple treatments and/or interventions may have limited generalisability as successive treatments may have a cumulative effect on performance.

There is always a certain amount of repetition when learning a new strategy. The WWW SSURF strategy is designed to be used recursively. This situation is different to the case where repeated use of the same or similar tests may contribute to improved test results, apart from any consideration of the use of a learning strategy.

Summary

The study took part in a setting that was congruous with the participants' normal class work, and work setting. Data were gathered about their print-based reading comprehension skills and a range of cognitive/metacognitive skills that the participants made use of prior to the study. The participants' use of the elements of the acronymous metacognitive learning strategy, WWW SSURF, was tracked during the study through the participants' log books. The log books also provided data about students prior knowledge relating to the questions the teachers had asked and together with the their written answers to the questions, data were also obtained about the participants' perception of the amount of information needed to adequately answer the questions. This directly related to their reading comprehension skills. Further data were obtained relating to the participants' on-going use of the strategy elements for both electronic text, sourced on the Internet, and print-based text. Analysis of these data allowed the effectiveness of using an acronymous metacognitive strategy designed to improve reading comprehension in an electronic environment to be evaluated and whether this, in turn, impacted on the participants' reading comprehension of print-based text. Participants' level of use of cognitive strategies and the pattern of usage of the individual strategy elements was able to be tracked from a point in time prior to the study, through the stages of the study, to a point in time beyond the study. This allowed for the uptake and sustainability of strategy use to be investigated and provide insight into how the elements of the strategy are applied in different situations. Data from the replication study involving an experimental and a comparison group, allowed for the effect of the WWW SSURF strategy's use to be compared with its not being used. Confirmatory factor analysis of a conceptual model for reading comprehension of web-text provided insight into the scope of factors contributing to success in this endeavour. The results from this study are presented and discussed in the following two chapters, "Chapter 4: The Preliminary Research Question: results and discussion", and "Chapter 5: The Primary Research Question: results and discussion."

CHAPTER 4

THE PRELIMINARY RESEARCH QUESTION: RESULTS AND DISCUSSION

The focus for this, the first of two chapters presenting the results of the study, is reading comprehension on the Internet through the consumers' lens. An analysis of the data addressing the preliminary research question, "Is the use of an acronymous metacognitive learning strategy a contributing factor to the ability to read web-text with understanding?" is presented and discussed. The research question is addressed in two main ways: first of all, through the reading comprehension outcomes for a group of participants who used the WWW SSURF strategy compared with the outcomes for a second group undertaking a parallel study, but without the use of the strategy and, secondly, by tracking the use of the strategy during the course of the study through repeated measurements. These approaches provide information about the uptake of the strategy by students and their use of the individual strategy elements over an extended period of time. A third way, the overall contribution that the acronymous metacognitive learning strategy WWW SSURF makes to reading comprehension outcomes for web-text, is a focus of the second research question which is considered in the following chapter "The Primary Research Question: Results and discussion".

Data relating to use of the WWW SSURF acronymous metacognitive strategy were gathered from two groups in the original study and one group in the replication study. Four data gathering tools, described in the Methods Chapter, were made use of in connection with the preliminary research question: the asTTle reading comprehension tests (used in the original study), the PAT reading comprehension tests (used in the replication study), the modified MSLQ questionnaire, and the WWW SSURF questionnaire. The asTTle tests are directly scored from their respective scoring rubrics; the modified MSLQ questionnaire, used to gain information about the study participants' possible use of cognitive and metacognitive strategies prior to the study and the WWW SSURF questionnaire, used to assess participants' use of cognitive and metacognitive strategies during and following the study, are self-assessment tools.

Self-assessment tools can offer either *multiple choice* or *forced choice* formats. A Likert type scale is in the multiple choice format. It allows the respondent to record their degree of consent or disagreement towards each question in the questionnaire (multiple choice), as opposed to choosing between two or more objects from a given group of objects, or, ranking a list of objects in some order (forced choice). The term *multiple choice* can be characterised as *graduated appraisal* (Karpatschof & Elkjaer, 2000). Gradation may be continuous or discrete. The latter is the case for a Likert type scale. Multiple choice data, as derived from a Likert type scale assessment tool, are *normative* and may be used for intra- as well as inter-individual comparison. Individual completion of a Likert scale type assessment can be subject to a *response bias* due to differences in the ways individuals respond, for example, a tendency to inflate or, alternatively, to understate one's feeling or opinion. If this is the case it becomes problematic to compare the relative responses of individuals. The data from the modified MSLQ questionnaire, and the other tools used in this study which employ a questionnaire using a Likert type response scale, are not used to compare individuals. The reliability of these data is considered in the following section "Data Reliability".

Data Reliability

Reliability of the overall asTTle reading scores (aRs) for the two asTTle reading comprehension tests used in the original study, and their six sub-scales (Finding Information, Knowledge, Understanding, Connections, Inference and Surface Features) was estimated using Cronbach's alpha for the study participants who had sat both tests. The estimate of reliability (alpha) for the first test was .94 and for the second test was .94. Data were also used from the whole year level cohort to investigate whether knowledge of the WWW SSURF strategy had a transfer effect to reading comprehension for print-based text. The estimate of reliability for the first test was .96, and for the second test was .95. The estimate of reliability for the overall PAT reading scores (aRs) for the PAT reading comprehension test used in the replication study was .88. Only subjects who sat both tests were included.

In the case of the modified MSLQ questionnaire, participants in both the original and the replication study were asked to record their responses to 39 items in the questionnaire, using a six point likert type scale. Scores for each of the seven categories (Rehearsal, Elaboration, Organisation, Critical Thinking, Self-Regulation, Effort and Help Seeking) ranged from 1, corresponding to the descriptor “Never”, through to 6 corresponding to the descriptor “All the Time”. The estimate of reliability was .84. Scores for each of the eight items of the Likert type scale for the WWW SSURF questionnaire ranged form 1, corresponding to the descriptor “Never” through to 6 corresponding to the descriptor “All the Time”. The estimate of reliability was .95.

These estimates of reliability allow us to proceed with confidence in the reliability of the baseline data.

The WWW SSURF Strategy

Group Comparisons: The Replication Study

The small scale replication study carried out during the second phase of this research involved two year eight classes. The classes were set the same learning outcomes as the classes involved in the original study. There were two differences in the procedures for this second study. The researcher, rather than the regular classroom teacher, supervised the students as they worked at the computers. One class (the "treatment" group) received the strategy instruction while the other class (the "comparison" group) had the use of a booklet to record their information in, but were not made aware of the strategy. As in the case of the original study, a "score" was computed reflecting the number of relevant discrete pieces of information that the students recorded in their logbooks to use in answering the questions set by their teachers. For example, consider the following extract from the introductory page to the "Kid's" web site about climate change provided by the United States Environmental Protection Agency (EPA):

> **Global Warming:** Global warming refers to an average increase in the Earth's temperature, which in turn causes changes in climate. A warmer Earth may lead to changes in rainfall patterns, a rise in sea level, and a wide range of impacts on plants, wildlife, and humans. When scientists talk about the issue of climate change, their concern is about global warming caused by human activities.
>
> (http://www.epa.gov/climatechange/kids/cc.html)

Possible pieces of information that could be relevant to answering one of the set questions might be:

1. Global warming refers to an average increase in the Earth's temperature, which in turn causes changes in climate
2. A warmer Earth may lead to changes in rainfall patterns, a rise in sea level, and a wide range of impacts on plants, wildlife, and humans
3. When scientists talk about the issue of climate change, their concern is about global warming caused by human activities

A catalogue (rubric) of possible relevant information for each question was similarly compiled by the researcher for all the web sites used by the study participants. Data derived from the use of this rubric are discussed in Chapter 5 in the section "Relationship Between Reading Age and Information Obtained."

The task for the students was to be able to access this information, understand how it related to the questions and then choose what they would use in answering the questions.

Traditional measurement of reading comprehension typically invites a response to short answer or multiple choice questions. The reader unpacks the question, searches the text, then either writes their short response, or selects the "best" answer from the choices given. Both of these approaches satisfy current definitions of reading comprehension which acknowledge that reading comprehension involves the construction of meaning from text using a wide variety of skills and knowledge (Paris, 2007). Choice of a measure of reading comprehension depends on the purpose of the assessment. When the researcher looked at the written answers of the participants in the original study and compared them with the student log books where the students had recorded the information that they had selected to use in their answers, it was apparent that there was no "added value" in considering the answers. The relevant information selected by participants was readily accessible from their logbooks where it had been recorded in list form.

The researcher therefore determined that the "scores", obtained as discussed in the preceding paragraphs, would suit the purpose of the assessment. The items were "scored" by referring to the rubric of possible relevant information as discussed above. The reliability of the scores is ensured by using this common standard. Justification for this approach can be found in contemporary research literature

Assessment of reading comprehension is acknowledged to be challenging because it is a complex and multiply determined outcome (Snow, 2002a). This has led to different perspectives on what, exactly, should be assessed. Suggestions range from the erudite "measure of the student's ability to construct deeper meanings from what they read in relation to what they already know" (Snyder, Caccamise & Wise, 2005, p. 41), to the utilitarian "assessments should draw on a number of components of comprehension, including background knowledge, cognitive and metacognitive strategies, inference, vocabulary and working memory" (Mislevy, 2003, p. 18). There is, however, general agreement that reading comprehension is a complex cognitive ability requiring the capacity to integrate text information with the knowledge of the reader and resulting in the elaboration of a mental representation. (Meneghetti, Cerreti & de Beni, 2006). The outcome of successful reading comprehension is knowledge building.

One view of reading comprehension requires the reader to construct a “situation model” from the text they are reading. Situation models include information from the text, relevant prior knowledge, and inferences that relate the text and prior knowledge (Verhoeven & Perfetti, 2008). Reading web-text involves active reading and construction of a situation model. This is not a superficial task. At each point of choice the reader has to select a good continuation; specifically, choose to follow a new hyperlink that will contribute to the construction of a coherent situation model. Good readers are able to use existing knowledge to achieve this; low-knowledge readers will end up with a fragmented, disorganised situation model, unless they have access to appropriate guidance (Kintsch, 2009). Kintsch’s Construction-Integration (CI) model of reading comprehension is acknowledged as being a foundational model for a “cognitive architecture”, that is, a process model of reading comprehension. The construction component of the model involves the formation of an elaborated propositional network from elements of relevant knowledge, chosen with reference to the reader’s own knowledge. The Integration component involves the achievement of a final text representation by refining the elaborated propositional network into a coherent, interpretable whole (Wharton & Kintsch, 1991, pp. 169-170).

Guthrie (1988) tackles reading comprehension from a different perspective, the location of information in documents. His cognitive model for document reading contains five elements, which can be seen to correspond with elements of the WWW SSURF strategy used in this study:

1. Goal formation (this corresponds to the task set by the teacher for the students)
2. Category selection (W2, the selection of key words and phrases)
3. Extraction of information (a broad category corresponding with W3, locating web-sites and web-pages to use; S1, skim reading to locate web-pages with likely information; S2, systematic

reading of likely pages to find relevant content; U, use of classroom strategies for print-based text to facilitate understanding)

4. Integration (R, relating new information back to prior knowledge, W1, and F, finish, figure out if a particular bit of new information is relevant for the task and record it if it is)

5. Recycling. The above steps are repeated until task completion is achieved.

Theories of text comprehension, such as Kintsch's, explain how people build up mental representations from the reading of text, but have little to say about selective reading or the integration of information across multiple texts. On the other hand, theories of information search, such as Guthrie's, focus on selection and localisation processes, but have little to say about the comprehension and actual use of information in a problem-based situation (Rouet, 2010, p. 7).

Rouet's "Multiple Documents – Task based Relevance Assessment, and Content Extraction model" (MD-TRACE) builds on both these types of theories (Figure 18).

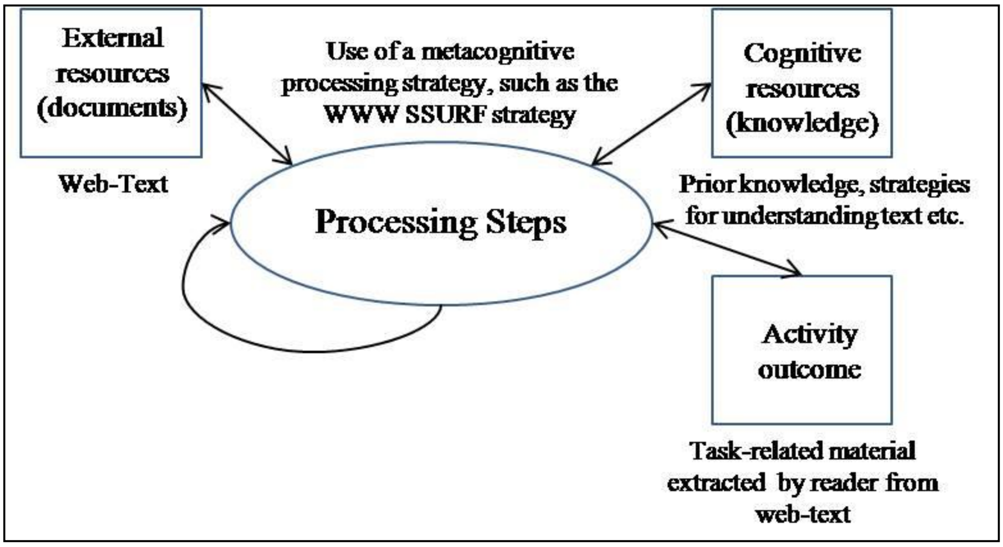

Figure 18. Rouet's MD-TRACE model of document use and its relationship to this study

The output, or "activity outcome", of the MD-TRACE model is the content extracted by the reader after processing web-text and making decisions about the relevance of the material being read with respect to the task. For example, information recorded by a student about "the highest railways in the world" would be an interesting adjunct, but not directly related to the topic "the highest mountains in the world".

Relevance, both in terms of the reliability of the source and also the information selected to complete a web-based task, is a key element of success in the reading comprehension process. The task-relevance of the material selected by the reader can therefore be used as a key indicator of the success of the reading comprehension process.

The entire year eight cohort had sat a PAT reading comprehension test prior to the study taking place. Over the course of the study, measurements were made at eight points. Two were the standard tests for reading comprehension held before and after the study. Six were surveys of strategy usage, prior-, during and post-study. The nature of an Intermediate school in New Zealand (Years 7 and 8) is that the population of classrooms can be quite mobile at times as students leave class for music lessons, inter school sports teams, and cultural group events for example. The summary information for the subset of students who sat the initial PAT test and were present for all six strategy usage measurements during the study were treatment N = 18, M = 59.2, SD = 7.76; comparison N = 17, M = 62.3, SD = 7.40.

While these data suggest that the treatment group was slightly less able than the comparison group with respect to reading comprehension ability for print-based text, a two-sample t-test, assuming equal variances, established that the difference was not enough to be statistically significant ($t(33) = 1.20$, $p = .12$).

Each of the classes had a wide range of students with abilities ranging from "above average" to "special needs". The treatment group recorded more pieces of information to use in answering the questions set by the teachers than the comparison group (treatment M = 8.9, comparison M = 4.9), and showed more variability across the group (treatment SD = 4.67, comparison SD = 2.76).

A two-sample t-test, assuming unequal variances, provided evidence to reject a hypothesis that the difference between the means for the treatment and comparison groups was zero ($t(33) = 3.15$, $p < .01$, $d = 1.08$). Cohen's effect size suggests a very large difference in the results, and provides strong support for the hypothesis that "the use of an acronymous metacognitive learning strategy *is* a contributing factor to the ability to read web-text with understanding".

Group Comparisons: The Original Study

The two groups in the original study both received the treatment, that is, they both received the strategy instruction. Prior to the study their year group cohort had sat an asTTle test, a standard assessment for reading comprehension ability with print based text. The summary information for the subset of students from each class who were present throughout the study were Group 1 $M = 610.7$, $SD = 35.13$; Group 2 $M = 534.4$, $SD = 62.05$.

Group 2 represented the wide range of abilities present in the school population while Group 1, by school policy, had a high proportion of "above average" students. A two-sample t-test, assuming unequal variances, provided strong evidence that there was a very large difference in ability between the two groups with respect to reading comprehension of print-based text ($t(40) = 5.45$, $p < .001$, $d=1.54$). This difference did not appear to be reflected in the amount of information recorded by students for use in answering the questions set by the teachers (Group 1 $M = 9.7$, $SD = 6.38$; Group 2 $M = 9.9$, $SD = 6.33$).

A two-sample t-test, assuming unequal variances, provided very strong evidence for not rejecting the hypothesis that the difference between the means for the two groups is zero ($t(43)= 0.15$, $p = .45$, $d = .04$). Cohen's effect size suggests a negligible difference in the results, both groups apparently performing very similarly in terms of the amount of information accessed and recorded to be used in answering the questions set for the study. The two preceding results provide evidence that the Internet is a “level playing field” in that prior ability to read print-based text appears not to be a significant factor in accessing information when reading web-text.

Strategy Use

Prior Study Strategy Use: the MSLQ questionnaire

In order to gain further insight into the uptake and effect of strategy use, relevant data were collected prior-, during, and post-study. The data gathered during and post-study involved the use of a self-reporting questionnaire, discussed in the previous chapter “Methods and Procedures” and the introduction to this chapter. The modified MSLQ questionnaire was used to estimate students’ prior use of the WWW SSURF strategy elements, without exposing them to the strategy itself. Figure 19 indicates that students in the original study predominantly reported using Critical Thinking (application of previous knowledge to solve problems, reach decisions or make critical evaluations), Elaboration (using strategies to integrate and connect new information with prior knowledge) and Effort (self-regulation of effort in the face of distractions and uninteresting tasks) as comprehension strategies.

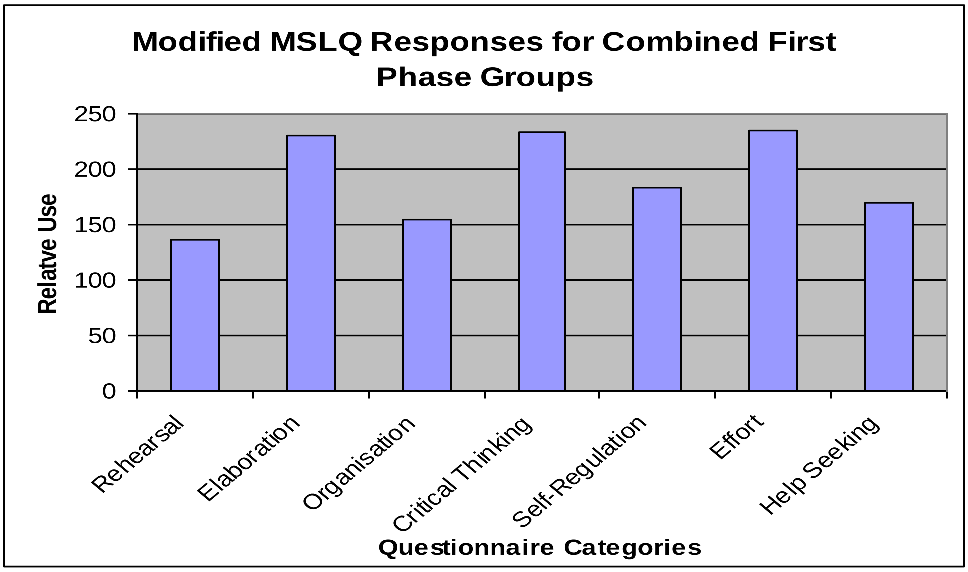

Figure 19. The modified MSLQ questionnaire identified critical thinking strategies amongst those reported by students as most often used. Prior to the study, critical thinking skills had been a focus in the classroom for the year level cohort the study participants were drawn from.

