A descriptive study of middle school ESL students' reading moves and uses of visual inscriptions when inferring the meaning of unknown words in a science passage

by

Ryan Deschambault
B.A., Trent University, 1998

A Thesis Submitted in Partial Fulfillment of the

Requirements for the Degree of

MASTER OF ARTS

in the Department of Curriculum and Instruction

University of Victoria

A descriptive study of middle school ESL students' reading moves and uses of visual inscriptions when inferring the meaning of unknown words in a science passage

by

Ryan Deschambault
B.A., Trent University, 1998

Supervisory Committee

Dr. Robert J. Anthony, Supervisor
(Department of Curriculum and Instruction)

Dr. Margie Mayfield, Departmental Member
(Department of Curriculum and Instruction)

Dr. Deborah Begoray, Departmental Member
(Department of Curriculum and Instruction)

Supervisory Committee

Dr. Robert J. Anthony, Supervisor
(Department of Curriculum and Instruction)

Dr. Margie Mayfield, Departmental Member
(Department of Curriculum and Instruction)

Dr. Deborah Begoray, Departmental Member
(Department of Curriculum and Instruction)

ABSTRACT

The purpose of this study was to describe the moves used by middle-school ESL students to infer the meaning of unknown words in a science passage, and to describe the use of visual inscriptions in their inferencing process. Data from 10 female ESL students were collected using think-alouds while reading a test passage from a science textbook. In addition participants completed a Survey of Reading Strategies survey and participated in an open-ended interview about reading strategies. The think-aloud transcripts were analysed using an inductive process based on the constant comparison method, and resulted in the development of a taxonomy consisting of two meta-categories, six categories, and 20 sub-categories of inferencing moves. This taxonomy resulted in the identification of five sub-categories of inferencing moves that had not been described in previous lexical inferencing research. Each of these five new sub-categories occurred among the top ten most frequently used moves overall. Further analysis revealed that participants used Regulatory category moves more frequently than Heuristic moves. This suggested that participants in this study expended a larger portion of their resources managing the inferencing and the social aspects of the reading task than attending to word, sentence, discourse, or prior knowledge moves. The use of visual inscriptions was

reported with low overall frequency, but this sub-category was used in complex ways in conjunction with other Regulatory and Heuristic moves. This suggested that the use of inscriptions was firmly embedded in the lexical inferencing processes of participants when reading science texts. Suggestions for future research include using texts with additional multimodal characteristics, expanding the age range of participants to include younger ages, and including descriptions of moves resulting from the social aspects of the reading tasks. Pedagogical implications include: (1) developing instruction which targets the use of less frequently reported Regulatory and Heuristic moves to expand the inferencing repertoire of learners, and (2) developing instruction which encourages students to draw links between inscriptions and the construction of lexical meaning to aid in the interpretation of complex text. Further it is suggested that textbook designers: (1) develop more calculated design strategies that will assist students in using inscriptions and text in tandem to construct meaning, and (2) use the published results of lexical inferencing to include features that facilitate the identification of words that are anticipated to be problematic for ESL learners.

Table of Contents

List of Tables

List of Figures

Acknowledgements

The first person I would like to acknowledge is my supervisor, Dr. Robert Anthony. His patience, wisdom, and occasionally crusty comments have motivated, frustrated, and pacified me during the completion of my thesis and M.A. program. My heartfelt thanks go out to him, as well as my best wishes for many years of good luck, health, and happiness.

It is also necessary to mention and thank my committee members Dr. Margie Mayfield and Dr. Deborah Begoray, and my external examiner Dr. Hossein Nassaji. Their questions and comments regarding the thesis have helped me to deepen my own understanding if its scope, character, and shortcomings – and have helped to make the presentation of the thesis stronger.

Finally, I am indebted to my partner Jung Eun for her support during the last three years. Her faith in me has remained unquestioned, and her constant encouragement is a large part of the reason this thesis was completed. And then there is our son, Noah. Thanks to him for appearing in our lives at the perfect time, and for teaching me so much about myself and life during his first six months on earth.

Dedication

우리 노아 야...

너 의 초롱초롱한 눈을 보고 있으면
나 의 과거 와 미래를 이해 할 수 있다.

Dad:

It *was* Education.
Thanks for sticking around to not have to confirm you were right.
Your continued courage and strength, especially during these last few years, is a true source of inspiration for us all.

Chapter 1 Introduction

1.1 Background

Classroom dynamics in Canada, the United States and elsewhere have changed rapidly during the recent past. Transnational migration patterns and the internationalization of education are two of many factors responsible for the general increase in cultural and linguistic diversity of students. These have contributed to one particular change in classroom dynamics – namely, to growing numbers of English as a second language (ESL) students alongside monolingual English speaking students in schools and classrooms. In these classrooms, where in the past teachers and their students often shared a common first language, increases in cultural and linguistic diversity have highlighted the limitations of both teachers and curricula in meeting the unique needs of students who are attempting to learn English at the same time as area-specific content information.

An important by-product of the diversification of the student population has been an increase in the volume of discussion in both academic and professional journals, about how teachers and institutions can best develop a heightened sensitivity to the literacy needs of ESL students. There is now widespread agreement about the central function of language and literacy skills in the learning of content-area material (for both monolingual English speaking and ESL learners) (e.g., Carrier, 2005; Chamot and O'Malley, 1987; Cummins, 1980; Mohan, 1986, 2001; Schleppegrell, 2004; Unsworth, 1997, 2001). In the specific content area of science, the role of these skills in the development of scientific literacy has received consistent attention in academic literature for more than a decade (e.g., Gee, 2004; Halliday & Martin, 1992; Lemke, 1990; Roth, in press; Roth & Barton,

2004; Roth & Lawless, 2002; Thier, 2002; Yore, 2000; Yore & Anthony, 2006; Yore, Bisanz, & Hand, 2003; Yore & Treagust, 2006). Unfortunately, only a few scholars have taken interest in how language and literacy function in the development of scientific literacy among ESL students (e.g., Fang, 2006; Lee, 1999, 2003; Westby, Dezale, Fradd, & Lee, 1999).