In order to provide a basis for comparison with data from the study the individual questions from the modified MSLQ questionnaire were mapped by the researcher and two independent raters onto the elements of the WWW SSURF strategy (Figure 20). The estimate for inter-rater reliability was = .82. The most commonly used elements prior to the study were: W3 (making choices where to look for relevant information), S1 (skim reading to locate information) and S2 (systematic reading to access information), although the figure indicates that all the strategies were in use by students prior to the study.

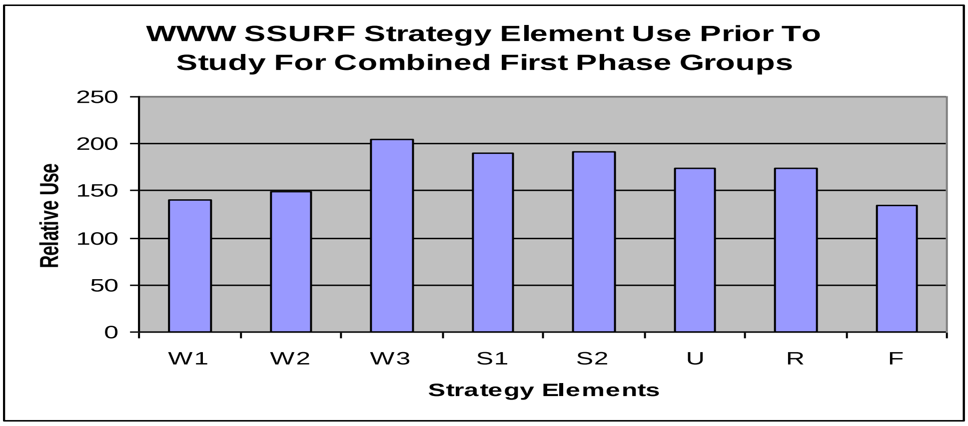

Figure 20. The modified MSLQ questionnaire identified strategies for locating relevant information (W3 – choosing where to find information, S1 – skimming text, and S2 – systematically reading text) as reading strategies for print text most often used prior to the study.

When the MSLQ data were mapped to the elements of the WWW SSURF strategy for the “treatment” class in the replication study, the reported levels of strategy usage prior to the study highly correlated with that of the groups in the original study (r = 0.998). This provided convincing evidence for the robustness of the mapping process.

Strategy Use Prior-, During and Post-Study

Figure 21 compares the overall level of strategy usage for the combined study groups in the original study with the study group from the replication study. In both cases we see the level of strategy use rising from pre-study levels, through the study. Importantly, this higher level of strategy use continued after an extended period of time without any further training in the use of the strategy. The group in the replication study reported use of strategy elements at a slightly lower level than the two groups of the original study, yet the pattern of reported usage was consistent over the six measurements (r = .92).

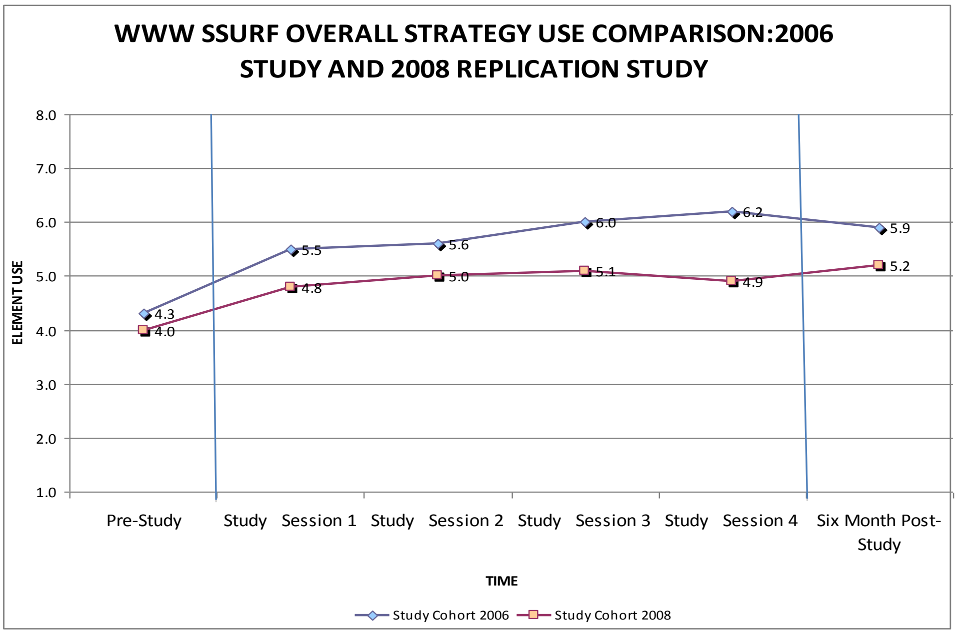

Figure 21. Use of the WWW SSURF strategy increased levels of strategy use by students in the study groups and the higher level of usage was sustained over an extended period of time post-study. Scores for strategy use are reported in the range 1 to 8.

The strategy use data from the two original study groups were combined with the corresponding data from the replication study group for the pre-, study, and post-study periods (estimated reliability = .94) and variable names were assigned to the data (Table 11).

An Intermediate School has a very mobile environment and participants in the study were not always able to be present when assessment data were being collected. The consistency and reliability reported above for the original and replication study data suggested that it would be appropriate to combine the data from the two studies. There are several concerns that need to be addressed before data can be combined with confidence: the reference frame for data gathering, the nature of the data and the underlying population the data is derived from (see, for example, Romeu & Dudley, 2004).

Table 11
Variable names assigned to the elements of the WWW SSURF strategy

Strategy Element	Variable Name
W1 (Identifying prior knowledge)	Prior
W2 (Using key words and phrases to help locate information)	Key
W3 (Choosing where to go/what to read next)	Choice
S1 (Skim reading to locate possible relevant information)	Skim
S2 (Systematic reading to locate specific relevant information)	System
U (Using existing cognitive strategies to understand text being read)	Under

Table 11 (Continued)

R (Relate what is being read back to prior knowledge and the questions for which information is being sought)	Relate
F (Figure out what is going to be useful – make a decision about what information will be recorded for further use)	Relevant

The first concern relates to errors due to situation and/or the manner in which the data are gathered. This was not likely to be a factor as the process followed in this study was very tightly scripted and the data were gathered independently of the adult supervising the participants (refer to Chapter 3). The second concern asks whether the underlying population appears to be symmetric and unimodal, or skewed. The values for skewness and kurtosis of the data gathered are well within the guidelines for normality (see Table 20, Chapter5). The final concern is also not likely to be a factor as the school from which the study participants were drawn has regularly tested the student cohort over a number of years. Results for PAT Reading Comprehension tests indicate a stable population over time, with the school mean approximating the national mean and a symmetrical normal distribution without the extreme outlying values of the national distribution. The combined data set is used in the further analysis presented in this chapter and also in the Structural Equation Modelling discussed in Chapter 5.

A repeated measures multivariate analysis of variance was used (with alpha = .01) to ascertain whether there were differences across the six occasions (pre-study, four study sessions, six month post-study) for the eight WWW SSURF factors for the combined data. There were statistically significant differences across the eight factors across time (*Lambda* = .07, *Mult.F* = 7.65, *df* = 40,23, $p < .001$, *partial eta-squared* = .93). An inspection of the univariate anovas indicated that all eight factors showed an over-time effect: Prior (F = 5.43, df = 4,235, p < .001), Key (F = 22.17, df = 4,241, p < .001), Choice (F = 3.86, df = 4,269, p < .01), Skim (F = 13.94, df = 4,246 , p < .001), System (F= 4.03, df = 4,246, p < .01), Under (F = 4.14, df = 4,255, p = .001), Relate (F = 3.61, df = 4,234, p < .01), Relevant (F = 17.08, df =4, 258, p < .001).

In Figure 22 we see that the level of use of the individual WWW SSURF strategy elements increased through the study period and beyond. The increase in the use of individual strategy elements was not uniform however. This is seen a little more clearly in Figure 23.

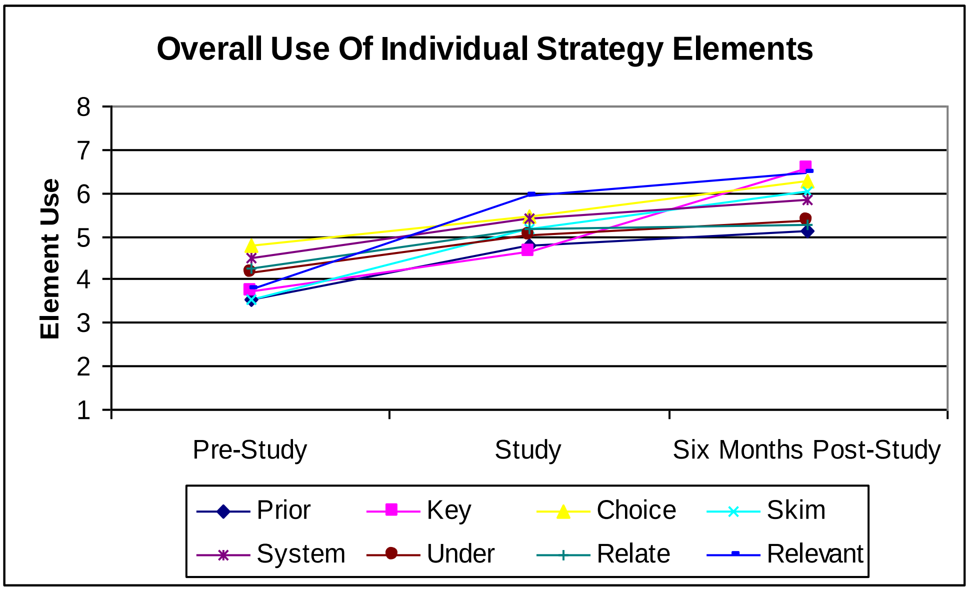

Figure 22. Comparative use of the WWW SSURF individual strategy elements prior-, during and post-study shows that the use of all strategy elements increased with time. The measure for “Study” is the average of the measurements made over the four study sessions.

The elements that sustained the greatest overall increase during the intervention were Relevant (pre-study M = 3.76, study M = 5.92), Skim (pre-study M = 3.56, study M = 5.18) and Prior (pre-study M = 3.54, study M = 4.80). Beyond the intervention, the use of the strategy elements Key (pre-study M = 3.74, post-study M = 6.57), Relevant (pre-study M = 3.76, post-study M = 6.46) and Skim (pre-study M = 3.56, post-study M = 6.04) showed the greatest increase in use over the pre-study levels.

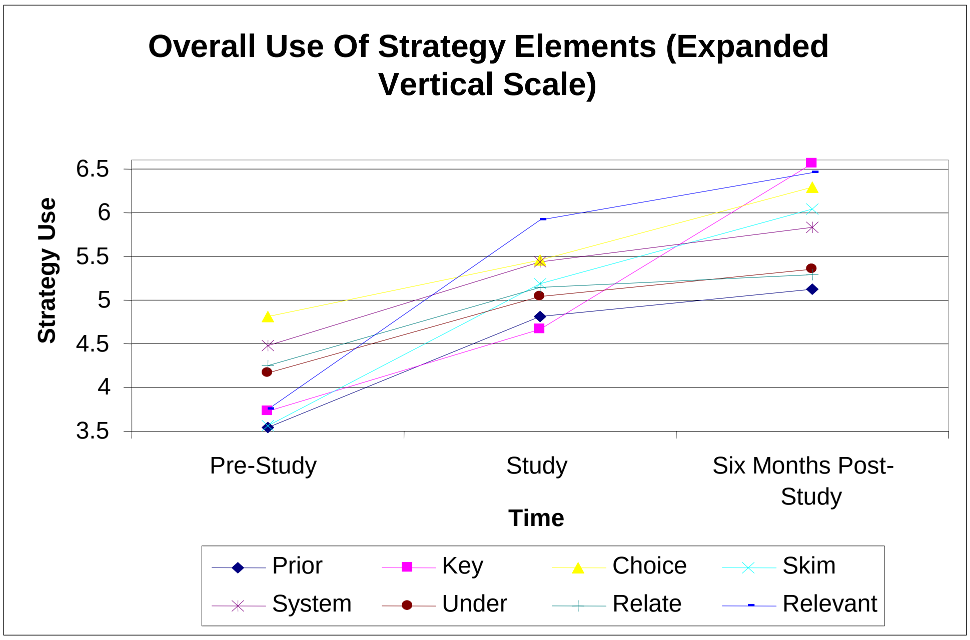

Figure 23. Comparative use of the WWW SSURF individual strategy elements prior-, during and post-study with an expanded vertical scale shows that the increase in strategy use was not uniform across individual strategy elements.

Differences in strategy use among participants and groups are to be expected. Web-text differs from print-based text in that each consumer is free to construct individual texts from the information encountered. Reading web-text is a continuous synthesis and evaluation process, with consumers choosing the information that they need. The reading process is often interrupted by the need for new searches for information. The processes are repeated until the consumers decide that they have enough information for their purposes (Leu, 2007, pp. 4 and 13).

Strategy Use During Study: Relationship between strategy elements

An inspection of the correlation table for the total use of strategy elements over the four sessions of the original study reveals that individual strategy elements do not stand alone; there is a degree of inter-dependence (Table 12). This can be visualised by noting correlation coefficients that are 0.40 or greater, for example. Using this criterion, we could conjecture that making a choice of relevant information is associated with relating new information back to what is already known and the systematic reading of web pages previously identified as potentially having useful information. Again, relating potential new knowledge with old (prior knowledge) is, in turn, associated with the use of existing classroom strategies for understanding print-based text, and the systematic reading of web pages identified by skim reading pages to locate potential sources of information.

Table 12
Correlation table for the total use of strategy elements during the original study. Values >.40 are highlighted in bold type.

	Prior	Key	Choice	Skim	System	Under	Relate	Relevant
Prior	1.00	**0.77**	0.27	**0.63**	**0.50**	**0.67**	**0.78**	0.37
Key		1.00	**0.44**	**0.61**	**0.45**	**0.67**	**0.69**	0.21
Choice			1.00	**0.44**	0.26	0.39	0.35	0.23
Skim				1.00	**0.58**	**0.54**	**0.58**	0.33
System					1.00	0.39	**0.58**	**0.64**
Under						1.00	**0.59**	0.37
Relate							1.00	**0.42**
Relevant								1.00

\The strength of these potential relationships between strategy elements was tested through multiple linear regression. The elements Relate and System appeared to be very strongly associated with Relevant (*Mult.R* = .99, *adjusted R-squared* = .98), however the main association was with System ($p < .001$). The elements Under, System, Skim, Key and Prior appeared to be very strongly associated with Relate (*Mult.R* = .99, *adjusted R–squared* = .98), with System ($p < .001$) and Prior ($p < .001$) contributing most to the association. The elements Skim, Key and Prior appeared to be very strongly associated with Understand (*Mult.R* = .98, *adjusted R-squared* = .94), with Skim ($p < .001$) and Prior ($p < .001$) contributing most to the association. The elements Skim, Key and Prior appear to be very strongly associated with System (*Mult.R* = .98, *adjusted R-squared* = .94), however the main association was with Skim ($p < .001$). The elements Choice, Key and Prior appeared to be strongly associated with Skim (*Mult.R* = .98, *adjusted R-squared* = .94), with Choice ($p < .001$) and Prior ($p < .001$) contributing most to the association. The element Key appeared to be very strongly associated with Choice (*Mult.R* = .95, *adjusted R-squared* = .88, $p < .001$) and Prior appeared to be very strongly associated with Key (*Mult.R* = .98, *adjusted R-squared* = .93, $p < .001$). These associations are pictured in Figure 24.

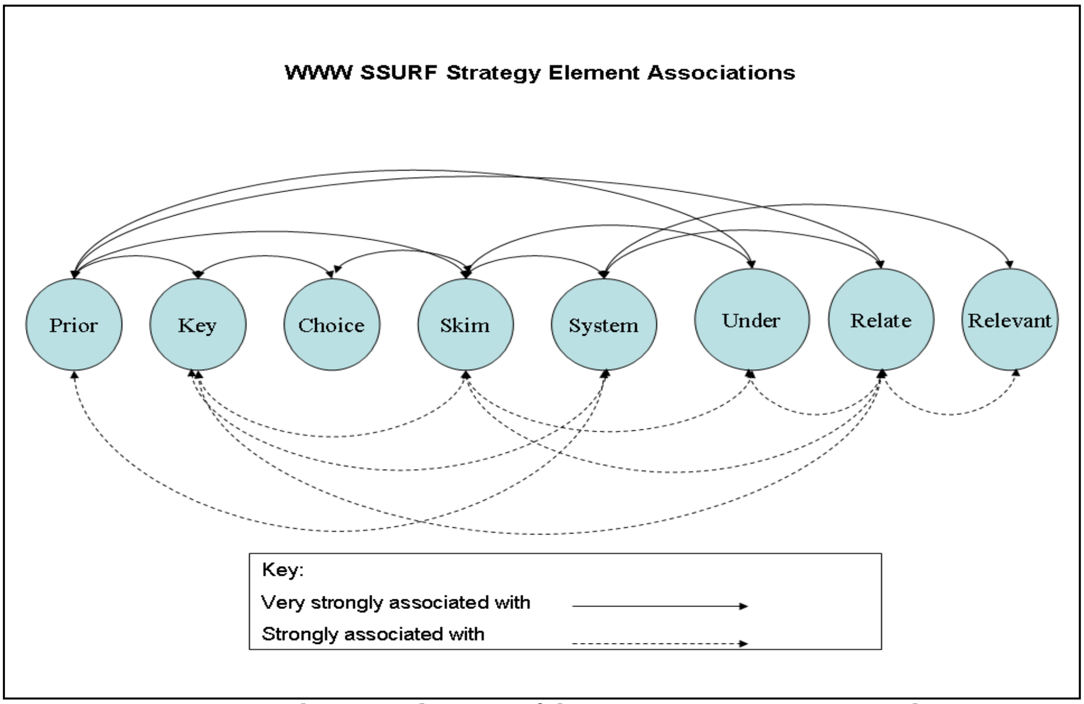

Figure 24. Associations between elements of the WWW SSURF strategy. The associations are bi-directional. For example, the arrow between Skim and System indicates both that students may move on to using the Systematic reading strategy after Skim reading and also that after a period of Systematic reading they may return to Skim reading as a strategy.

The WWW SSURF strategy puts a selection of cognitive strategies in front of the students and provides a pathway for them to use the strategies meaningfully. While there is an implied linear order to the strategy, beginning with identifying prior knowledge and building until a decision is made whether some new information will be recorded towards fulfilling the goals of the reading task, in reality, students cycle back and forth between elements of the strategy as they endeavour to unpack the meaning of the web-text they are reading. Differences in usage of the elements of the strategy were verified by means of a repeated measures multivariate analysis of variance across the six occasions (pre-study, the four study sessions, and six month post-study) between the three class groups from both phases of the study.

A recently reported study by Coiro and Dobler (2007) focused on locating, evaluating and synthesising information. These tasks translated into four strategies: planning and predicting, which correspond to the "WWW" part of the acronymous metacognitive learning strategy implemented in this study, and monitoring and evaluating, which corresponds to the "SSURF" part of the WWW SSURF strategy. The findings of Coiro and Dobler's study are interesting when compared to the elements of the WWW SSURF strategy (Table 13). Their conclusion that the complexities of web-text reading comprehension may result from a process of self-directed text construction leads them to suggest that a "new metacognitive regulatory strategy is required ... in order to support all readers in this challenging environment" (pp. 56-57). The WWW SSURF acronymous metacognitive learning strategy implemented in this study does precisely that.

Table 13
The correspondence between the findings from a recent study by Coiro and Dobler, and the elements of the WWWSSURF acronymous metacognitive learning strategy.

Findings (Coiro & Dobler, 2007, P.50)	$W_1W_2W_3\ \underline{S_1S_2}$ URF Strategy
Skilled readers draw on knowledge of topic …	W_1 Use of prior knowledge
… to guide their reading and pathway	W_2 Use of key words and phrases
	W_3 Making choices about where and what to read next
Readers often used inferential reasoning	W_2
strategies informed by their use of literal	W_3
matching skills, structural clues and contexts	S_1 Skim reading, and
	S_2 Systematic reading using clues and

Table 13 (Continued)

	contexts
	R Relating new knowledge back to old (prior)
… frequently used traditional self-regulating reading processes such as goal setting, predicting, monitoring and evaluating the relevancy	U Use strategies for reading print-based text R F Make a decision (Figure out) whether to use a particular piece of information or not

A repeated measures multivariate analysis of variance found that there were statistically significant differences between the three class groups that participated in the original and replication studies across the six strategy factors across time (*Lambda* = .42, *Mult.F* = 3.79, *df* = 16,110, $p < .001$, *partial eta-squared* = .36). This moderate difference is largely due to differing levels of reported strategy use, although multiple comparisons of the observed means, using the Bonferroni correction, revealed statistically significant differences between the two groups in the original study for Key ($p < .001$) and Choice ($p < .05$) and between one of the original study groups and the replication study group for Skim ($p < .01$). This confirms that students' overall use of the strategy was remarkably similar, in spite of a lack of homogeneity between the three study groups.

The combined groups' use of the individual strategy elements in the original study changed over the four sessions in two ways: individually, over the four sessions, and relatively, within each of the four sessions. Choice of web site and/or web page to go to, for example, featured strongly in the first session, and decreased in use over the following three sessions (Figure 25), as did use of the elements Skim reading and Systematic reading. The strategy elements involving reference back to Prior knowledge, the use of Key words and phrases were used more often after the first session. The use of classroom strategies to facilitate Understanding of what was being read increased after the first session,

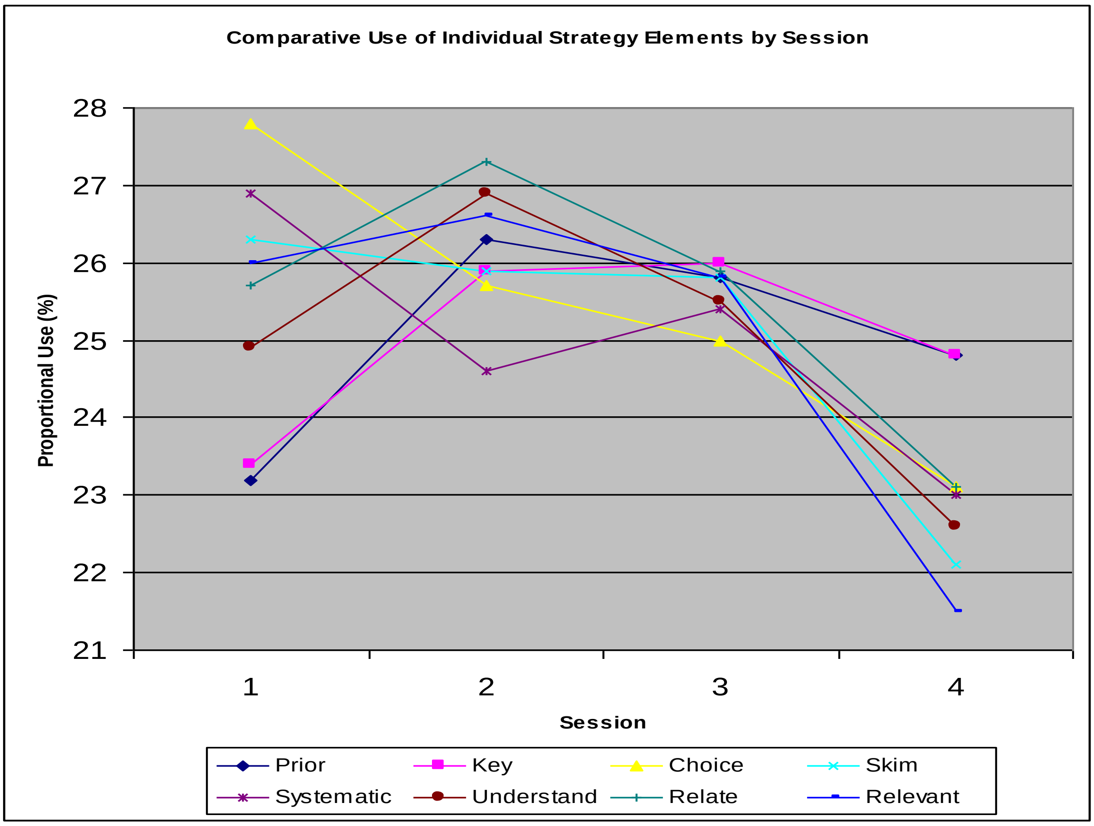

Figure 25. Comparative use of individual strategy elements over the four sessions.

but dropped away in the fourth. The strategy elements Choice and Relevant were used the most consistently, as was the element Skim, particularly over the first three sessions.

The strategy element that was used most frequently on a session-by-session basis was the decision strategy Relevant (Figure 26), which involved participants deciding whether to record the information they were reading for later use in answering the questions set by the teachers. Systematic reading remained a relatively high use strategy element across the four sessions, as did Choice of web sites or web pages to read. Use of Key words and phrases, reference back to Prior knowledge and use of general classroom comprehension strategies were the least frequently used strategy elements across the four sessions. Relating information back to prior knowledge, including new material being assimilated as the study progressed, stands out as being neither a high use (except briefly in session two) nor a low use strategy element.

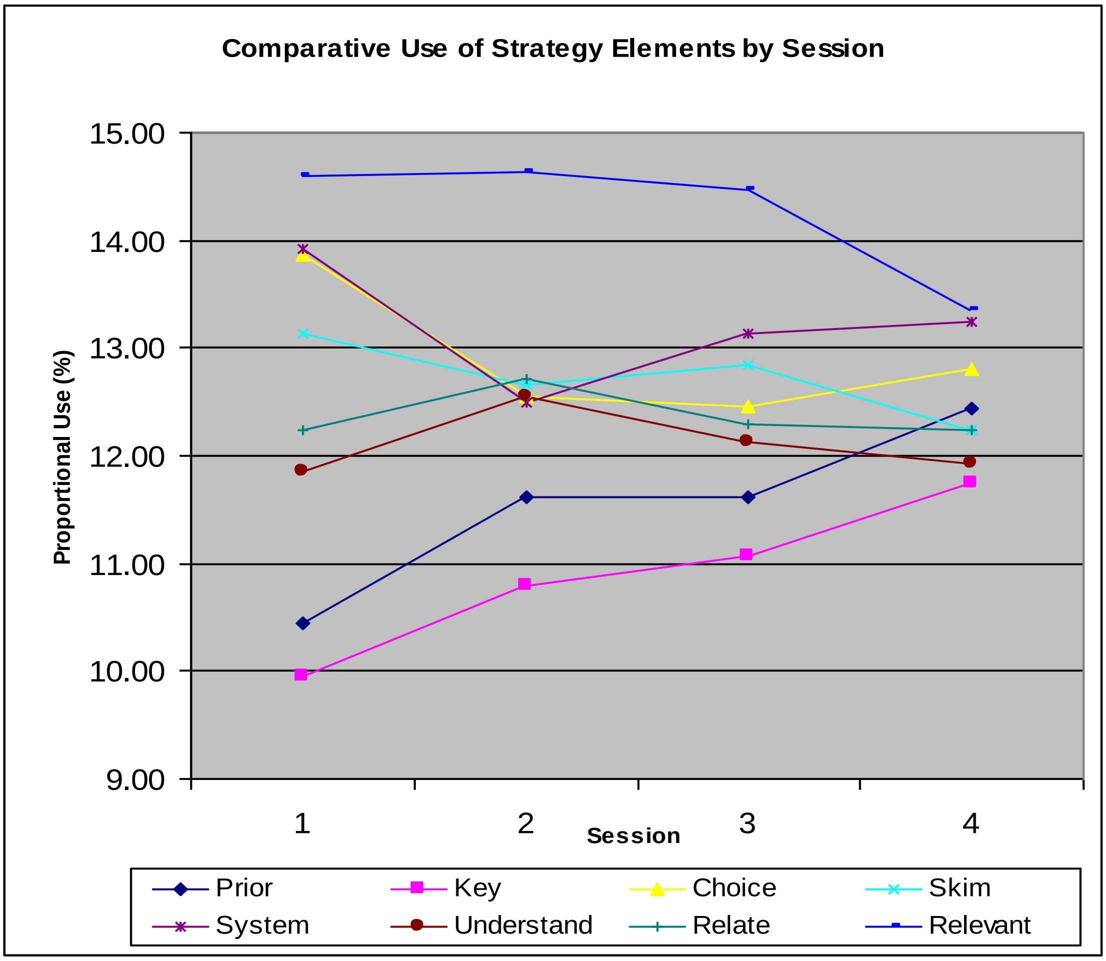

Figure 26. Relative use of strategy elements within each of the four sessions.

Strategy use and asTTle

A repeated measures multivariate analysis of variance was used to ascertain whether there were differences across the two occasions (pre-, and six months post-study) for the three asTTle factors Processing Information, Exploring language and Thinking between the participants (S Group) and non-participants (Non-S Group) in the original study. All students in the year level were tested; the non-participants were the balance of the year-level cohort. There were statistically significant differences across the three factors (Processing Information, Exploring Language and Thinking) over time (*Lambda* = .13, *Mult.F* = 182.2, *df* = 3,324, $p < .001$) and also the three factors over time between the two study groups (*Lambda* = 0.82, *Mult.F* = 4.28, *df* = 3,324, $p < .001$).

An inspection of the univariate anovas indicated that all three of the factors showed an over-time effect: Processing Information ($F = 25.7$, $df = 1,326$, $p < .001$), Exploring Language ($F = 512.0$, $df = 1,326$, $p < .001$) and Thinking ($F = 158.4$, $df = 1,326$, $p < .001$). Figure 27 shows the mean changes and it can

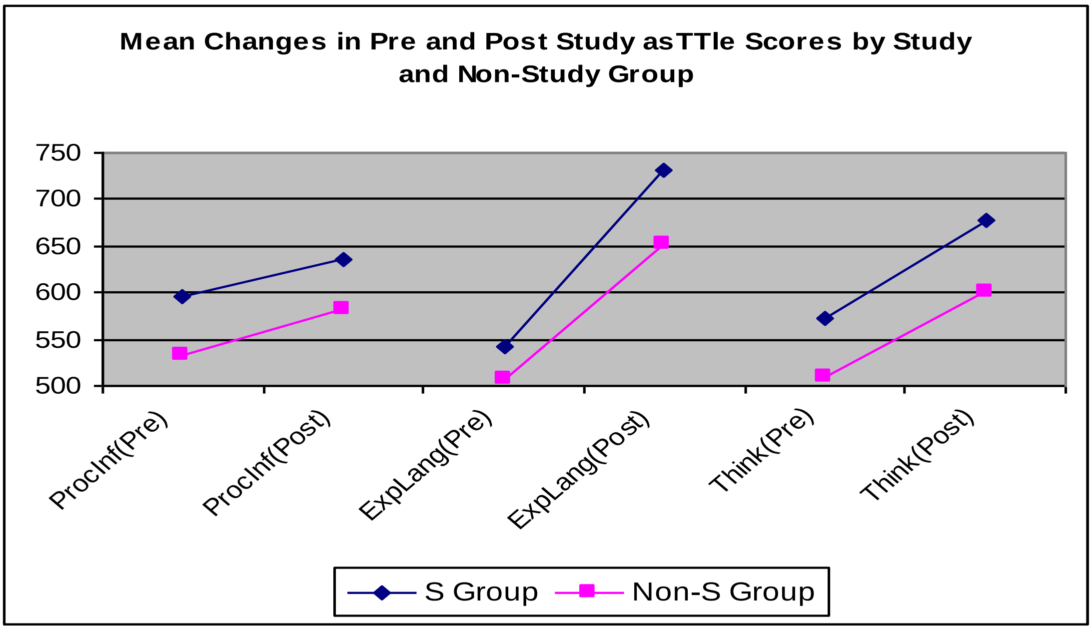

Figure 27. Pre- and Post-Study asTTle Scores by Study and Non-Study Groups from the original study.

be seen that the biggest change was in the Exploring Language score (pre-M = 512.52, post-M = 664.33), with Thinking (pre-M = 518.97 and post-M = 611.97) and Processing Information (pre-M = 596.81 and post-M = 589.62) also recording gains, to a lesser degree.

Inspection of the univariate anovas also indicated that one factor showed an over-time between-group effect: Exploring Language (F = 9.04, df = 1,326, p < .001). The two factors that did not change were: Processing Information (F = 25.7, df = 1,326, p = .52) and Think (F = 158.4, df = 1,326, p = .35). The study group participants made larger gains than the non-study group participants over all three of the factors: Exploring Language (S Group gain = 189.2, Non-S Group gain = 144.8), Processing Information (S Group gain = 64.3, Non-S Group gain = 48.7) and Think (S Group gain = 105.3, Non-S Group gain = 90.7). The difference in increased scores between the study group and the non-study group from the first to the second asTTle test was largest for the Exploring Language factor (Difference = 44.4), with the Processing Information (Difference = 15.6) and Think (Difference = 14.7) factors showing smaller, comparable, differences. The summary information for the post-test/pre-test difference in scores in the original study is S Group M = 104.7, SD = 10.23; Non-S Group M = 91.78, SD = 9.58.

The two individual class groups comprising the S Group were in themselves different. One class had a higher number of "above average" students (that is, stanine 7 or higher on a standardised test of reading comprehension for example) than the other. This is reflected in the difference between their asTTle scores as demonstrated by the following t-tests, assuming unequal variances: (t(38) = 5.27, p < .001, d = 1.52) for the first asTTle test and (t(35) = 5.09, p < .001, d = 1.47) for the second asTTle test. However, a one-tailed t-test, assuming unequal variances, established that the performance of these two classes was homogeneous in terms of the mean score increase from the first to the second test (t(43) = 0.15, p = .44, d = .04). Combining the two classes into the S Group provides a valid basis of comparison with the Non-S Group when comparing the increase in mean scores from the first asTTle test to the second one.

The mean difference in scores is larger for the class groups that participated in the study making use of the WWW SSURF strategy in an internet environment, than the corresponding mean difference score for the class groups that did not participate. A t-test, assuming unequal variances, found this difference to be statistically significant ($t(120) = 2.27$, $p < .05$, $d = .33$). While the computed effect size is considered small, the result does provide evidence for the conjecture that learning to use the WWW SSURF metacognitive learning strategy in the context of reading web-text may transfer back to the print-text domain. An asTTle test of reading comprehension is highly structured with the questions to be answered immediately following the passage of text, so there is less need to make decisions of "Choice" with respect to where and what to read. The questions can be quite searching, so it is not surprising to note that the most often used strategy elements were Skim and System (Figure 28). That the students were able retrospectively to identify their use of the WWW SSURF strategy in the print-based text situation provides further evidence of the efficacy of the strategy.

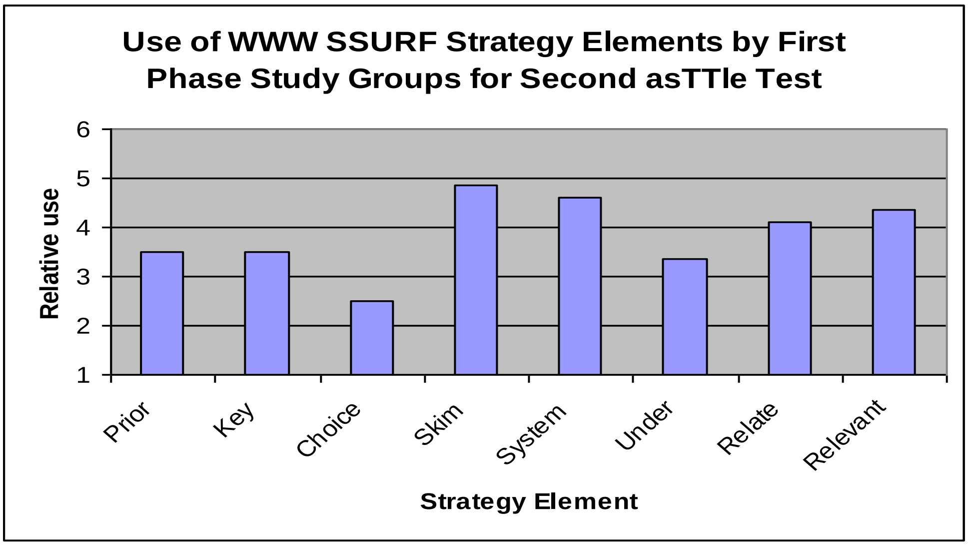

Figure 28. Students identified the use of Skim and System as the most often used strategy element when sitting the second asTTle test, and Choice as the least often needed strategy element.