Middle years ESL students are often portrayed as being at-risk of marginalization where academic achievement in science is concerned (e.g., Carrier, 2005; Chamot & O'Malley, 1987; Fang, 2006; Hadamenos, Heires, & Young, 2004; Lee, 1999, 2003; Lincoln & Beller, 2004; Watson, 2004), and this marginalization is thought to limit the future possibility that these students will enter into science-related academic or professional fields. Portrayals of 'at-risk-ness' come despite policy statements by the Canadian Council of Ministers of Education (CME; 1997) and the American National Research Council (NRC; 1996) promoting the equitable development of scientific literacy skills for all students. Although these documents acknowledge the contingent nature of scientific literacy, through statements such as "[s]cientific literacy is an evolving combination of the science-related attitudes, skills, and knowledge students need to develop inquiry, problem-solving, and decision-making abilities, to become lifelong learners, and to maintain a sense of wonder about the world around them" (CME, 1997, n.p.), neither acknowledges that the capacity for reading and comprehending the language of science is a fundamental prerequisite for the development of scientific literacy (Norris & Phillips, 2003).

The 'language of school science' plays a key role in reading comprehension difficulties for students (Fang, 2006). Indeed, the "structural, lexical, semantic and

syntactic features" of science text (Craig & Yore, 1992, p. 3-4) distinguish it from other, perhaps more familiar types of text. One of the characteristic 'structural features' of science text is that it requires students to interpret content presented via different semiotic modalities and construct their understanding via these interpretations (e.g., Alexander & Kulikowich, 1994; Jewitt, 2005; Kress, Ogborn, & Martins, 1998; Lemke, 1998; Martins, 2002). Since the most common modes for presenting content in school science textbooks are expository prose and visual inscriptions, knowing how to 'read' these two modes, both in isolation and in unison – "requires a tremendous, perhaps insurmountable amount of work" (Han, Roth, & Pozzer-Ardenghi, 2005, p. 1) – even for monolingual speakers of the language in which a text is written.

For students who are learning the language of the text as their second (or third, etc.) language, the amount of work required for 'reading' (and integrating) these different modes is multiplied exponentially. The syntactic and semantic work required to construct meaning from text is bound to students' reading proficiency in their first language (L1) and their oral proficiency in their L2 (Bernhardt & Kamil, 1995), their knowledge of L2 vocabulary (Fang, 2006; Saville-Troike, 1984), and their ability to use other available resources (e.g., prior knowledge and environmental clues) (Valencia & Pearson, 1987, p. 727). We can only presume that 'reading' visual inscriptions requires work that is similarly bound to syntax and semantics (Schnotz, Bannert, & Seufert, 2002; Kress & van Leeuwen, 1996; Kress et al., 1998). Thus, like language and vocabulary use, inscriptions "take their meanings from the situations of their use in communities where members share many of the same assumptions, preconceptions, and commonsense understandings about what the world is like" (Roth & McGinn, 1998, p. 51). This means that students

learning science content in their L2 are required to learn not only how to read in their second language, they are required to learn to read the language of school science and how to read the 'language' of visual inscriptions.

Thus in middle-school classrooms, where *reading* becomes one of the most important foundational skills for accessing content-area knowledge (Chall, 1996; Shorzman & Cheek, 2004), comprehending content-area textual materials is a high-stakes undertaking for ESL students. Professional literature which discusses the welfare of ESL students in the content-area of science has offered educators suggestions for addressing the language and literacy needs of ESL learners in that subject area (e.g., Carrier, 2005; Berndhardt, Hirsch, Teemant, Rodriguez-Munoz, 1996; Hadamenos, Heires, & Young, 2004; Lincoln & Beller, 2004; Watson, 2004). Few of these suggestions, however, have been supported by research findings, nor have they identified or addressed any of the specific reading processes of ESL students as they interact with science content or science text.

Thus on a local level, if we are able to gain a more in-depth understanding of how middle years ESL students' use visual inscriptions and inferencing to cope with the lexical demands of science content, the findings could have implications for textbook and supplementary materials design, textbook choice for classroom use, explicit strategy instruction for ESL readers in the content area of science, and science teacher education.

On a more global level, although they would address only a minor piece of the larger puzzle that is science literacy, findings could also serve to widen the scope of investigation into the literacy needs of ESL students in specific disciplines such as (but not limited to) science, could promote a more equitable realization of the science literacy

standards endorsed by the CME (1997) and the NRC (1996), and ideally would provide for more inclusive science reading models and curriculum development. Finally, the findings of the proposed study would serve to expand our general knowledge about the science reading strategies of middle school ESL students.

1.2 Purpose

The purpose of this study was to explore and describe the tactics middle-school ESL students used to infer the meaning of unknown words when reading science content and especially to examine the use of visual inscriptions to facilitate those inferences. Data were collected using a Likert-scale type survey, think-aloud protocols, and open-ended interviews within a descriptive (Seliger & Shohamy, 1989[1]) approach to inquiry. The survey was intended to generate information on the general reading strategies ESL students anticipated using when they read science content, but also the extent to which they anticipated inferring and using visual inscriptions to comprehend unknown lexical items. Think-aloud protocols were analysed to create a taxonomy of the reading moves ESL students appealed to when confronted with unknown lexical items in a science reading task. Finally, open-ended interviews were used to obtain background information about participants, and to obtain information that was related to students' experiences with science reading and could be used as interpretive aids during analysis and discussion.

---

[1] According to Seliger and Shohamy (1989), the purpose of descriptive research is "both heuristic and deductive" (p. 31). "Descriptive research involves a collection of techniques used to specify, delineate, or describe naturally occurring phenomena without experimental manipulation" though it "shares characteristics with both qualitative and experimental research designs" (p. 124).

1.3 Research Questions

The following research questions have been developed as guides for the investigation of ESL learners' strategies when interacting with science text:

1. Are lexical inferencing and the use of visual inscriptions among the general reading comprehension strategies middle-school ESL students anticipate using during a science reading task?
2. What kinds of lexical inferencing tactics do middle school ESL students make when they encounter unknown vocabulary in science textbook passages?
3. How do visual inscriptions influence ESL students' lexical inferences when they encounter unknown vocabulary in science textbook passages?

1.4 Definition of Terms

The term 'meta-category' becomes integral to the study beginning in Chapter 2 (subsection 2.4.4). The use of this term arose from the need for a label to refer to the hierarchical characteristics of taxonomies of lexical inferencing. In combination with this term, the terms 'category' and 'sub-category' are also employed to refer to items at different levels within a given taxonomy.

'Regulatory moves' in this study refers to tactics used by learners to regulate their completion of the research task according to specific target words, cognitive load, or the social aspects of the research context. Further elaboration of this term begins in Chapter 3 (subsection 3.7.3).

'Heuristic moves' in this study refers to tactics used by learners to complete the research task based on their attention to language based aspects of the test passage (e.g., word features, sentence- and discourse-level characteristics), and to the relationship between their prior knowledge and the test passage (e.g., content, L1). Further elaboration of this term begins in Chapter 3 (subsection 3.7.3).

The use of the terms 'Regulatory' and 'Heuristic' bears no relation to the meaning of these terms developed through the work of Halliday (1975).

Chapter 2 Literature Review

2.1 Introduction

In order to briefly contextualize this study, the review has been divided into the following general sections. Section 2.2 examines current research (in monolingual settings) on science reading and the use of strategies for comprehension of science text, and identifies areas for expansion within these existing frameworks that are related to vocabulary knowledge and ESL learners. Section 2.3 looks at the research done (in monolingual settings) with visual inscriptions in the content area of science, and suggests ways in which this research could be more inclusive toward ESL learners, and hence could intersect with vocabulary knowledge. Section 2.4 looks at current research on the role of vocabulary knowledge and lexical inferencing in L2 reading comprehension, and suggests ways in which this research could benefit by examining science texts and visual inscriptions. Finally, Section 2.5 offers a brief review of each of the sections which have preceded it, in an attempt to integrate the different suggestions.

2.2 Reading comprehension strategies and science text in L1 English research

2.2.1 Overview

'L1 English research' has been specified in the heading for this section as a result of the fact that the overwhelming majority of research investigating reading comprehension in the content area of 'science' has been conducted with populations of monolingual native English speakers. A quick overview of these studies reveals that researchers have taken an interest in identifying different types of reading strategies or awareness students have or make use of (Craig & Yore, 1992; Wandersee, 1988; Yore,

2000; Yore, Craig, & McGuire, 1998), identifying individual and contextual factors that affect comprehension (Alexander & Kulikowich, 1994; Reif & Allen, 1992), and articulating models of 'good' or 'efficient' science readers based on strategy use or metacognitive awareness (Craig & Yore, 1992; Fergusson-Hessler & de Jong, 1990; Yore & Denning, 1989; Yore *et al.*, 1998). In a brief synthesis of this research, Yore (2000) identified four salient findings for the development of science reading instruction. According to Yore (2000, p. 110), students

- have limited strategies to address comprehension failure, with re-reading being the most common strategy used (Wandersee, 1988);…
- lack procedural and conditional knowledge and astuteness [in] application of strategy (Fergusson-Hessler & de Jong, 1990);
- lack appropriate scientific knowledge to interpret text (Reif & Allen, 1992); and
- lack understanding of bilingual character of (mathematical/linguistic features) of science text (Alexander & Kulikowich, 1994).

The rationale for research which has investigated comprehension of science text has often been based on the fact that scientific text uses "different structural, lexical, semantic and syntactic features…and makes different demands on readers" (Craig & Yore, 1992, p. 3-4; Flood, 1986; Yore & Shymansky, 1985) than does narrative text. Scientific text also differentiates itself from narrative text insofar as it requires readers to construct meanings based on their interpretations of science content presented via different semiotic modalities (e.g., Alexander & Kulikowich, 1994; Jewitt, 2005; Kress *et al.,* 1998; Lemke, 1998; Martins, 2002). In particular, visual inscriptions play integral

roles in most modern science texts (Lemke, 1998), "are crucial to the conceptualization of scientific ideas", and serve as "powerful aids to communicate specialist ideas to audiences of non-experts" (Martins, 2002, p. 74-5).

Given the demands made on readers by the structural, lexical, semantic, and syntactic features of science text, each of the four findings identified by Yore (2000) is of unique importance to this study. This is because an unstated goal of this study is to consider the extent to which these findings, at the level of vocabulary, are relevant foundations upon which the development of explicit science reading instruction for middle school ESL students should be based. This being said, however, the primary goal of this research is not to develop explicit reading instruction for middle school ESL learners, but rather to describe middle school ESL readers' methods of constructing meaning at the level of vocabulary.