In addition, a univariate analysis of variance was undertaken following the original study, to determine whether various classroom conditions, specifically whether students were either in the study group or students were not in the study group, differed with respect to their general reading comprehension scores. The pre-study asTTle test was treated as a covariate, students either being in the study group or non-study group was treated as an independent variable and the post-study asTTle test scores were treated as the dependent variable. The analysis was undertaken using alpha = .01. There was a statistically significant difference for the between-group effects (F = 224.4, df = 2, p < .001, *partial eta-squared* = .60), with mean difference between the group scores for the dependent variable (the second asTTle test) being statistically significant (p < .001). This corroborates the evidence detailed earlier in this section where we noted that "… the result does provide evidence for the conjecture that learning to use the WWW SSURF metacognitive learning strategy may transfer back to the print-text domain".

Finally, this study was undertaken with some New Zealand intermediate school students (ages typically 11 to 13 years). The applicability of the study to other age ranges will be commented on in the following chapter "Chapter 5: The Primary research Question: results and discussion". One other factor warrants mention: the use of the strategy was assimilated relatively quickly and sustained over an extended period of time. Uptake of the strategy by students may have been expedited through the use of the self-reflection questionnaire that each student completed at the end of each session before leaving the computer lab.

Summary

In this chapter, the reliability of the data were established through computation of Cronbach's alpha. A comparison of the comprehension results for two groups of participants in the replication study, one group making use of the WWW SSURF acronymous metacognitive learning strategy, the other not, provided strong evidence to support the preliminary research question in the affirmative, that is, that the use of an acronymous metacognitive learning strategy is a contributing factor to the ability to read web-text with understanding. An in-depth examination of the data revealed that prior reading comprehension ability with print-based text was not a contributing factor to being able to read web-text successfully. Levels of cognitive strategy use increased as a result of the intervention in this study, and even though the intervention was “minimal” in terms of teacher input and the time allowed, study participants seemed readily to assimilate the strategy and, importantly, maintain the higher level of strategy element use over an extended period of time without any further training. The data also give insight into how participants used the WWW SSURF strategy. The apparent recursive use of strategy elements is isomorphic to the results of contemporary research (Coiro & Dobler, 2007; Leu, 2007). In particular, research by Coiro and Dobler has postulated the need for just such a strategy as the WWW SSURF strategy (p. 56).

The focus in this chapter was reading comprehension of web-text through the lens of the consumer (reader). The study has confirmed the benefit of using an acronymous metacognitive learning strategy, such as the WWW SSURF strategy, to assist students of a wide range of ability, to read web-text with understanding.

CHAPTER 5

THE PRIMARY RESEARCH QUESTION: RESULTS AND DISCUSSION

The focus now changes to examining reading comprehension on the Internet through the Producers' Lens. Starting with the reading age of the textual components of the web sites, data relating to the usability aspects of the web sites used in the study are examined and discussed. The two lenses of the consumers and the producers are then brought together to focus on the primary question "What factors contribute to the ability to read web-text with understanding?" in the section "Glasses Have Two Lenses: A structural equation model for reading on the Internet".

Reading Age Of Web Pages

Comparison Of Web Sites By Reading Age

Two web sites were provided for the participants' use as their primary source of information. There were differences in the style of presentation between the two sites (Figure 29), one site was presented as being suitable for "Kids", the other "General" site was provided for a more adult audience. The Kids' site was contained within the more general site. Reading ages for the web pages contained within these two sites were calculated using the FOG Index by submitting the URL of each page to the site http://www.juicystudio.com/fog. Tables 14 through 16 detail the reading ages of the pages found at each site. The average reading age for the Kids' site was 10.9 years, and that for the General site 14.7 years. The Kids' site has a spread of reading ages of 4.82 years, ranging from 8.98 to 13.8 years. The General site has a spread of 5.73 years, ranging from 13.23 years to 17.29 years.

Figure29. Examples of pages from the Kids' and General sites recognise the different needs of difference audiences.

Table 14

Kids' Site (Global Warming) http://www.epa.gov/climatechange/kids...

URL	Reading Age
/index.html	16.38
/cc.html	8.98
/climateweather.html	11.23
/greenhouse.html	10.90
/climatesys.html	12.67
/history.html	9.74
/detectives.html	10.32
/change.html	13.80
/bigdeal.html	10.74
/difference.html	10.82
/glossary/index.html	13.03

The reading age of the "/index.html" page is likely to be in error, since there is very little content in relation to navigation items on the page and the on-line algorithm used to estimate reading age captures the underlying text required for formatting the page. This is not important, however, as it is only a navigation page and contains no content. This page was not included in the calculation of the average reading age of the Kids' Site.

Table 15

General Site (Global Warming) http://www.epa.gov/climatechange...

URL	Reading Age
/	14.49
/emissions/index.html	16.07
/emissions/co2.html	14.74
/emissions/co2_natural.html	14.25
/science/recentac.html	14.66
/basicinfo.html	14.07
/wycd/calculator/ind_calculator.html	13.39
/wycd/road.html	13.65

Table 15 (Continued)

/wycd/school.html	
/wycd/office.html	14.03
/wycd/home.html	15.14
/methane/sources.html	13.23
/nitrousoxide/sources.html	16.11
/highgwp/sources.html	15.84
	17.29

Table 16
http://www.epa.gov

URL	Reading Age
/airmarkets/arp/	16.75
/acidrain/index.html	11.56
/acidrain/what/index.html	16.34
/acidrain/effects/index.html	13.85
/acidrain/effects/surface_water.html	16.75
/acidrain/effects/forests.html	13.87
/acidrain/effects/health.html	14.95
/acidrain/effects/visibility.html	14.43
/acidrain/effects/materials.html	14.08
/acidrain/effects/auto.html	17.71

Figure 30 contrasts the reading ages of the pages found at the Kids' and General sites.

The pages in Figure 30 have been ordered by increasing reading age, however, in general, the further one goes into a site the higher the reading age associated with the text becomes. There is some overlap between the reading ages of the Kids' and General web sites. The web designers have clearly been successful in differentiating between the needs of the two target audiences.

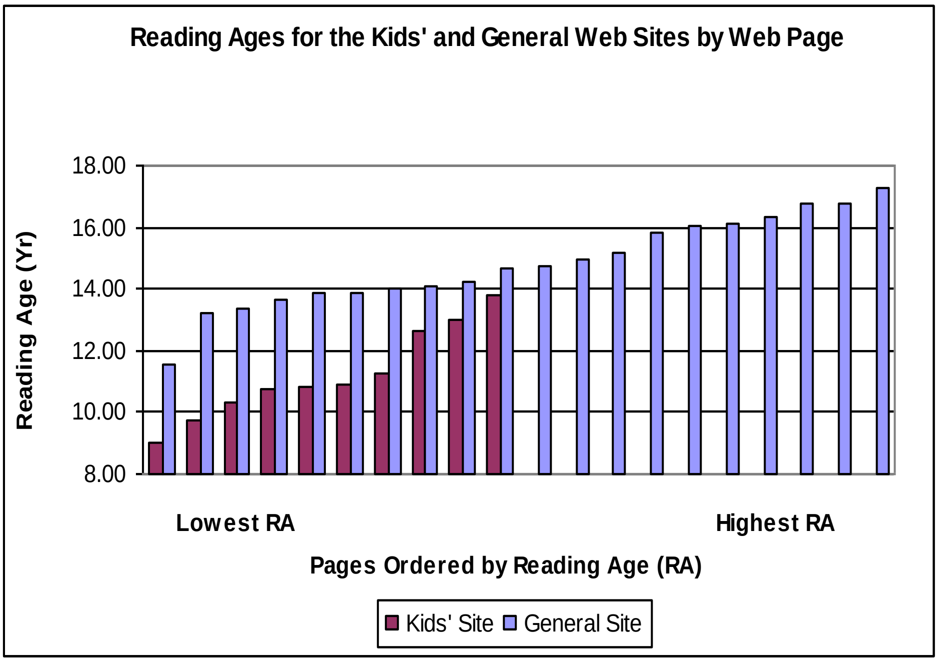

Figure 30. Overlapping ranges of reading age requirements for individual pages of the Kids and General Web Sites.

Relationship Between Reading Age And Information Obtained

The information available on the web sites used in this study can be classified as either "facts", an "elaboration" of a fact or, an item of "vocabulary". For the purposes of this study the researcher coded each of these types of information as a "discoverable fact" (Table 17).

Table 17
Examples of pieces of information coded by the researcher as "discoverable facts"

Category	Piece of Information
Fact	Many glaciers, large sheets of ice that move very, very slowly, are now melting.
Elaboration	Some scientists think that they are melting partly because the earth is getting warmer.
Vocab	Glacier: a very large body of ice moving slowly down a slope or valley or spreading outward on a land surface

A comparison of the reading ages of individual web pages and the total amount of information recorded by the groups in the original study reveals some anomalies. Specifically, some pages had information recorded more often by students, against the trend that the amount of information recorded drops off with increase in reading age of the web pages (Figure 31). The information count, arrived at by simply taking the number of pieces of information (discoverable facts) each student has recorded for each web page and finding the total for all students, serves as an indicator of information understood by students

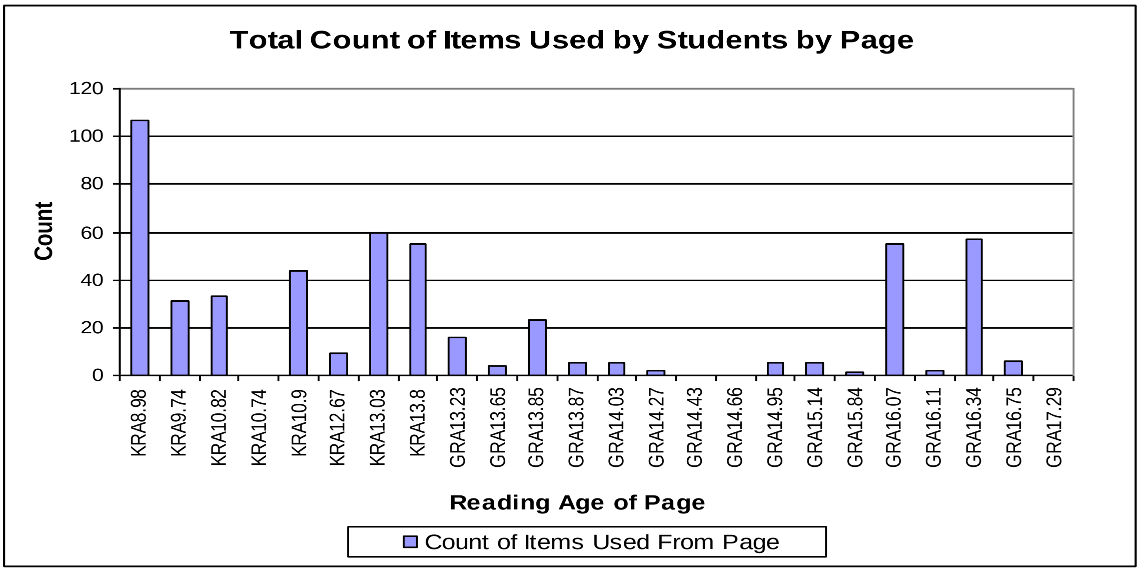

Figure 31. The graph shows the total number of times items from each web page were recorded by the study groups in the original study. "KRA8.98" refers to a page on the Kids' web site with a reading age of 8.98 years, similarly the prefix "G" refers to a page from the General web site.

and recorded as being relevant for the task of answering the questions set by the teachers. The General pages with reading ages of 16.07 years and 16.34 years particularly stand out. A comparison of the information displayed in Figure 29 alongside the "Available Number of Discoverable Facts" for each web page (Figure 32) reveals that the total number of discoverable facts (items) used by students has little in common with the number of facts available on a page-by-page basis (r = .19).

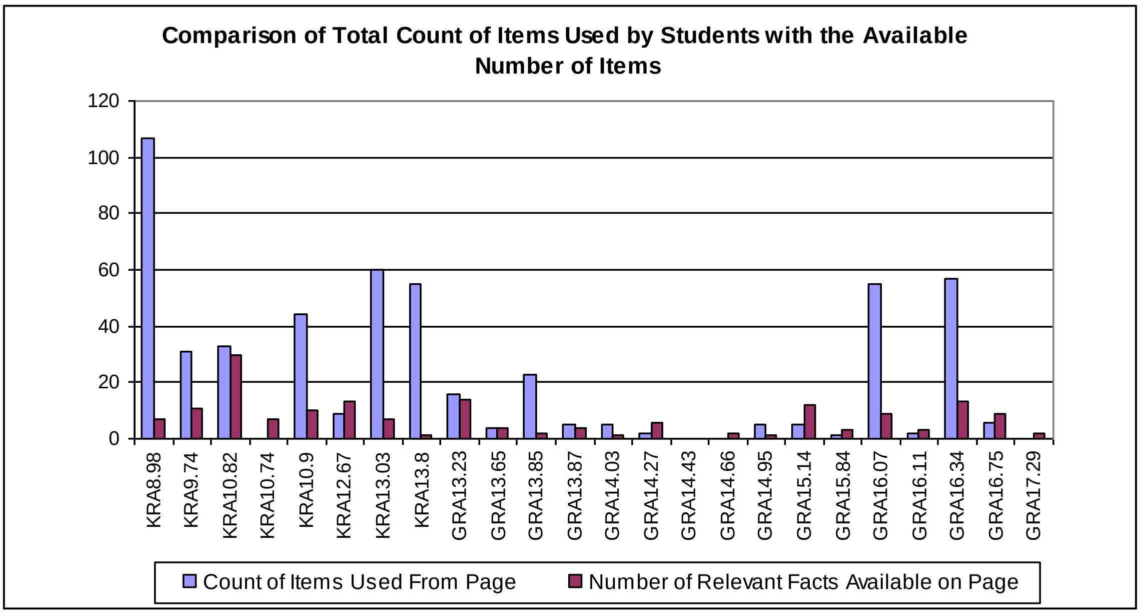

Figure 32. The graph suggests that there is apparently little in common between the total number of facts used by students in comparison with the number of available facts.

The pages with reading ages of 16.07 years and 16.34 years again stand out in this comparison. While the number of facts available on the page with reading age 16.34 years is comparable with pages from the Kids' site, the page from the general site with reading age 16.07 years has fewer discoverable facts available. The comparatively high "usage count" for the page with estimated reading age 16.07 years was achieved by a small number of students making use of four to thirteen of the 13 discoverable facts available; many more students just made use of one fact from this page. An explanation for these anomalies may be found by inspecting the particular pages.

The page with an estimated reading age of 16.07 years is an index page for Greenhouse Gas Emissions. The first part of the page has some basic introductory information and provides some facts about specific Greenhouse gases (Figure 33). The greater part of this web page continues on with information about "Greenhouse Gas Inventories", "Emission Trends and Projections" and "Project Methodologies".

Figure 33. The first part of the web page with estimated reading age of 16.07 years contains information that is accessible to readers with a lower reading age.

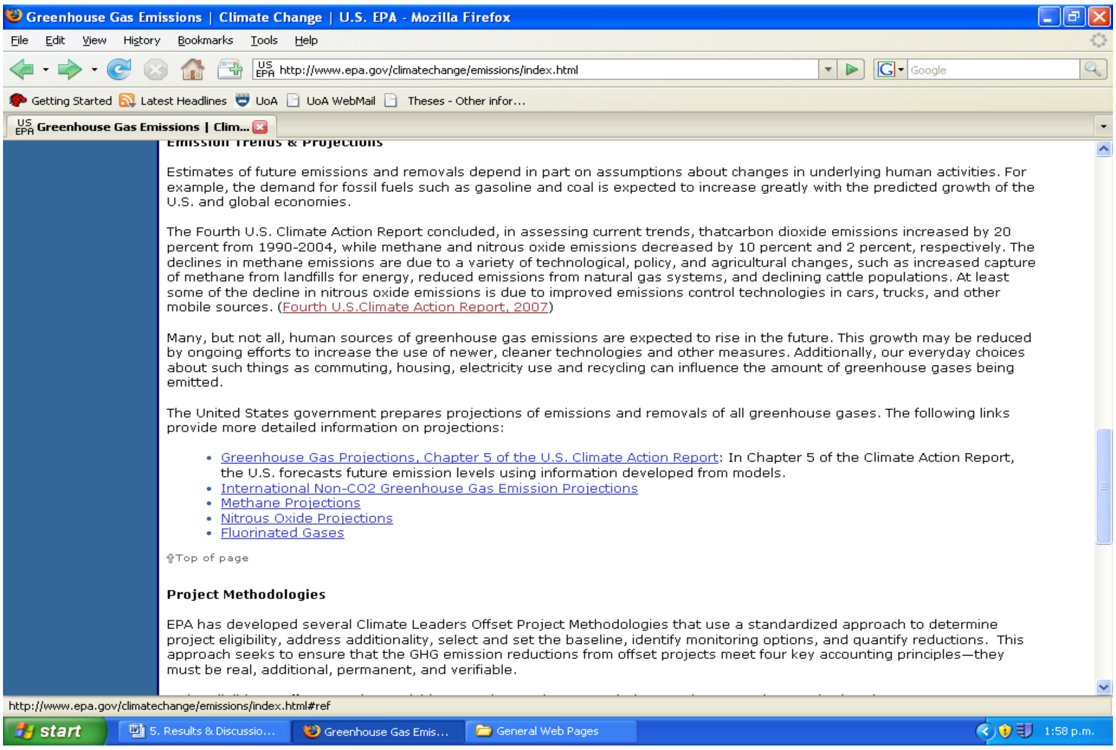

Figure 34. Further down the page with estimated reading age of 16.07 years, the discussion and the associated language, becomes more technical.