2.2.2 Changes in what it means to 'read' in science

As general awareness of the complexity inherent in comprehending science text has increased, the conceptualization of what it means to 'read' in science has also evolved. The first change deals with the effects of the interactive-constructive model of reading on science literacy research. The second change focuses on recent research that has investigated the role of visual inscriptions in science texts. Findings from this strand of research have given rise to questions concerning different attributes of visual inscriptions and their effect on student comprehension of science texts.

Yore *et al.* (2003) articulate the first change in a general discussion of the changes that L1 reading research in the topic area of science has undergone during the last 20 years. In unison with the movement away from science literacy research that was

dominated by "behavioralist" and "reductionist" approaches, Yore *et al.* highlight how research on reading in science morphed from a theoretical perspective which understood "reading as taking meaning from text and reading as readers creating meaning exclusively" (p. 698) to a more *interactive-constructive* position – through which "interactions between text and reader, readers' metacognition…and how explicit instruction might improve science reading strategies, metacognitive awareness, and executive control" (p. 699) – became central areas of inquiry.

> The interactive-constructive position, according to Valencia and Pearson (1987),
>
> > emphasizes the active role of readers as they use…clues to 'construct' a model of the text's meaning. It de-emphasizes the notion that progress toward expert reading is the aggregation of component skills. Instead, it suggests that at all levels of sophistication, from kindergarten to research scientist, readers use available resources (e.g., text, prior knowledge, environmental clues, and potential helpers) to make sense of text (p. 727).

Metacognition, or "knowledge that takes as its object or regulates any aspect of any cognitive behaviour" (Flavell, 1978, p. 8), involves both knowledge of cognition and the ability to regulate cognition. Jacobs and Paris (1987) have argued that metacognition consists of self-appraisal (awareness) and self-management (executive control[2]). Self-appraisal is the mindful assessment of one's own knowledge of thinking, of tasks, and of topic, and consists of three types of knowledge: declarative, procedural, and conditional. According to Craig and Yore (1992), "[d]eclarative knowledge indicates students' beliefs that something is the case; procedural knowledge indicates students' knowledge of how to proceed; and conditional knowledge indicates a students' knowledge of why and when to carry out a procedure" (p. 14). Self-management, conversely, is the ability to skillfully

---

[2] Yore (2000, p. 108; also Yore et al., 1998 and Yore et al., 2003) uses the word *awareness* to refer to Paris and Jacobs' (1987) 'self-appraisal', and likewise the term *executive control* to refer to their 'self-management'.

administer one's reading strategies according to task, topic, and cognitive load, and consists of three types of monitoring: planning, evaluation, and regulation.

The second change has seen science reading researchers include different semiotic systems occurring in science text in their understanding of 'reading'. Examples of these systems include mathematical lexis (e.g., equations and symbols), typographical markers (e.g., bold, italics, highlighting), and most importantly for this study, visual inscriptions (e.g., concept maps, pictures, illustrations) – all of which play a role in the construction of meaning by readers of science text. As a result of these multiple forms of representation in scientific texts, Lemke (1998) has argued that to 'read' and comprehend scientific text, students must construct meaning by interacting with multiple, socially and historically situated semiotic systems.

As Yore *et al.* (2003) suggest, the influence of the interactive-constructive model and the concept of metacognition have supported the general belief in science reading research that explicit instruction will lead to improvements in science text comprehension. In the attempt to develop this instruction, the range of reading strategies 'expert' learners employ during science reading tasks have been highly sought after. The second shift in the understanding of what it means to 'read' in science, though more recent, has raised important questions about the facilitative role played by visual inscriptions in students' comprehension of science text. A brief review of literature related to these two changes will follow in order to help contextualize this study.

2.2.3 Science reading strategies, experts, and novices

Strategy research on L1 English reading comprehension using science texts has typically divided readers into experts and novices (e.g., Pearson, Roehler, Dole, & Duffy,

1992; Reif & Allen, 1992; Yore *et al.*, 1998) or has used some variation on this idea (e.g., Fergusson-Hessler & de Jong, 1990). Yore (2000) provides a list of the reading strategies that research has identified as being "critical to the expert reader…underdeveloped in novice readers, and respon[sive] to instruction" (Dole, Duffy, Roehler & Pearson, 1991, as paraphrased in Yore, 2000, p. 108). These strategies are:

1. Assessing the importance of text-based information and prior knowledge,
2. Generating questions to set purpose,
3. Summarizing,
4. Inferring meaning,
5. Monitoring comprehension,
6. Utilizing text structure,
7. Reading and reasoning critically,
8. Improving memory,
9. Self-regulating to fix comprehension failures, and
10. Skimming, elaborating, and sequencing. (Yore, 2000, p. 108, citing Dole, Duffy, Roehler, & Pearson, 1991 and Pressley, Johnson, Symons, McGoldrick, & Kurita 1989)

While Yore's (2000) list is brief, it must be noted that these are the strategies that have been 'responsive to instruction'. Additionally, this list addresses strategies that are related to readers' cognition and metacognition at the local textual level, but does not take into account the fundamental role played by a learner's vocabulary knowledge during meaning construction at this level. Therefore, we must presume this list is neither

comprehensive nor fittingly descriptive of the strategies upon which instruction should be based for the diverse range of readers present in today's science classrooms.