Each of these topics contributes to the higher reading age requirements for the page (Figure 34). Students were apparently able to access the presenting information at the start of the page, and did not continue on to read the harder material. The web page with the estimated reading age of 16.34 years contained a graphic which helped explain the discussion in the text (Figure 35). A number of students used information from the opening sentences of the sections: “What is Acid Rain?”, “Wet Deposition”, and Dry Deposition”, recording one to three of the available discoverable facts. A few students read more deeply and recorded four to six of the nine discoverable facts potentially available from this

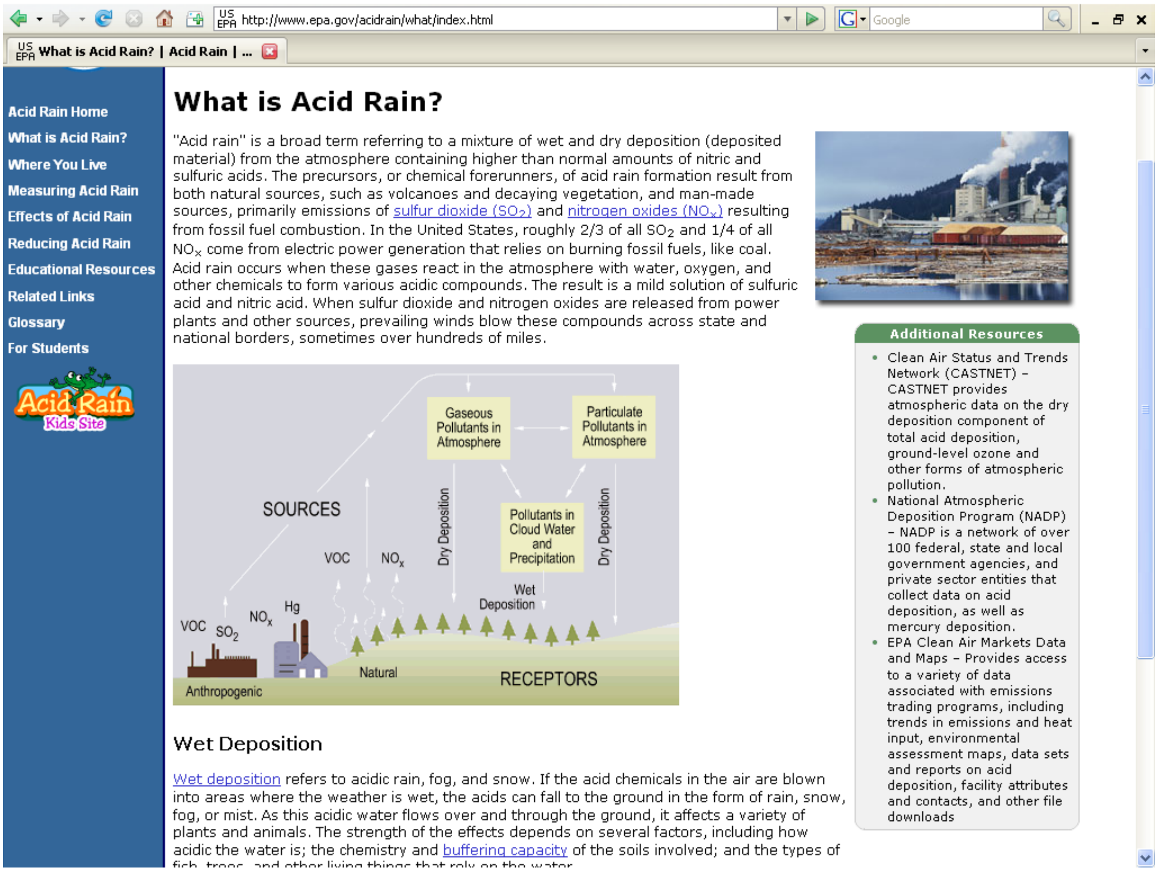

Figure 35. The web page with estimated reading age 16.34 years used in the study. Note that the site has been updated and that there is now a link to an “Acid Rain Kids’ Site” that was not available at the time of the study.

page. The information panel on the right hand side of this page, “Additional Resources”, contributes to the high reading age associated with this page, but did not contain information that was useful for the students’ project.

Usability Of Web Pages

The reading age associated with the text embedded in web pages is part of a wider phenomenon that has been termed the "usability" of web sites. Figure 35 and Figure 36 provide a "smorgasbord" of web pages used in the study with some basic information about their reading ages and some other usability features. These figures help to visualise some of the material being discussed in this section. The page from the Kid's site with reading age 8.98 (Figure 35) contained relatively fewer discoverable facts than a number of other pages (Figure 31) , but these facts were easily accessible and often recorded by students for later use. By comparison, the page with reading age 12.67 had a greater number of discoverable facts, yet these were not selected very often by students. This page gave information about the "climate system", a topic that may have been seen by students as being "outside" the information needed to complete the questions set for them by their teachers, but the page also contained links to several animations explaining how the planet's water cycle is likely effected by climate change and how the carbon cycle is affected by global warming. This page may have been simply treated as a "gateway" to access these animations, rather than as a source of information in its own right. The use of summary information, the inclusion of material with "high interest value" for some of the students, the chunking of information and the use of graphics to support the text are some of the devices highlighted in Figures 36 and 37 which were used to make the information contained in these web pages available to the reader.

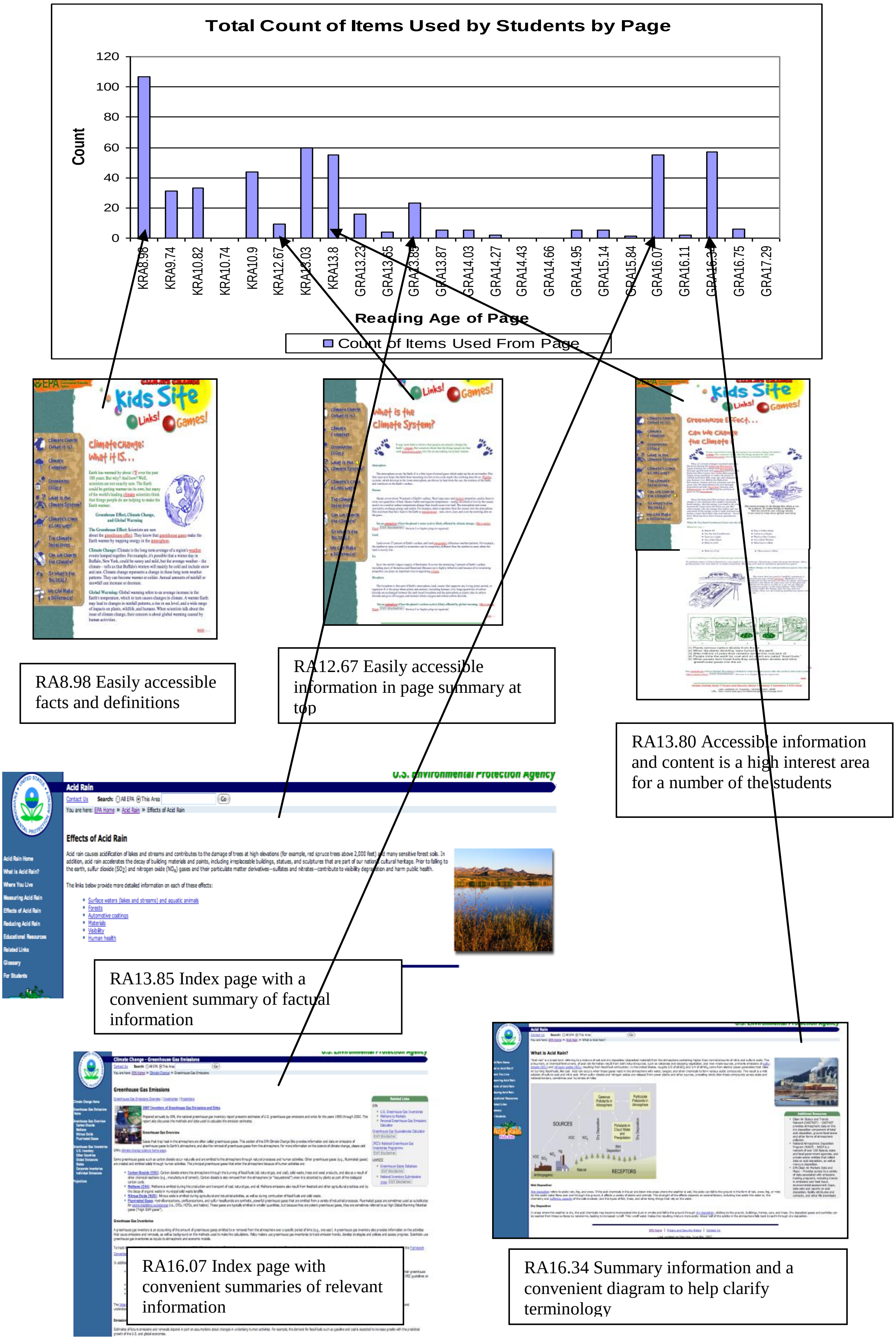

Figure 36. Selection of web pages used in study (part 1 of 2)

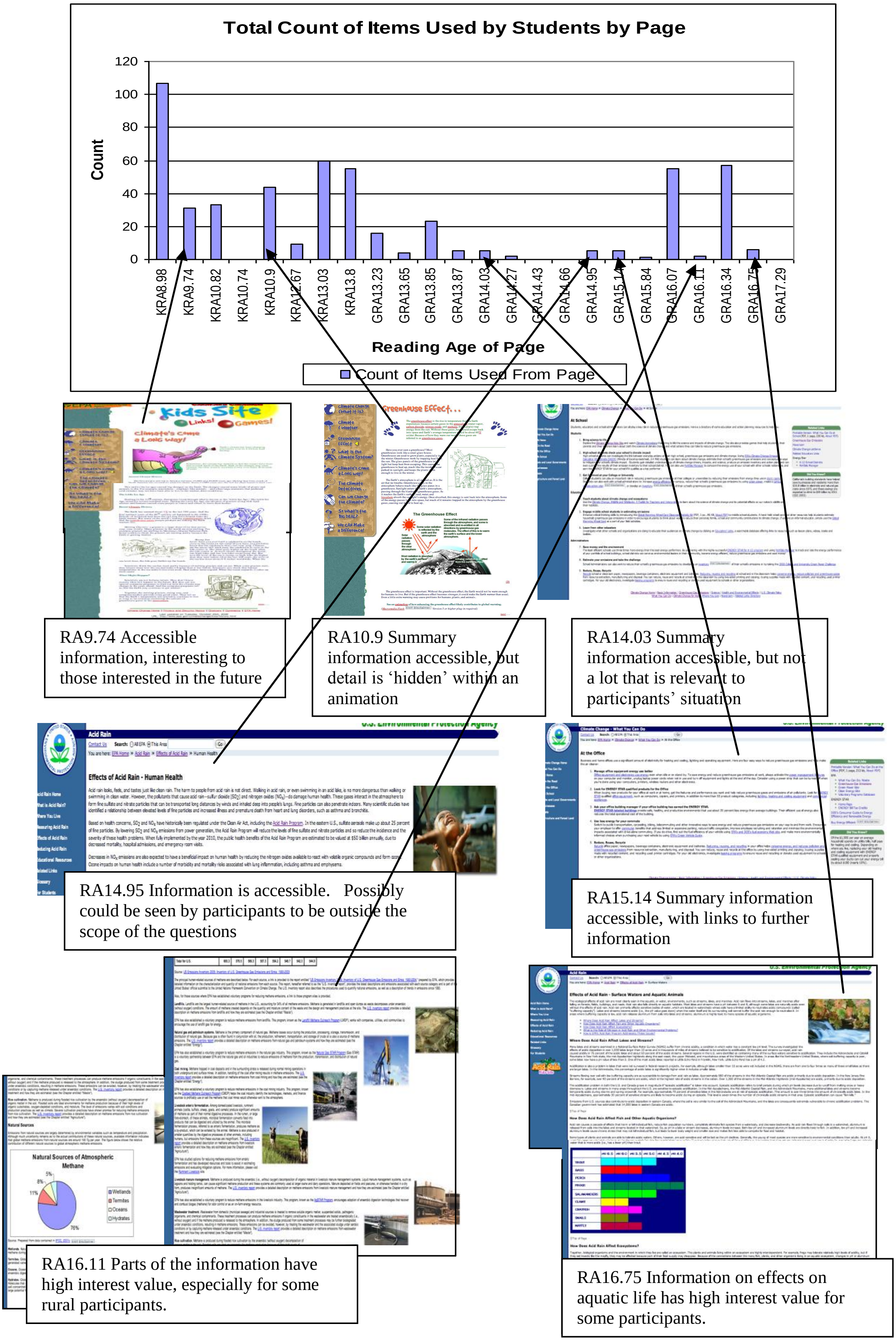

Figure 37. Selection of web pages used in study (part 2 of 2)

The usability rubric used to assess the usability of the two websites used the categories Navigation, Content Presentation, Multi-Media Contribution, Discourse Features and Appearance. Individual pages for each of the Kids' and General web sites were scored using the scoring rubric and the average score per page computed. A comparison of the two sites (Figure 38) shows that both sites catered very well for navigation. It was clear where hyperlinks would take the user to and mechanisms were provided that allowed the user to keep track of where they were and to easily return to previous pages.

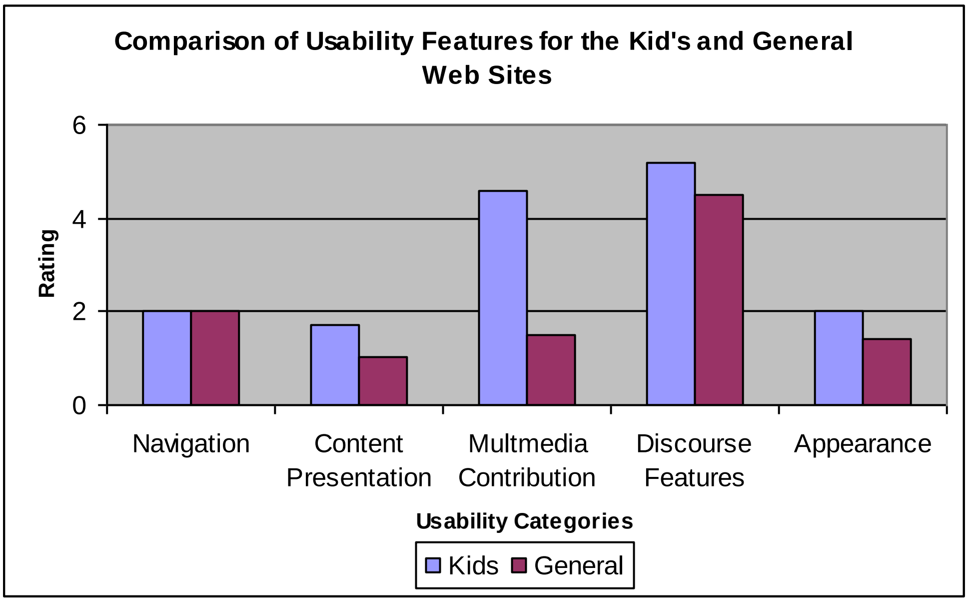

Figure 38. The Kids' web site scored more highly than the General web site on most of the usability categories. Maximum possible scores: Navigation = 2, Content Presentation = 4, Multimedia Contribution = 11, Discourse Features = 6, Appearance = 2 .

Both the Kids' and the General web sites received the maximum score for Navigability. Content was more accessible on the Kids' site than the General site in the sense that fewer pages had to be accessed to obtain sufficient information to cover all aspects of the topic being researched. The Kids' site, however, contained less depth in its content. A two sample t-test assuming unequal variance was statistically significant ($t(11) = 1.88$, $p < .05$, $d = .72$) and provided evidence of a medium difference between the two sites on this measure of usability. The multimedia content of the Kids' site was visually appealing and easy to navigate (Figure 39) and scored particularly highly in comparison to the General site with respect to the availability and quality of multimedia elements. A two sample t-test assuming unequal variances was statistically significant ($t(13) = 2.54$, $p < .05$, $d = .98$) and provided evidence of a very sizeable difference between the two sites on this measure of usability.

Figure 39. Sample animation screen in the Kids' web site. Controls are easily accessible, and the use is made of moving images, co-ordinated with information provided in the form of a real time chat room conversation between two young people

The discourse features were rated relatively highly for both sites. The reading ages of web pages for both sites have been discussed earlier in this chapter. Both sites made good use of headings to signpost content and the vocabulary appropriate to the different sites. A two sample t-test assuming unequal variances was statistically significant ($t(18) = 2.04$, $p < .05$, $d = .79$) and provided evidence of a large difference between the two sites on this measure of usability. The appearance of the pages in the Kids' site rated more highly than those of the general site. The greater "busyness" of the pages in the General site reflected the fact that this site contained a greater breadth and depth of content than the

Kids' site and used more space on each page to present the information.   A two sample t-test assuming equal variances was statistically significant ($t(33) = 3.76$, $p < .01$, $d = 1.45$) and provided evidence of a very large difference between the two sites on this measure of usability.

Overall, the Kids' web site was more usable than the General web site (Figure 40).   While the usability of individual pages was variable for both sites, with the Kids' site showing more variation in

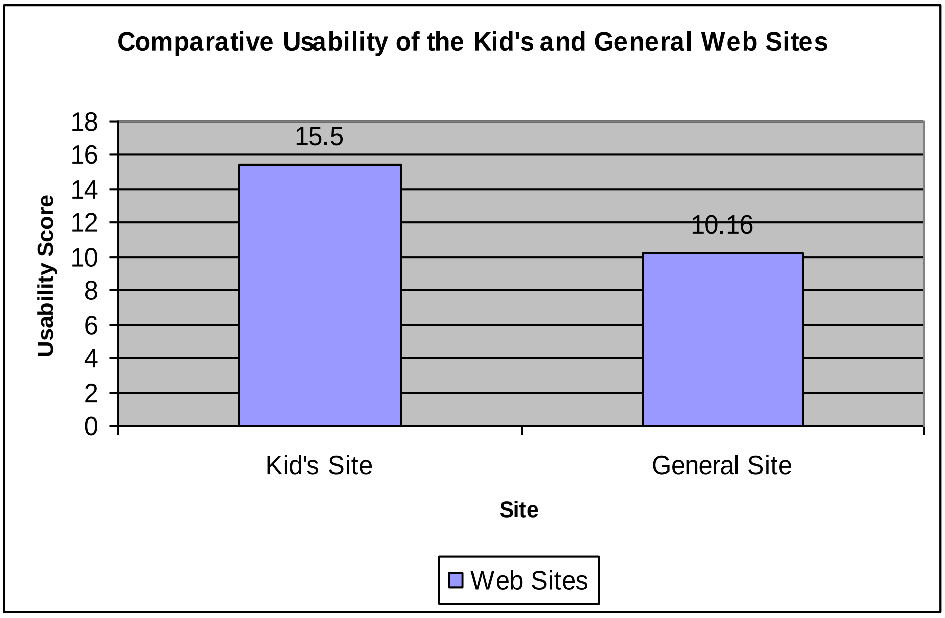

Figure 40. Comparison of the overall usability scores for the Kids' and General web sites. The maximum score for usability is 25.

usability than the General site ($F = 2.38$, $p < .01$; $d = .92$) , the pages of the Kids' site are generally more usable overall than those of the General site ($t(12) = 4.54$, $p < .01$, $d = 1.72$).   The difference in usability is quite transparent when the two sites are compared with respect to the usability of individual pages (Figure 41).

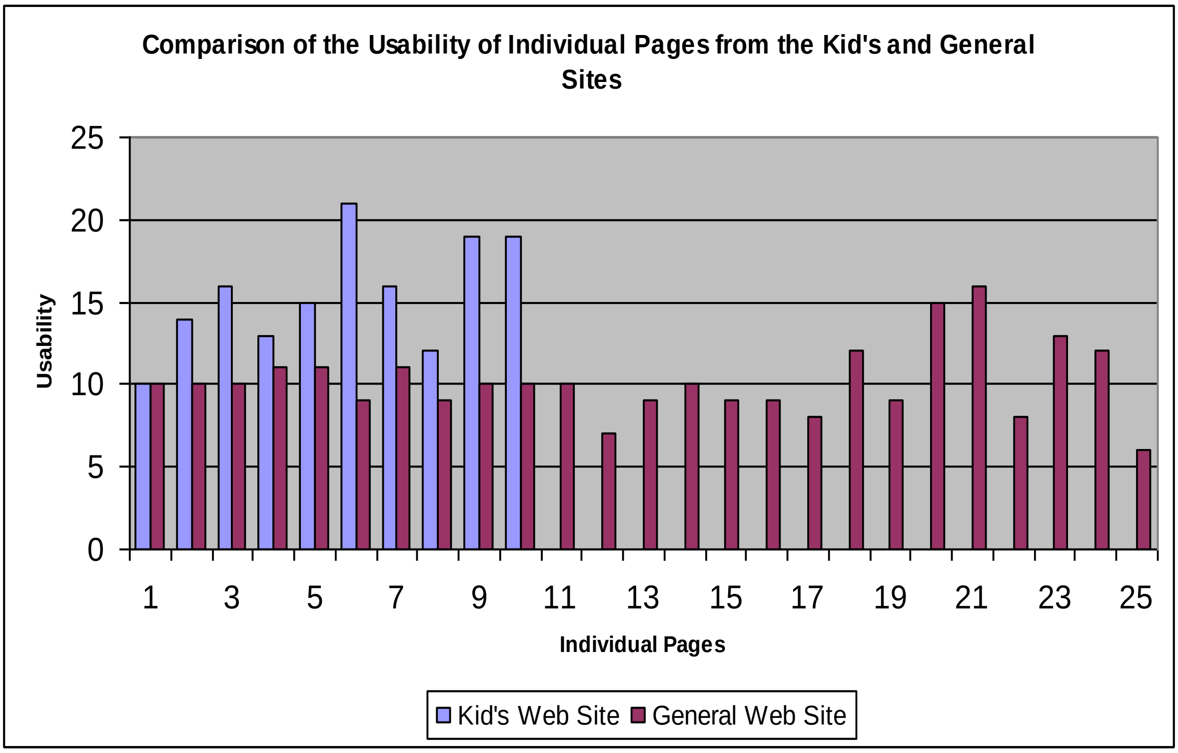

Figure 41. The usability of individual pages varies for both the Kids' web site and the General web site. The maximum "usability" score for any one page is 25.

Glasses Have Two Lenses:

A Structural Equation Model for Reading on the Internet

A structural equation modelling (SEM) analysis of factors involved in reading comprehension of web-text, or, material sourced directly on the Internet, was undertaken using the AMOS statistical program, Version 7.0. SEM was selected as a statistical methodology because of its several advantages over regression modelling, including the use of confirmatory factor analysis (CFA) to reduce measurement error by having multiple indicators per latent variable; the desirability of testing models overall rather than coefficients individually; the ability to test models with multiple dependents; the ability to model error terms, and the desirability of its strategy of comparing alternative models to asses a relative fit model. Reporting SEM results varies widely among researchers, but it is common for multiple fit indices to be reported. This study reports the results of the SEM analysis making use of four goodness-of-fit indices (GFI) chosen to reflect diverse criteria: The relative Chi-square (CMIN/DF), the Comparative Fit Index (CFI), the Root Mean Square Error of Approximation (RMSEA) and the Expected Cross Validation Index (ECVI).

The relative Chi-square (CMIN/DF), which is the ratio of CMIN (the minimum discrepancy), and DF (the degrees of freedom), is a *discrepancy function*. The CMIN/DF index simultaneously tests the null hypothesis (H_0) that the specification of factor loadings, factor variances/co-variances and error variances for the model under study are a good fit (Byrne, 2001). A value of 2 or less reflects a good fit, while a value between 2 and 3 could be considered an acceptable fit (Garson, 2008b; Schermelleh-Engel, Moosbrugger & Muller, 2009). The index should *not* be significant if there is a good model fit, therefore the associated probability p must satisfy $p \geq .05$. This probability value represents the likelihood of obtaining a CMIN/DF value that exceeds the computed CMIN/DF value when the null hypothesis is true. The Comparative Fit Index is derived from the Normed Fit Index (NFI), one of a group of so called "incremental indices" which compares the hypothesised model against some standard. This standard is often the "null" model which assumes no relations between any variables. The CFI corrects for the tendency of the NFI to under-estimate fit in small samples. Values of the CFI > .90 are regarded as being an adequate fit, with values > .95 being indicative of a good fit, although these *rules of thumb* are now under review. Hu & Bentler (1999), for example, have suggested CFI $\geq$ .96 as being more appropriate as an indicator of goodness-of-fit, while Schermelleh-Engel et al (2009) recommend CFI $\geq$ .97 for a good fit and .95 $\leq$ CFI < .97 as an acceptable fit. The Root Mean Square Error of Approximation does not require comparison with a null model and is one of the fit indices less affected by sample size, although a true population model can be rejected when the sample size is small. A good fit is indicated by values $\leq$ .05, although Hu and Bentler (1999) have suggested RMSEA $\leq$ .06 as the cut-off for a good model fit. Values between .05 and .08 are generally regarded as indicating an adequate fit. The RMSEA index is usually reported with its 90% confidence interval. An associated statistic PCLOSE tests the hypothesis that RMSEA is not greater than .05. PCLOSE $\geq$ .05

indicates a good fit. The Expected Cross-Validation Index is used in this study when reporting back the acceptability of the final structural equation model. It measures, in a single sample, the likelihood that the model cross-validates across similar-sized samples from the same population. ECVI indices can take on any value so there is no determined range of appropriate values (Byrne, 2001, p. 86). However, if the values of the ECVI follow the pattern: hypothesised model < saturated model < independence model, then we can conclude the model represents a best fit to the data.

The strategy adopted for model-building was to start by identifying a "conceptual model" then use the established process of "model trimming". The conceptual model is discussed in the next section.

The Conceptual Model

The model to be tested conceives of reading comprehension of web-text as a multi-faceted activity. It postulates that the consumers' (readers') possession of appropriate cognitive skills, a strategy for using those skills, prior ability to comprehend print-based text and attributes of the web sites created by the producers (writers) that may either facilitate or hinder the reading task are foundational to successful acts of reading comprehension. Combined data from the two classes in the original study are used to validate measurement models embedded in the structural equation model. The model consists of latent variables representing possession of cognitive strategies prior to the study, the ability to comprehend print-based text, the use of a meta-cognitive learning strategy during the study, aspects of the web sites themselves that help or hinder reading comprehension and the reading comprehension outcomes for students who took part in the study. Each latent variable has a number of measured variables associated with it (Table 18). The values of the measured variables are the aggregates of the scores from individual questions associated with that variable. These relationships are unpacked in the following sections.

Table 18
Variables appearing in the CFA and SEM

Latent Variables	Measured Variables
Existing Cognitive Strategies	Rehearsal (Rehearse)
	Elaboration (Elab)
	Regulation (Reg)
	Critical Analysis (Crit)
	Organisation (Org)
	Effort (Effort)
	Help (Help)
Use of WWW SSURF Metacognitive Strategy	Prior knowledge (Prior)
	Key words and phrases (Key)
	Choice of web site and/or Web Page (Choice)
	Skim read first (Skim)
	Systematically read (System)
	Use existing strategies to help Understand (Under)
	Relate new information back to prior knowledge and the questions to be answered (Relate)
	Figure out what to record/decide what information to use (Relevant)

Table 18 (Continued)

Reading Comprehension for Print Text	Understanding
	Making Connections
	Inference
	Processing Information
	Exploring Language
	Thinking Critically
Usability Factors of Web Sites	Navigation (Navig)
	Content Presentation (Cont Pres)
	Multimedia Content (Mult Cont)
	Discourse features (Disc Feat)
	Appearance (Appear)
Reading Comprehension Outcome	Number of pieces of information selected by participants to use in answering the questions set for the study by their teachers (Score)

Confirmatory factor Analysis (CFA) is used to test the measurement models to be incorporated into the Conceptual Structural Equation Model.

Measurement model for "Existing Cognitive Strategies"

A Confirmatory Factor Analysis (CFA) was carried out for the latent variable "Existing Cognitive Strategies" and the measured variables Rehearsal, Elaboration, Regulation, Critical Analysis, Organisation, Effort, and Help previously described in Chapter 3 "Methods and Procedures" in the section about the MSLQ questionnaire. As the critical ratios for the measurement variable Effort (CR = 1.17) and Help (CR = .34) were less than the accepted cut-off value of 1.96 ($p < .05$), these two measurements were removed and a CFA was carried out with the remaining five measurement variables (Figure 42).

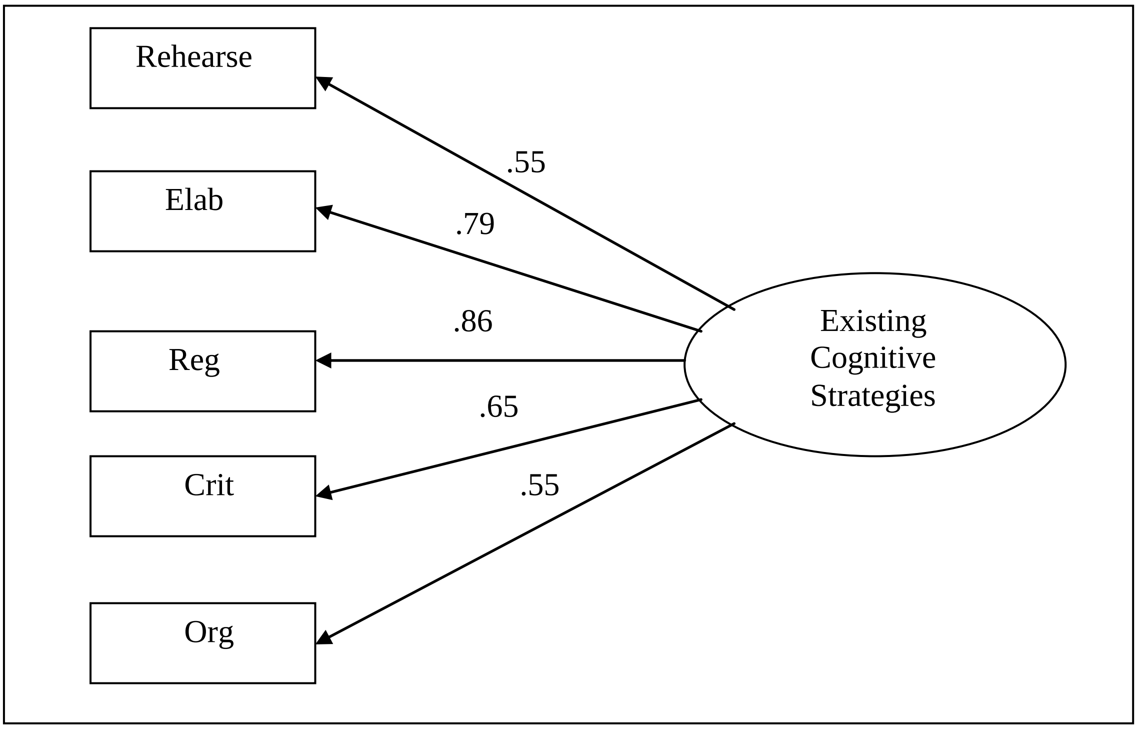

Figure 42. CFA for the measurement model "Prior Cognitive Skills". Residuals are standardised. N=58, CMIN/DF = 1.10, p = .36, CFI =.99, RMSEA = .01, PCLOSE = .44 .

Measurement model for "Metacognitive Strategy Use"

A CFA was carried out for the latent variable "Strategy Use" and the measured variables Prior Knowledge, Key Words and Phrases, Choice of Web Site and or Web Page, Skim Read First, Systematically Read, Understand, Relating New Information and Choose Relevant Information previously described in Chapter 3 "Methods and Procedures" in the section about the WWW SSURF metacognitive learning strategy. While the critical ratios were all in the acceptable range, this measurement model was not a good fit (*N*=58, CMIN/DF = 1.81, p = .02, CFI =.90, RMSEA = .12, PCLOSE

= .05). The CFA was re-run with the removal of the variable Relevant. The decision was made to remove this variable because it could simply be seen as signalling "it is time to make a decision about using this fact" rather than being part of the process of comprehending what is being read (Figure 43).

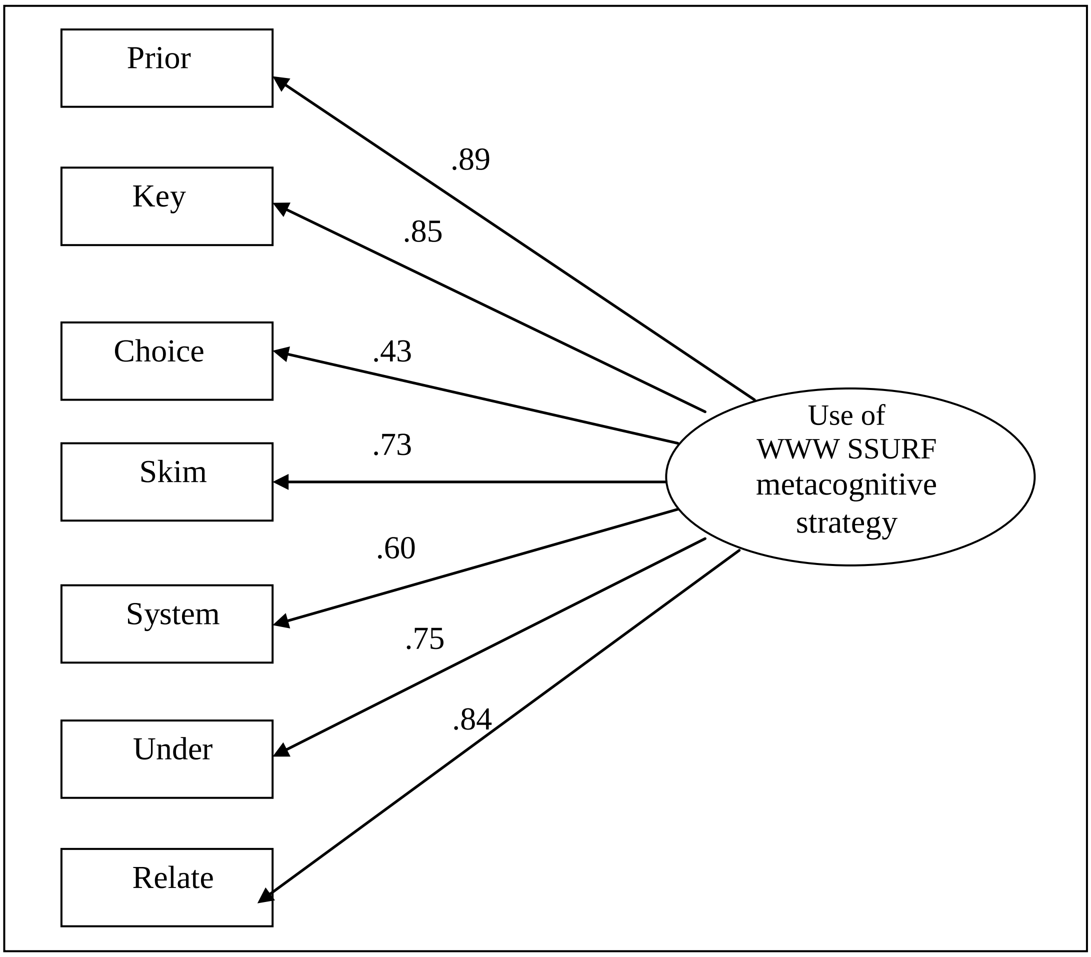

Figure 43. CFA for the measurement model "Strategy Use". Residuals are standardised. N=58, CMIN/DF = 1.13, p = .32, CFI = .99, RMSEA = .05, PCLOSE = .46 .

Measurement model for "Reading Comprehension for Print Text"

A CFA was carried out for the latent variable "Reading Comprehension" and the measured variables Understanding, making Connections, Inference, Processing Information, Exploring Language and Thinking Critically previously described in Chapter 3 "Methods and Procedures" in the section about the asTTle reading comprehension test. While the critical ratios were all in the acceptable range, this measurement model was not a good fit (N = 56, CMIN/DF = 38.6, p = .000, CFI = .93, RMSEA = .25, PCLOSE = .00).   There was no reason to run the analysis again with a reduced number of indicator variables. As the asTTle testing data was available for the whole year level cohort, the CFA was re-run with that data (Figure 44).

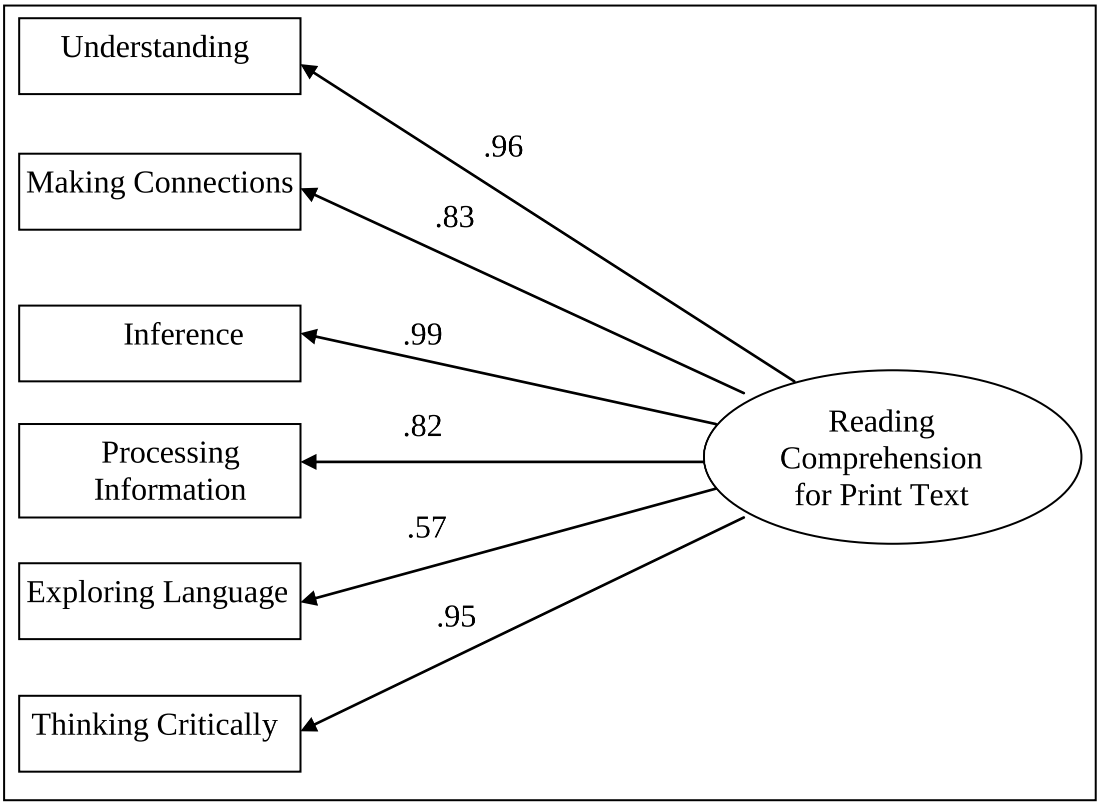

Figure 44. CFA for the measurement model "Reading Comprehension". Residuals are standardised. N=328, CMIN/DF = 25.80, p = .00, CFI = .91, RMSEA = .28, PCLOSE = .00 .