2.2.4 The role of vocabulary in science reading comprehension

Given the lexical density and complexity of science textbooks, Yore's (2000) list of strategies does little to acknowledge the importance of vocabulary knowledge in students' meaning construction when reading science textbooks. Though attention is given to the importance of strategies like 'Inferring meaning', 'Monitoring comprehension', 'Self-regulating to fix comprehension failures' – it is presumed that students would have the requisite knowledge of vocabulary to be able to utilize these strategies effectively. More specifically, even though a student may know how to 'utilize text structure' to 'infer meaning' from the text, the possibility exists that they may infer erroneously according to the *limits* of their vocabulary knowledge or contextual understanding. Consider the following example: "A mammal is a warm blooded animal that feeds its young milk" (Fang, 2006, p. 495). A student might mistakenly infer the meaning of 'young' as an adjective that describes 'milk' because she is not aware that it can be used as a noun which refers to a group or class.

While an examination of the role of vocabulary in meaning construction in science is important for monolingual English speaking students, it is of even greater importance for the academic achievement of international or ESL students – especially in light of their portrayal as 'at-risk' in the subject area of science. The above example highlights the necessity for research which examines the role of vocabulary in the construction of meaning from science text – and especially so for learners for whom the language of the text is not an L1.

2.2.5 Theoretical concerns for development of explicit science reading instruction

Along with the need for a more comprehensive set of 'strategies' that characterize learners' attempts to make meaning from science text at the level of vocabulary, there is a need to rethink the application of the interactive-constructive model to explicit science reading instruction. Though Yore *et al.* (2003) ground more recent investigations of science reading in the interactive-constructive model of reading, which "de-emphasizes the notion that progress toward expert reading is the aggregation of component skills" (Valencia & Pearson, 1987, p. 767), Yore's (2000) list names and describes the skills expert science readers have – implying that a students' aggregation of these skills through explicit instruction has the potential to effect some type of 'expertise' in science reading comprehension. Yore (2000) does not address this point. Curiously, however, Yore *et al.* (1998) do, writing that the habits put forth in the list "...may misrepresent the interactive-constructive nature desired, since expertise in science reading does not consist of a set of strategies stacked on top of one another but rather a compensatory set of strategies that are efficiently substituted for one another based on constant monitoring..." (p. 33); and further that "[i]t may be more productive and accurate to think of the efficient, successful science reader in a wholistic [sic] manner as a flexible, strategic person who is aware of and managers [sic] her or his science reading and use of science text, and uses science reading strategies to construct understanding within a specific sociocultural context" (p. 33).

This contradiction is problematic for explicit instruction based on the strategies of 'experts', insofar as the notion of 'expert' implies proficiency with various types of knowledge (e.g., language of the text, cultural, content-area, vocabulary). It is possible

that explicit instruction based on the habits of monolingual experts may be beneficial to ESL students only after a threshold level of experience or proficiency in one of these types of knowledge has been accumulated. This hints at the possibility that requisite experience in a given 'sociocultural context' (e.g., in a North American science classroom) may be equally as important as explicit instruction for the development of science reading strategies.

Since the focus of this study is on the vocabulary knowledge construction of middle school ESL readers during science reading, and is based upon the framework implicit in the interactive-constructive model of reading, there is a need for a description of the methods used by ESL students to cope with problematic vocabulary while reading in science that includes methods beyond those used solely by monolingual 'experts'.

2.3 Science texts and visual inscriptions

Science text distinguishes itself from other forms of text based on unique lexical, structural, syntactic, and semantic features. It also asks readers to construct meaning based on their interpretations of information presented via different semiotic modalities (Kress *et al.* 1998; Martins, 2002; Jewitt, 2005; Lemke, 1998). Indeed, many researchers agree that visual inscriptions are integral to science texts (e.g., Amettler & Pinto, 2002; Hannus & Hyona, 1999; Lemke, 1998; Moore & Scevak, 1997), and many (e.g., Kress *et al.*; Martins) also believe that these inscriptions are important for the successful relaying of important science concepts and ideas.

Published work mentioning the relationship between visual inscriptions and science reading comprehension has used a wide range of terms to refer to these 'inscriptions': 'illustrations' (e.g., Mayer Steinhoff, Bower, & Mars, 1995; Harp &

Mayer, 1997; Iding, 1997; Hannus & Hyona, 1999); 'multimedia summaries' (e.g., Mayer, Bove, Bryman, Mars, & Tapango, 1996); 'visual representations' (e.g., Amettler & Pinto, 2002); 'visual imagery' (e.g., Martins, 2002); 'visual aids' (e.g., Moore & Scevak, 1997); and 'visual adjuncts' (e.g., Craig & Yore, 1992; Harp & Mayer, 1997; Yore, 2000).

2.3.1 Visual inscriptions and science reading comprehension with middle school aged students: Research from studies with monolingual learners

Few studies have been done which examine the use of visual inscriptions in science text by middle school aged students. These studies have investigated the use of visual inscriptions as facilitators for students' comprehension, and have relied on recall, short answer questions and eye movement (Hannus & Hyona, 1999), interviews (Craig & Yore, 1992), and think-alouds (Moore & Scevak, 1997) to obtain data.

According to Hannus & Hyona (1999), the intellectual abilities needed to "integrate text and illustrations" require a student to know "(1) when to look at an illustration during reading, (2) what picture to inspect, (3) what information to focus on in the illustration, and (4) how to integrate different pieces of information into a coherent mental representation" (p. 110). Based on their prediction that these abilities were more likely to be possessed by higher-ability students, Hannus and Hyona conducted two experiments with ten year old Finnish students to examine "the effects of illustrations on learning authentic textbook materials" (p. 95). Contrary to "the compensatory function of illustrations proposed by Levie and Lentz (1982)" (p. 96) – which presumes that inscriptions aid the comprehension success of low-ability readers – Hannus and Hyona observed that: (1) high-ability students "were aided more by illustrations in answering comprehension questions" than were low-ability children (p. 110), and (2) that "high-

ability students devoted relatively more time to studying pertinent segments of text and illustrations than did low-ability students, and they carried out more back-and-forth looking between text and a relevant illustrations" (p. 118).

On the surface, Hannus and Hyona's (1999) findings seem to concur with an interview study conducted by Craig and Yore (1992) which suggested that 'intellectually capable students' are more likely to integrate text and visual displays for the purpose of aiding reading comprehension. Craig and Yore found that although students between grades four and eight had "an awareness of the function" of 'visual adjuncts' in science texts, they "indicated an inefficient use of the visuals, referring to them after reading but not to solve problems during reading" (1992, p. 20). Unlike Hannus and Hyona (1999), though, Craig and Yore temper their findings with the caution that students' minimal amount of exposure to expository texts may have played a role in students' lack of awareness of how to efficiently use the visual displays to their advantage during reading.

The sensibility of Craig and Yore's (1992) caution is legitimized by a study conducted by Moore and Scevak (1997). Moore and Scevak successfully employed a think-aloud protocol to examine the developmental patterns of "above-average in reading ability" (p. 209) middle school students' uses of visual aids to facilitate comprehension of materials in science textbooks. Moore and Scevak found that older students (Grade 9; 15 years old) "more often produced reports relating to the diagram main ideas and the usefulness of the diagram for learning the materials" (p. 218) than did younger students (Grade 5, 11 years old; Grade 7, 13 years old), and likewise that "even the grade 7 students placed little emphasis on the relationship between the diagram main ideas and the text main ideas" (p. 219). Given these findings, Moore and Scevak suggest that there

is a "critical role for explicit teaching of strategies to enhance meaningful links between texts and [visual] aids", and claim that the results are evidence of the need for explicit instruction in how to make 'meaningful links' between the text and visual aids (p. 220). They also suggest longitudinal studies to investigate the seemingly 'late' and sudden development of the ability to use visual aids as facilitators for comprehension, and wonder about the role played by reading ability and cognitive preferences in the use of visual aids during meaning construction.

2.3.2 The role of visual inscriptions in science reading comprehension

Keeping in mind the importance of visual inscriptions both in science textbooks as modes for relaying scientific information, there seems to be some disagreement about whether inscriptions have a facilitating or confounding effect on readers' meaning construction process. Moore and Scevak's (1997) findings indicate the likelihood that extended interaction with and exposure to science text that includes visual inscriptions increases the use of those inscriptions as facilitators for comprehension. Additionally, the suggestion that 'more able' students are better equipped and more likely to utilize visual inscriptions as facilitators for comprehension (Craig & Yore, 1992; Hannus & Hyona, 1999) run contrary to those of Levie and Lentz (1982), whose review of the literature suggests lower-ability students are more likely to make use of visual inscriptions than are high-ability learners.

The fact that so little literature has investigated ESL students' use of visual inscriptions in the process of constructing meaning from science text (cf. Tang, 1991; 1992; 1996) raised general questions about learners for whom the language of instruction was not the first they had learned: To what extent would these students utilize visual

inscriptions to facilitate comprehension of science content? To what extent would they be successful? Similarly, would they use inscriptions in ways that had not yet been reported by research conducted with monolingual learners?

2.3.3 The role of visual inscriptions in vocabulary knowledge construction

Based on the identified need for a more comprehensive understanding of the role of vocabulary knowledge in middle school ESL students' science reading comprehension, and on a paucity of research aimed at understanding middle school ESL students' uses of inscriptions during science reading comprehension, a natural progression was to consider the role of visual inscriptions in the construction of vocabulary knowledge while reading science text. Thus, along with describing the ways middle school ESL readers cope with unknown vocabulary items during science reading, this research sought to describe the extent to which middle school ESL students might exploit visual inscriptions to facilitate inferences about unknown vocabulary items.

2.4 The role of vocabulary in L2 English reading comprehension

One of the central assumptions of this study is that vocabulary knowledge plays a key role in L2 reading comprehension generally, and in L2 science reading comprehension in particular. This is because, as Nassaji (2003) and others (e.g., Nation, 2001) have suggested, the comprehension abilities of L2 readers depend greatly on the "efficiency of lower level textual process", and that "encountering many unknown words in a text may negatively influence the reading comprehension of L2 readers" (Nassaji, 2003, p. 646). Perhaps the most important component of lower-level textual processing is vocabulary knowledge. Where content-area learning for ESL students is concerned, Saville-Troike (1984) conducted a study with 10 low-proficiency students from second to

sixth grade. She found that only vocabulary knowledge could account for the differences in year-end achievement between students who had been matched for English proficiency and socioeconomic status at the beginning of the year. This led Saville-Troike to conclude that vocabulary knowledge was "the single most important area of second language (L2) competence when learning content through that language" (p. 199). In a recent (and more comprehensive) work on the subject of vocabulary learning for second language learners, Nation (2001) has also suggested that the 2,000 most frequent words in English will account for roughly 78% of academic text. Thus, not only is learning the 2,000 most frequent words "the best decision for learners going on to academic study" (Nation, 2001, p. 15), these words are "so clearly important that considerable time should be spent on them by teachers and learners" (p. 16).

Despite the fact that there is little research which has examined the role of vocabulary knowledge for middle school ESL learners in the specific content-area of science, Fang (2006) has identified the need for this type of research by arguing that the prominence of "technical vocabulary" and "ordinary words with non-vernacular meanings or usages" in science textbooks are often obstacles to ESL students' successful comprehension of content.