Measurement model for "Usability of a Web Site"

"Usability Factors of a Web Site" is also a latent variable in the conceptual model.   The measurement variables associated with are Discourse Features", Navigability, Content Presentation, Appearance and presence of Multimedia Presence previously described in Chapter 3 "Methods and Procedures" in the section about the usability of web sites.   A CFA was carried out using all these variables (Figure 45). The smaller sample size for these measurements is due to the unit of analysis being the number of web pages available to students in the study, rather than the number of students.

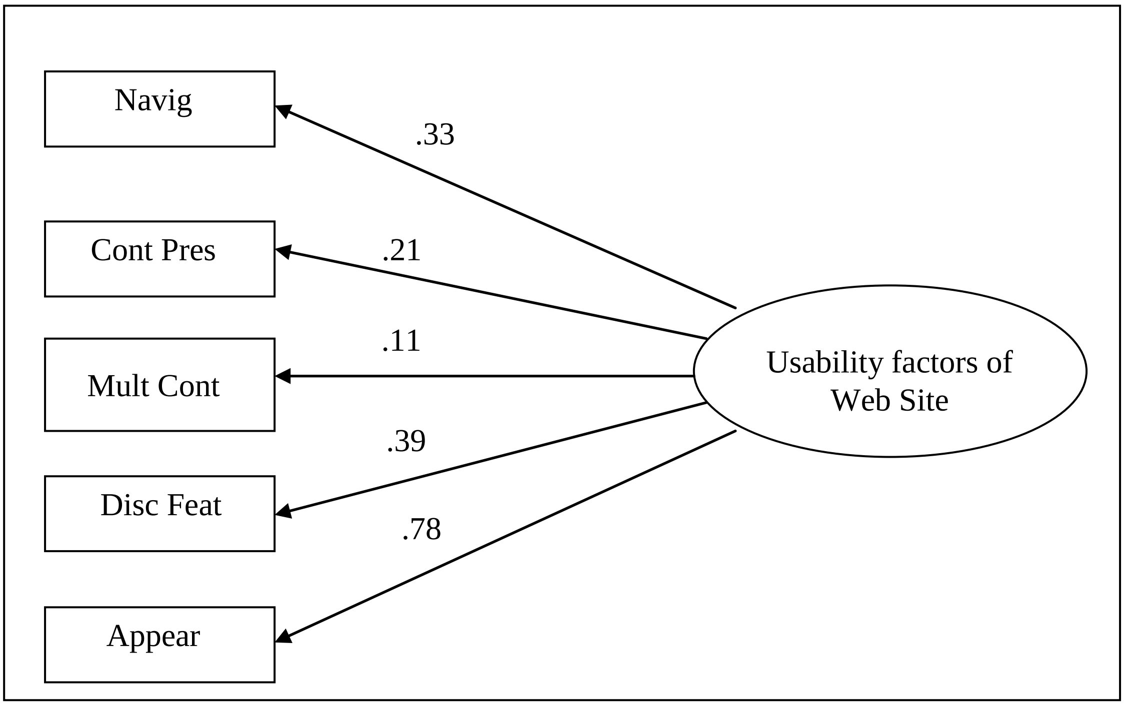

Figure 45. CFA for the measurement model "Usability". Residuals are standardised.
N = 37, CMIN/DF = .72, p = .63, CFI = 1.00, RMSEA = .00, PCLOSE = .68

Other variables in the conceptual model

The final measurement variable is the Score that students obtained from the study, that is, the number of distinct pieces of information that they recorded to include in their answers to the questions set by the teachers. This measurement is associated with the latent variable "Reading Comprehension Outcome". In addition, the three latent variables Prior Cog Use, Strategy Skills and Usability Factors of a Web Site are conceived as being indicators of a further latent variable, "Factors Underpinning Reading Comprehension Success on the Internet". These variables are all incorporated in the final conceptual model.

The conceptual model

The structural equation model incorporates both a first-order CFA model and a second-order CFA model (Figure 46). The second order CFA model on the left hand side of the diagram integrates the two lenses of the consumers and the producers. The first order CFA model on the right hand side models the outcome of the comprehension process.

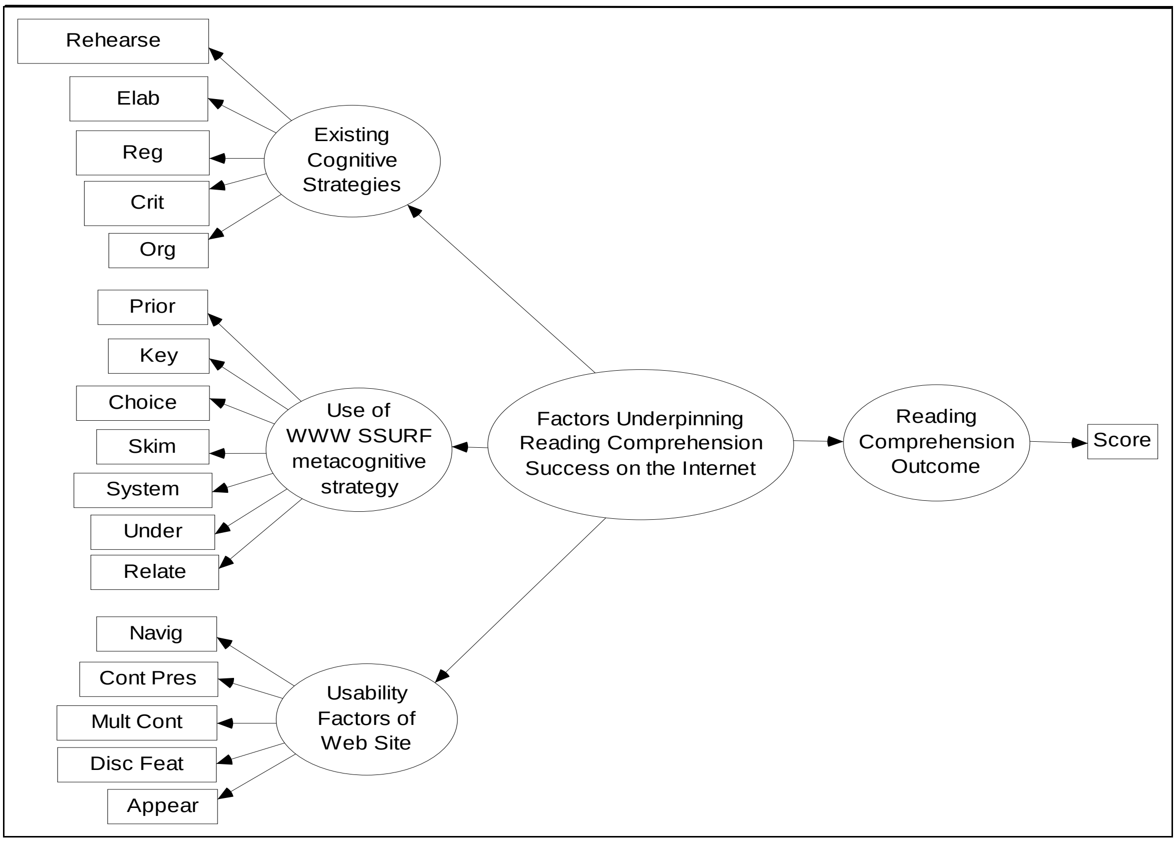

Figure 46. Conceptual Model for Reading Comprehension for Web-Text.

The Structural Equation Model

The data

A correlation table (Table 19) and a table of selected descriptive data (Table 20) show the relationships amongst the measured variables used in the conceptual model. Table 20 shows that an assumption of multivariate normality holds for all the participant-derived data. Large values for the kurtosis and skewness of the variable "Navig" are due to maximum possible scores being obtained for the sites used in this study. This is an unusual situation. A wider selection of web sites would very likely have produced some variation in the "Navig" score across web sites.

Table 19
Correlation table for measured variables appearing in the conceptual structural model

	Score	Rehearse	Elab	Org	Crit	Reg	Prior	Key	Choice
Score	1.00								
Rehearse	0.03	1.00							
Elab	0.07	0.37	1.00						
Org	-0.09	0.16	0.37	1.00					
Crit	0.00	0.27	0.53	0.26	1.00				
Reg	0.08	0.28	0.66	0.44	0.55	1.00			
Prior	0.23	0.11	0.09	0.20	0.33	0.19	1.00		
Key	0.10	0.12	0.16	0.41	0.32	0.17	0.76	1.00	
Choice	0.18	0.32	0.08	0.19	0.33	0.14	0.58	0.57	1.00
Skim	0.14	0.08	0.09	0.20	0.38	0.14	0.72	0.64	0.63
System	0.17	0.00	0.13	0.17	0.45	0.23	0.69	0.61	0.60
Under	0.20	0.13	0.17	0.22	0.43	0.22	0.79	0.74	0.64
Relate	0.21	0.08	0.21	0.24	0.40	0.26	0.87	0.74	0.65
Navig	0.03	-0.12	-0.19	0.05	-0.30	-0.18	-0.02	0.09	0.04
Cont Pres	0.16	-0.23	-0.16	-0.10	0.00	-0.19	-0.18	0.00	-0.02
Mult Cont	-0.27	0.22	0.26	-0.01	0.48	0.27	-0.07	0.00	0.15
Disc Feat	-0.07	0.20	-0.02	-0.21	0.02	-0.15	-0.20	-0.41	-0.27
Appear	-0.22	-0.03	-0.04	-0.21	-0.06	-0.28	-0.27	-0.31	-0.11

Table 19 (Continued)

	Skim	System	Under	Relate	Navig	Cont Pres	Mult Cont	Disc Feat	Appear
Skim	1.00								
System	0.76	1.00							
Under	0.73	0.72	1.00						
Relate	0.71	0.78	0.80	1.00					
Navig	-0.08	-0.03	-0.05	-0.09	1.00				
Cont Pres	-0.08	-0.03	-0.01	-0.08	0.07	1.00			
Mult Cont	-0.04	0.13	0.03	-0.05	-0.09	0.19	1.00		
Disc Feat	-0.25	-0.28	-0.25	-0.16	0.16	-0.08	-0.13	1.00	
Appear	-0.26	-0.43	-0.11	-0.34	0.26	0.20	0.13	0.33	1.00

Table 20
Summary data for measured variables appearing in the conceptual structural model

Variable	*M*	*SD*	Kurtosis	Skewness	*N*
Score	17.41	12.22	1.90	1.43	63
Rehearse	9.99	3.81	0.36	0.19	63
Elab	20.56	5.12	-0.04	-0.29	63
Org	11.92	3.60	0.87	0.63	63
Crit	17.67	4.70	0.29	0.36	63
Reg	41.10	7.93	-0.16	0.14	63
Prior	2.38	0.89	-0.73	-0.10	63
Key	2.30	0.95	-0.78	-0.18	63
Choice	2.72	0.93	-0.88	-0.38	63
Skim	2.61	0.88	-0.49	-0.34	63

Table 20 (Continued)

System	2.74	0.78	-0.20	-0.57	63
Under	2.55	0.88	-0.29	-0.39	63
Relate	2.57	0.84	-0.78	-0.16	63
Navig	1.95	0.23	15.77	-4.11	37
Cont Pres	1.22	0.75	5.62	2.12	37
Mult Cont	2.27	3.15	-0.23	1.06	37
Disc Feat	4.65	1.01	-0.17	-0.26	37
Appear	1.54	0.50	-2.09	-0.17	37

The results

Structural equation modelling was initially undertaken with the data from the two classes in the original study. This gave acceptable results for the model discussed in this section (CMIN/DF = 1.19, p = .07, CFI = .95, RMSEA = .059, PCLOSE = .33). Modelling was not undertaken with the single class in the replication study as the number of complete sets of data was too small.

Modelling in AMOS is susceptible to sample size. Although it contains routines for the “imputation” of data, the researcher’s preference was to work with complete data sets. The combination of data from the original and replication studies was discussed in Chapter 4. The results reported in this section make use of the combined data from the original and replication studies.

Maximum likelihood (ML) was chosen as the method of estimating the free parameters in the structural equation model. Maximum likelihood performs well under a variety of less than desirable analytic conditions such as sample size and excessive kurtosis (Hoyle & Panter, 1995, p. 162). The fit indices for the conceptual model were "promising" (CMIN/DF = 1.41, p = .001, CFI = .89, RMSEA = .08, PCLOSE = .04). Inspection of the critical ratios for the measured variables highlighted several that failed to meet the generally accepted cut-off value of 1.96. The researcher took a cautious approach and trimmed the conceptual model by removing the variable "Mult Cont" (estimate = 1.09, stand error = 1.62, CR = .67, p = .50) as an indicator for the latent variable "Usability factors of Web Site". The pragmatic justification for this was that the General web site contained no multimedia elements and the Kids' web site contained only a small number of unobtrusive elements which made a valuable contribution to the site as a whole. The fit indices for this revised model are (CMIN/DF = 1.35, p = .01, CFI = .92, RMSEA = .08, PCLOSE = .09). If other web sites had been used in the study, it is likely that the Mult Cont variable would have remained in the structural equation model. This is a good example of the indicator variables for the usability of web sites being very site specific.

Several further measurement variables for the "Usability" latent variable still had critical ratios less than the suggested cut-off value. The researcher determined not to remove these as they were accurate indicators of the difference between the General and Kids' sites. The latent variable "Use of the WWW SSURF metacognitive strategy" and its indicator variables were central to this study. In addition, the critical ratios all met the acceptable cut-off value (values ranged from 7.01 through to 8.82). Further improvement in the model had to come from adjustments to the latent variable "Existing Cognitive Strategies" and its indicator variables. In Chapter 3 "Methods and Procedures" it was noted that the variable Rehearse was to do with committing information to memory through the use of such devices as reciting items from a list. This was not an essential strategy in this study.

Participants recorded information in a booklet which alleviated the need to retain a lot of information in working memory. The variable Rehearse was trimmed from the conceptual model, as was the variable Org. The Organisation variable related to the use of devices such as creating charts and/or diagrams in order to help construct connections between different ideas and pieces of information. While relating new information back to what is already known was part of the WWW SSURF metacognitive strategy, it did not call for the use of "pencil and paper" devices such as these. A comment by Leu et al (2007, p. 48) that synthesis of information is a central component of online reading comprehension and that much of the synthesis takes place in the mind of the reader lends support for this decision. The result for this further revision of the conceptual model is reported in Figure 47.

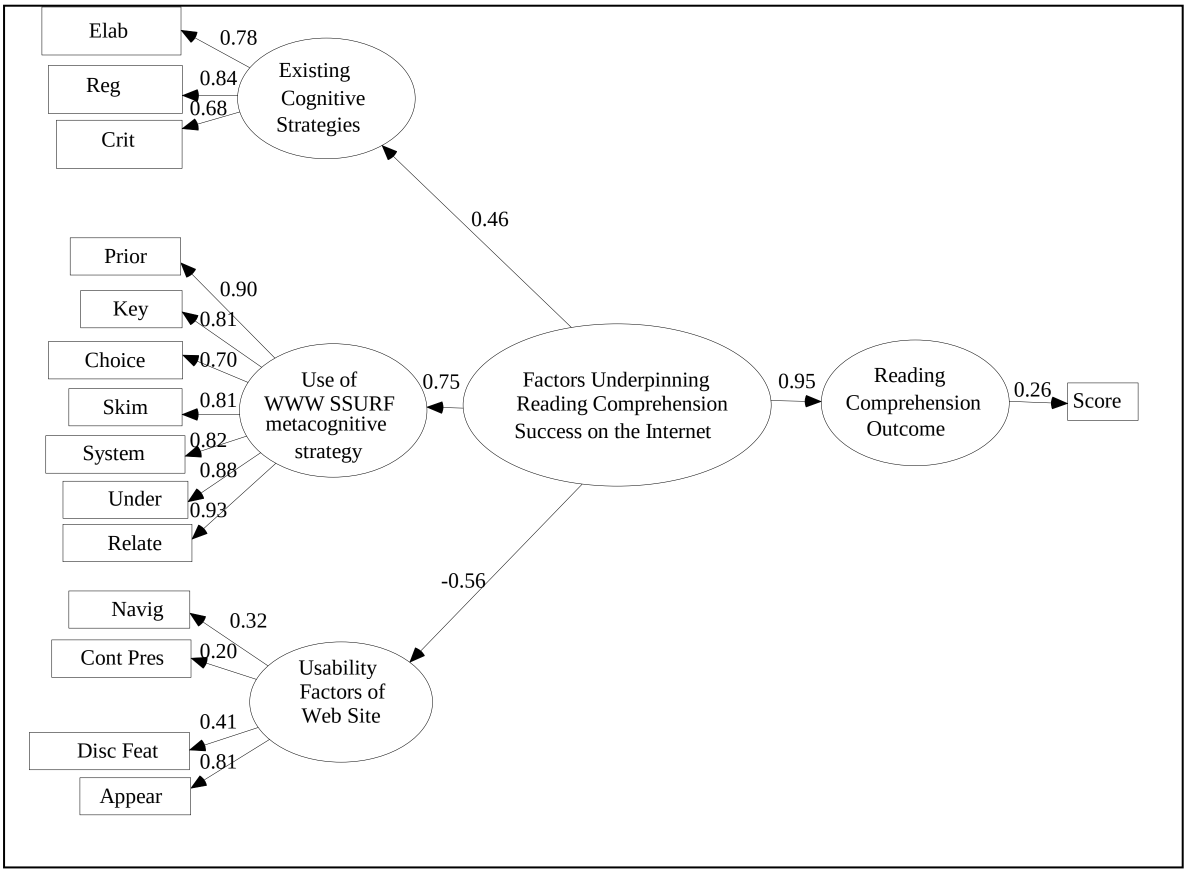

Figure 47. CFA for the final model. Residuals are shown standardised to help picture the relationships in the model. CMIN/DF = 1.19, p = .11, CFI = .96, RMSEA = .055 with 90% confidence interval [.00;.09], PCLOSE = .40, ECVI: 3.21 (default) < 4.36 (saturated) < 9.56 (independence) with 90% confidence interval [2.94;3.69] and 3.69 (HI 90) < 4.36 (saturated).