2.4.1 The role of lexical inferencing in the construction of vocabulary knowledge

Not only has L2 research suggested that an abundance of unknown lexical items in a text may be the reason ESL students read texts word by word and struggle with comprehension (Bernhardt & Kamil, 1995; Nassaji, 2003), it has further suggested that lexical inferencing (or the attempt to infer the meaning of an unknown or unfamiliar word during online text processing) is one of the most important strategies used by L2 readers

to make meaning of unknown words when they encounter them for the first time in context (Bengeleil & Paribakht, 2004; Nassaji, 2003; Nation, 2001; Paribakht & Wesche, 1999). Lexical inferencing has been defined in similar ways by some of the current researchers in the field of vocabulary learning: "guessing the meaning of an unfamiliar word using available linguistic and other cues" (Bengeleil & Paribakht, 2004, p. 225); "inferring from context on the basis of multiple clues that might be available" (Nassaji, 2003, p. 646); "[i]ncidental learning via guessing from context" (Nation, 2001, p. 232); and "making informed guesses as to the meaning of a word in light of all available linguistic cues and in combinations with the learner's general knowledge of the world, her awareness of the context and her relevant linguistic knowledge" (Paribakht & Wesche, 1999, p. 199, citing Haastrup, 1991, p. 40).

The importance of lexical inferencing to meaning construction during online processing notwithstanding, "inferencing is not always an efficient or easy strategy for L2 students to use" (Bengeleil & Paribakht, 2004, p. 226), and is dependent on a number of linguistic and other social and contextual factors which mediate both the availability of cues to assist during inferencing and the success with which those cues can be used. Nation (2001), for example, has suggested that in order to learn "vocabulary from meaning-focused input" in academic text that has not been simplified, ESL learners require a threshold level knowledge of 95% of the lexical items in the text (p. 148).

While these conditions are considered optimal for learning unfamiliar vocabulary from context, it is likely that for middle school ESL students, especially those who are learning content-area material from textbooks written in their L2, that these conditions rarely apply (e.g., Nation, 2001, p. 232). Recourse to an electronic dictionary or the

teacher's guidance may offer some relief in these situations. The gravity of vocabulary knowledge becomes especially salient in high stakes testing situations, where electronic dictionaries are not permitted and students often cannot receive assistance from teachers. Thus, developing a comprehensive understanding of what middle school ESL learners do when facing unknown lexical items may be an important way to develop instruction aimed at raising students' and teachers' awareness about how students can cope in these situations. Much recent work has already been done to develop taxonomies of readers' lexical inferencing 'strategies' and 'knowledge sources', and will be briefly reviewed in the next subsection.

2.4.2 What L2 learners do during lexical inferencing: Research

Recent published literature on the subject of inferencing in L2 research spans over two decades and has most often relied on think-aloud data collection procedures. While some has relied on individual ESL learners' think-aloud data generated during reading tasks (e.g., Bengeleil & Paribakht, 2004; Nassaji, 2003), others have relied on pair think-alouds (Haastrup, 1987) and translation tasks (Huckin & Bloch, 1993) to generate data.

There are two levels at which the terminology adopted for use in some of these taxonomies operates, and which cause difficulty for interpreting the similarities and differences between different studies of learners' lexical inferences. The first (sub-section 2.4.3) is related to the way researchers have characterized the tactics learners appeal to during lexical inferencing, and the second (sub-section 2.4.4) involves the terms at what I refer to as the meta-categorical level.

2.4.3 Terms used to characterize what learners do during lexical inferencing

The terms 'knowledge sources' (Bengeleil & Paribakht, 2004; Haastrup, 1987; Nassaji, 2003) and 'strategies' (Huckin & Bloch, 1993; Nassaji, 2003) have been used regularly in the literature examining learners' lexical inferencing procedures. While on paper the distinction between the terms is well-defined and simple enough to comprehend, upon closer examination it appears that the decision to use a particular term (e.g., 'knowledge source' or 'strategy') is more an attempt to assert some sort of transferability of findings between studies that have very different participant groups and research contexts. It may also be that the use of a particular term serves the purpose of aligning a particular study with a specific research tradition or paradigm.

Knowledge sources. Haastrup (1987) reports on the use of introspective and retrospective think-alouds as a viable method of investigating Danish high-school aged learners' use and combination of 'knowledge sources' during an English lexical inferencing task. She would later (Haastrup, 1991) go on to differentiate between two different types of knowledge sources – 'holistic inferencing' and 'analytic processing'. The former refers to "prediction on the basis of context, which typically involves the drawing on of knowledge of the world in the form of schematic or conceptual knowledge", whereas the latter refers to "some analysis of the linguistic features of the target word" (Haastrup, 1991, as cited in Bengeleil & Paribakht, 2004). In this characterization, although it is not made explicit in Haastrups' (1987) paper, it is presumed that she is drawing on a long tradition of lexical inferencing studies which have classified readers' 'knowledge sources'. However, nowhere in the paper is there an attempt to define the parameters of *what* a knowledge source is or to explain *how* a

student draws on a knowledge source, if the process of choosing a knowledge source is accidental, purposive, pre-planned, or otherwise.

In a more recent study, Bengeleil and Paribakht (2004) used individual readers' think-alouds to investigate the effect of L2 reading proficiency on the 'knowledge sources' appealed to by 17 Arabic-speaking university ESL learners when inferencing the meaning of unknown words in an expository text passage. Once again, the question of *how* a student appeals to a knowledge source is left unconsidered and the paper does not hint at the limits of *what* a knowledge source is. If a student taps into a particular source of knowledge based on an intuitive notion, or based on luck, can it be said that this is a source of the student's knowledge? Conversely, if a student purposively appeals to a knowledge source, are they strategizing?