The latent variable "factors underpinning reading comprehension on the internet" was modelled in terms of three latent variables. The latent variables "existing cognitive strategies" and "use of [the] WWW SSURF metacognitive strategy" have their origins in research into the consumers' (readers) need to access information sourced on the internet. The latent variable "usability factors of web sites" has its origins in research into the producers' (writers) need for consumers to be able to access the information that their web site contains. The structural equation model for "reading comprehension outcomes [on the internet]", takes both of these lenses (perspectives) into account. The structural equation model for this exploratory study is a good fit to the data, and confirms that "glasses have two lenses" when it comes to reading comprehension on the Internet. The standardised path coefficients (Figure 46) indicate that the use of the acronymous metacognitive learning strategy, WWW SSURF, was even more influential in obtaining good reading comprehension outcomes when reading web-text than the possession of appropriate cognitive tools. When the relatively short time frame for the implementation of the strategy in this study is taken into consideration (five, 45-minute sessions), metacognitive strategy instruction can be seen as a powerful adjunct to normal practices of teaching cognitive strategies for specific purposes in reading comprehension. Providing metacognitive strategy instruction for students is a matter of some urgency, in New Zealand at least, where the Ministry of Education has made considerable effort to improve literacy outcomes for students in New Zealand Schools. They have provided comprehensive resources, including teacher training. In their printed resources they acknowledge the wealth of research that points to proficient readers being able to select comprehension strategies according to the requirements of the task and that readers' comprehension improves when they are explicitly taught how to use processing and comprehension strategies (New Zealand Ministry of Education, 2006, pp. 141 and 151). The significance of this is articulated in another publication in which they comment that one of the things that distinguishes effective from less effective readers is the ability to take appropriate and conscious decisions about which reading strategy to adopt in which circumstances, and when to switch strategies (New Zealand Ministry of Education, 2004, p. 156). In both of these resources, considerable attention is given to developing specific examples of cognitive strategies, but they are strangely silent on the question of teaching students over-arching metacognitive strategies to operationalise these desirable traits. Neither do these Ministry sponsored materials address the question of texts other than print-based. While work with students using computers to source information does happen in New Zealand schools, it is usually at the discretion of individual schools and their teachers and presented under a banner such as "Information

Literacy" – a construct separate to traditional subjects. The need is to recognise formally the existence of new literacies, and incorporate appropriate instruction for dealing with these literacies within the core literacy programme. Leu et al (2007, p. 58) regard the failure to understand that online reading requires new skills and strategies, and the failure to integrate the Internet into literacy education, as a systemic failure that can not continue to be ignored. Here, New Zealand, and apparently the United States of America, are sadly behind. England, for example, recognised the importance and the difference of electronic text in their National Literacy Strategy, first reported in 1977. In their official guidelines, students are first deliberately exposed to IT-based sources of reading for non-fiction texts in Term 1 Year 3 of the National Curriculum (Year 4 in New Zealand), and then go on in Term1 Year 4 to investigate how reading strategies are adapted to suit the different properties of IT texts, for example: those which are scrolled and non-linear in structure; incorporate sound or still and moving images; can be changed; and, have a spatial dimension (Department for Education and Employment, 1998, pp. 33 and 39).

The latent variable "Reading Comprehension Outcome" is shown in the structural equation model as only having one indicator variable. Other variables may have their place here. For example, one of the questions left in the aftermath of this study concerns student perception over the amount of information that is required to adequately answer a question, and whether it is something that teachers need to address when setting students research tasks. It could also be a matter of maturity, that as students become older and more experienced they would include more depth in their work than younger students. At the moment this issue is in the realm of speculation, but it is an area that demands serious research.

The path coefficient for the latent variable "Usability Factors of Web Site" is negative. This indicates that the lower the usability of the website the more successful reading comprehension will be if existing cognitive strategies are used in conjunction with a metacognitive strategy such as the WWW SSURF acronymous metacognitive learning strategy used in this study. The contributions of its indicator variables will change for different web sites, as there is no "universal standard" for the creation of "consumer friendly" web sites, although producers (designers) of many individual sites do put a lot of thought in how to best "capture" the attention of their potential consumer base.

The three latent variables "Existing Cognitive Strategies", "Use of the WWW SSURF metacognitive strategy" and the "Usability of Web Sites" together are a strong set of indicator variables for the second order latent variable "Factors Underpinning reading Comprehension success on the Internet" which, in turn, is a very good predictor for the latent variable "Reading Comprehension Outcome". This model, which combines the perspectives of both the consumers and the producers, successfully addresses the primary research question: "What factors contribute to the ability to read web-text with understanding?"

Summary

In this chapter attention was first focused on the nature of the web sites themselves. Web sites are estimated to contain 90% text, so the question of age appropriate text is just as important for electronic web-text, as it is for print-based text. A consequence for teachers is that they should take some care in pointing their students to web sites. It would be preferable for them to investigate potential web sites and explore more than just the presenting pages of each site to gauge whether the text of pages further into each site will still be age-appropriate for the student readers. This is particularly true for students with ages represented by the participants in this study. Older students could be taught to take on this survey for themselves as part of a strategy for "choice" of suitable web sites. This was not really an issue for the participants in this study since the primary web sites to be used were chosen for the students. At the time of the study, participants did need to make use of a search engine to glean the information needed to address adequately the question set by their teachers to do with “acid rain”. Since this study, the EPA website has now been updated and incorporates a “Kid’s site” for the topic “Acid Rain” (http://www.epa.gov/acidrain/education/site_kids/). Other features of web sites also need to be considered. The navigability, or as has been colloquially expressed, the “ability to get lost” on a web site, should be vetted by the teacher, as should the presence of multi-media elements. If present, “are they there for entertainment?”, “do they distract from the main task?”, “do they make a worthwhile contribution?” are measures of the site’s usability. Presentation is also important, “Do the pages look busy (cluttered)?”, “is there plenty of white space around page elements?” are the guidelines here. While these questions have predominantly been addressed through the lens of the producers, there is also a need for the consumers to give these questions their attention.

Having selected web sites for their students that are “usable”, teachers can expedite the reading comprehension of web-text by teaching their students a metacognitive learning strategy such as WWW SSURF, the acronymous metacognitive learning strategy used in this study, to help master the reading task. This, together with the evidence presented in the previous chapter, could also help students improve reading comprehension outcomes for print-based text as well.

The initial focus of this chapter was through the lens of the producers. Combining the lenses of the consumers and the producers has allowed the primary research question to be examined, and the conclusion reached that a sharper focus of the issues surrounding regarding reading comprehension and web-text is indeed attained when we use “Glasses [that] have two lenses”.

CHAPTER 6

CONCLUSIONS AND IMPLICATIONS

This chapter draws heavily on the metaphor “Glasses Have Two Lenses”, used in this research to model reading comprehension for web-text. The first section, “Reflections” (from the lenses - pun intended), recaps the purpose of the research and what was achieved. Glasses are only as robust as the frames that hold the lenses. The following section “Plastic Or Titanium?” reviews the distinctive features of this research project in terms of the contribution the study has made both in a theoretical and a practical sense. Finally, vision is not static. Whether change is mandated, because the focus has been lost, or desirable, to appreciate better what can already be seen, up-dating the prescription for the lenses will always be beneficial. Suggestions for future research, for both the researcher and also the classroom practitioner, are presented in the final section “Re-focussing”

Reflections

The Consumers’ Lens

A major concern of any intervention is “has the intervention made a worthwhile /significant difference?” This study featured the use of an acronymous metacognitive learning strategy, WWW SSURF, as a device for improving reading comprehension outcomes for web-text. Research into the effectiveness of reading comprehension strategies has traditionally been reported for print-based text and it was salient to ask as the preliminary research question “Is the use of an acronymous learning strategy a contributing factor to the ability to read web-text with understanding?”

Self assessment tools were developed to track the implementation of the WWW SSURF strategy with several groups of classes, two in the first phase exploratory study, and one in the second phase replication study. A modified version of the MSLQ questionnaire was developed to assess the possession of relevant cognitive strategies by study participants prior to the study. This was used as a "blind" in that it contained questions other than those to be the focus of the study. A new tool, the WWW SSURF questionnaire, was developed to assess levels of use of the elements of the WWW SSURF strategy during and after the study. Data were also gathered from asTTle and PAT tests of reading comprehension during the first and second phase studies, respectively, in order to provide information about the study participants.

Each study involved five, 45 minute sessions with complete classes of students from a New Zealand intermediate school (NZ Year levels 7 and 8). Each student had one-to-one access to a computer. The first session involved the class teacher setting up the conditions for the study by providing the participants with their work books, explaining how to use the WWW SSURF strategy, and getting them started by having students record prior knowledge and identify and record key words and phrases that they could use as search or indicator terms. During the following four sessions the study participants used the strategy and recorded what they thought would be appropriate information to be used in answering questions that the teachers had set as the focus of their study.

All data derived from the study were subject to scrutiny before being used. This was particularly important in this exploratory study which was essentially a small scale study by nature. All the data adequately met the accepted standards for reliability, as measured by Cronbach's alpha, and Kurtosis and Skewness measures were well within accepted limits for the data to be considered to be drawn from a normally distributed population.

The answer to the preliminary research question was addressed first of all at the surface level. A comparison of the outcomes for two groups in the replication study, one of which used the WWW SSURF strategy, and the other one that did not, established that there was a difference. Digging deeper, it was anticipated that the data derived from the self-reporting questionnaire used at the end of each study session would provide further confirmation that using the strategy made a difference and give some insight into how participants used the strategy. Analysis established that the use of cognitive strategy elements by participants increased from their pre-study levels, through the study, and were sustained over a six month period post-study, without any further deliberate instruction or requirement that the WWW SSURF strategy be used in participants' on-going class-work. Support for confidence in the robustness of these results came by comparing levels of strategy use for the groups involved in the original study with those of the group in the replication study. In spite of the three groups in the study being "quite different" on a number of measures, the pattern for uptake of strategy elements by the group in the replication study paralleled that of the groups in the original study. The original study groups, along with the rest of their year level cohort, sat asTTle reading comprehension tests prior- and post-study. A statistically small significance was detected between the increases in asTTle scores for the study groups compared with the classes that were not involved in the study. There was no difference detected between the increases in asTTle scores for the two study groups, which supports the contention that metacognitive strategy training for reading comprehension in an on-line environment, specifically for reading web-text, does influence reading comprehension ability for print–based text.

Data also showed that differences between the groups in the study were reflected in the way in which individual strategy elements were used at different times in the study. Evidence was also presented that the WWW SSURF strategy did in fact provide a pathway for reading comprehension that was flexible. While the strategy suggests a linear pathway, participants were free to "jump" backwards and forwards through elements of the strategy as they strived to build understanding of the text they were reading.

The results of the study, collectively, provide affirmation of the preliminary research question "Is the use of an acronymous learning strategy a contributing factor to the ability to read web-text with understanding?"

The Producers' Lens

A further concern addressed in this study is the question "is metacognitive strategy training for reading comprehension for web-text enough?" The producers of web sites have taken the lead in investigating what it is about their sites that will ensure that consumers stay and access the information the site contains, or whether they move on to another site. It is a tautology to say that web-text is different to print-based text. Even though hyperlinks and navigation, perhaps the most obvious difference between print-based text and web-text, have captured the attention of some consumers of web-text, one of the real difficulties of being able to understand what a web-site contains parallels the print-based environment – the readability of text. This study found that there were demonstrable differences between the reading age requirements of pages from the Kids' site and those of the General site. While there was some overlap, the Kids' pages generally required lower reading ages than those of the General site. Both sites exhibited a common trend that pages "deeper" in each site required a reading age higher than those before. In general, the higher the reading age requirement of the page, the less information was used from that page by the study participants, although there were some anomalies in this trend.

Several web-pages, requiring higher reading ages, had a greater amount of information used by participants than might be expected. Visual inspection of those pages found that there was a particular feature which made some of the information more readily accessible: they had short summaries at the start of each page. Some participants had apparently extracted low-level detail from the summaries and had not explored the greater depth of information available in the main body of the web page. Other usability features of the two main web sites used in the study were also very highly rated. Navigability ratings were very high. It would be difficult for people accessing these sites to "get lost". The usability of a web site is a mix of different elements. Using the rubric discussed in Chapter 3, the Kids' site was rated as being "more usable" than the General site and this was reflected in the selection of information chosen by participants to answer the questions set by their teachers for this study.

This adds another dimension to the problem of reading comprehension of web-text. In contrast to print-based text, there is another "layer" to be dealt with before the consumer of web-text can access the textual component of a web site to read it. Our attention now turns from the preliminary research question "Is the use of an acronymous learning strategy a contributing factor to the ability to read web-text with understanding?" to the primary research question "What factors contribute to the ability to read web-text with understanding?"

Glasses Have Two Lenses

In order to address the primary research question, this exploratory study combined the lenses of the producers and the consumers and tested a structural equation model. The resulting model shows that the lens of the consumers and the lens of the producers both play a significant role in successful reading comprehension for web-text. Successful readers need to have a range of cognitive strategies at their disposal in order to be able to deal with specific situations that arise during the reading comprehension process. More significantly, they also need a plan for when to use their cognitive strategies. The WWW SSURF acronymous metacognitive learning strategy implemented in this study is just such a plan.

The structural equation also confirms the role of the usability factors of a web site in successful reading comprehension. The overall effect of a web site's usability is to work against the reader. This is indicated by the negative path coefficient in the structural equation model. The extent to which any web site impacts on reading comprehension outcomes is governed by its indicator variables. This effect is of more than theoretical interest. Classroom teachers who point their students to the Internet as a source of rich information really need to be "Internet savvy" themselves. The decision, in this study, to designate two web-sites to be used as the primary sources of information, reflected the pragmatic need to have participants not spend a lot of time locating potentially useful web-sites. This abrogated the need for considerations of validity and reliability. If teachers do not pre-select suitable web sites for their students they could facilitate student capacity to be able to distinguish between useful and useless web-sites (such as sites lacking credibility or hoax sites) by guiding their students through a judicious selection of sample sites. In any case, students of an age with the participants in this study (11 through 13 years) and younger, arguably, should not be "let loose" on the Internet. There needs to be a teacher presence vetting the usability of web sites that students will use. Sites that are "too difficult" for any reason, will result in consumers disengaging. To maximise valuable classroom time in front of a computer, sites that are consumer-friendly will afford the best opportunities. The choice of two web-sites as the primary sources of information for use in this study reflected the pragmatic need to have participants not spend a lot of time locating potentially useful web-sites. This also had the effect of by-passing considerations of validity and reliability of web-sites.

Students’ capacity to be able to distinguish between useful and useless web-sites could be facilitated by their teachers discussing with them an appropriate selection of web-sites.

Another feature of the structural equation model is the high degree of association between reading comprehension outcomes and the three factors modelled as underpinning reading comprehension success on the internet. The measurement component, “Score”, for reading comprehension outcomes is worth more thought. The relatively low path coefficient for the indicator Score hints at the possibility of other factors at play in terms of how much detail the participants in this study chose to record to make use of when answering the questions provided by their teachers. Questions relating to teacher expectations and student maturity, including chronological age and reading age, readily come to mind.

The results of this study provide a definitive response to the primary research question “What factors contribute to the ability to read web-text with understanding?” Prior ability with print-based text is not a factor; the possession of appropriate cognitive strategies, the use of an over-arching metacognitive strategy such as the WWW SSURF strategy implemented in this study, and the usability factors of a web-site collectively have an impact on the outcomes for reading comprehension for web-text.

Plastic or Titanium?

This study has made several contributions. The first contribution is the development and testing of new data gathering tools. The original MSLQ questionnaire was developed for use with undergraduate university students. The parts of the questionnaire that were used in this study were re-written using language that was more age appropriate for the study participants (approximately 11 – 13 years). The data from the revised questionnaire was validated as being reliable, and the modified MSLQ questionnaire's use as a data gathering tool validated. The reflective questionnaire developed for the study to monitor the use of elements of the WWW SSURF strategy, was also validated as a viable data gathering tool.

A substantive, innovative contribution arising out of this study is the development, trialling and validation of a practical classroom strategy to facilitate reading comprehension for web-text. The strategy is presented as a package comprising the elements: teacher instructions for how to implement the strategy, a workbook to support student learning to use the strategy itself, and the unique WWW SSURF acronymous metacognitive learning strategy developed for and implemented in this study. This is a practical package that any classroom teacher can pick up and implement with their classes in a short time frame, as testified to by the experience of the classroom teachers whose class groups were participants in the first phase study.

A further original contribution is the development and testing of a structural equation model for factors influencing reading comprehension success with web-text. For the first time, two disparate lines of research have been combined into a single model. The power of the model lies in the messages that it has for reading comprehension practice in the classroom and for foreshadowing further lines of research.

In this exploratory study, the frame that holds the lenses of the consumers and the producers together is titanium; the focus is sharp.

Re-Focussing

This study offers several consequences for the classroom practitioner and the researcher. At a pragmatic level, it makes sense not to reinvent the wheel. Classroom teachers could do worse than to pick up the WWW SSURF strategy and experiment with implementing it in their own classrooms. They also need to take up the challenge to become fully web-savvy. There is the potential for huge savings in time and unproductive effort if teachers were to search out suitable web sites for their students, rather than letting the students rely on search engines. That is a source of frustration even for accomplished adults. This definitely needs to happen at primary school level (NZ Year levels one to eight) and, arguably, for many students at higher education levels as well, although "older" students may benefit by being taught how to assess the usability attributes of web sites for themselves.

The classroom practitioner and researcher alike would benefit from an exploration into the role of "maturity" in student responses to information-seeking tasks. The depth of information that students report in response to information-seeking tasks can often be categorised as being "minimal". Questions need to be asked and answered about the role student maturity plays in the depth of answers that students think appropriate to tasks involving information-seeking. Is it an age maturity issue? Is it a reading age maturity issue? How can students be "taught" how much information is needed to adequately satisfy an information-seeking task?

A further area for research suggested by this exploratory study is the extent to which metacognitive strategy instruction for reading comprehension of web-text has a "spill over" effect into reading comprehension for print-text. Questions to be explored could include the amount of time given to strategy training, requiring the WWW SSURF strategy to be used with an appropriate accompanying booklet for a longer period of time than that used in this study for example. Perhaps an alternative strategy could be designed and trialled in the light of what is known about the use of the WWW SSURF strategy.

One small, yet potentially significant, consequence arising from this study that merits further exploration is the possibility that the use of the reflective questionnaire by participants at the end of each session in the computer lab may have helped them to assimilate the strategy. This could have implications for instructional practice beyond the focus of the present study.

When we use glasses with two lenses, we cannot help but see more clearly. This research project has helped to answer some questions about reading comprehension for materials directly sourced on the Internet, and brought to our attention further questions worthy of an answer.

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