Strategies. Huckin and Bloch (1993) used think-aloud protocols and a translation task to collect data on the strategies used by nonnative graduate students to infer the meaning of unknown words in their English course readings. Their analysis indicates that the learners, barring the unsuccessful recognition of "either the word or its stem…would look for a variety of *context clues*" (p. 160; *italics* added) as *strategies* to infer the meaning of unknown words. Huckin and Bloch also created a "tentative working model" (pp. 169-70) of the cognitive and metacognitive operations involved in the participants' inferencing process. This model distinguishes between the 'knowledge sources' appealed to by L2 learners during inferences (e.g., linguistic or contextual 'clues') and what Huckin and Bloch refer to as "metalinguistic control steps (e.g., "Try to generate hypothesis", "Test hypothesis?", "Make do?", "Need more context", and "Generate more context")" (p. 169). This distinction is important insofar as it makes explicit reference to

the "a conscious decision making process" implicated in the process of lexical inferencing (e.g., strategy use), which is separate from the knowledge sources appealed to by L2 readers. Huckin and Bloch's model, however, does not go as far as to identify different types of 'metalinguistic control steps' (read: strategies), nor do they indicate the extent to which these strategies are bound up in or reliant upon appeals to knowledge sources.

Drawing on Huckin and Bloch's (1993) distinction between 'knowledge sources' and 'metalinguistic control steps', Nassaji (2003) categorized university readers' lexical inferences into 'strategies' and 'appeals to knowledge sources'. In this study, which draws on data collected from 21 adult ESL learners, 'appeals to knowledge sources' are defined as "instances when the learner made explicit reference to a particular source of knowledge, such as grammatical, morphological, discourse, world, or L1 knowledge" (p. 655). 'Strategies', conversely, were considered to be "conscious cognitive or metacognitive activities that the learner used to gain control over or understand the problem without any explicit appeal to any knowledge source as assistance" (p. 655). Though Nassaji, like Huckin and Bloch, has distinguished between two types of processing that occur during lexical inferencing, Nassaji's distinction rests on the 'explicit mention' of a particular knowledge source during lexical inferencing. This distinction, as mentioned before, is logically sound but is difficult to imagine in the context of a think-aloud data collection methodology. Defining what a learner 'does' during lexical inferencing based on whether they make explicit mention of a knowledge source ignores the social variables that mediate both the task and the research context,

and furthermore equates 'being proficient enough to explain what one is doing' with 'knowing how to do' something.

In short, the ways of characterizing what learners do during lexical inferencing leaves much to be desired. Not only are knowledge sources and strategies difficult to distinguish from one another, both are insufficient in explaining the relationship that exists between the reader and the text. Neither term suggests that lexical inferencing is an interactive process of meaning construction, nor connotes the recursive nature of that interactive process. Thus, a goal of this study was to identify a better term with which to characterize what readers do during lexical inferencing.

Moreover, three of the four studies cited above have been conducted with adult learners (cf. Haastrup, 1987). While this may be a reflection of particular research situations within university contexts, little is known about the lexical inferencing processes of younger learners. This study hopes to expand the general knowledge of the field where these younger learners are concerned.

2.4.4 Characterizations of what L2 readers do during lexical inferencing at the meta-categorical level

At the meta-categorical level, these studies have also used different terms to group general types of methods used by readers during L2 lexical inferencing. For example: Contextual, Intralingual, Interlingual (Haastrup, 1987), metalinguistic control steps and linguistic or contextual clues (Huckin & Bloch, 1993), knowledge sources and strategies (Nassaji, 2003), and Linguistic sources and Non-linguistic sources (Bengeleil & Paribakht, 2004). These meta-categories, along with the resulting taxonomies, are presented below.

Haastrup's (1987) meta-categories were termed *Contextual*, *Intralingual*, and *Interlingual*. She characterized 'Contextual' knowledge sources as being comprised of cues that arose from the text or that arose from readers' knowledge of the world. 'Intralingual' knowledge sources, conversely, represented cues that arose from readers' proficiency in and knowledge of English, and 'Interlingual' knowledge sources were comprised of cues that arose from readers' L1s or knowledge of "foreign languages other than English" (p. 199; Table 1).

Table 1. Haastrup's (1987) taxonomy of knowledge sources used during L2 lexical inferencing (adapted from p. 199)

Contextual	Intralingual	Interlingual
I. The text 1. A single word from the immediate context 2. Immediate context 3. A specific part of the context beyond the sentence of the test word 4. Global use of the text II. Knowledge of the world	I. The test word 1. Phonology/Orthography 2. Morphology a. prefix b. suffix c. stem 3. Lexis 4. Word class 5. Collocation 6. Semantics II. The syntax of the sentence	I. L1 (Danish) 1. Phonology/Orthography 2. Morphology 3. Lexis 4. Collocations 5. Semantics II. L^n (Latin, German, etc.) 1. General reflections a. reflections about the origin of the word b. test word pronounced in L^n 2. Morphology 3. Lexis 4. Semantics

Bengeleil and Paribakht (2004) have chosen the terms *linguistic* and *non-linguistic* to denote the types of knowledge sources readers appeal to during lexical inferencing. Interestingly, their taxonomy (Table 2) includes two of Haastrup's (1987) meta-categorical terms (e.g., Intralingual and Interlingual) at the categorical level. Moreover, Bengeleil and Paribakht make no mention of 'strategy' use and yet there are striking similarities between their Linguistic-Intralingual-Target-word-level knowledge

source dubbed 'homonymy' and Nassaji's (2003) 'strategy' dubbed 'Analogy' (Table 3 below).

Table 2. Bengeleil and Paribakht's (2004) taxonomy of knowledge sources used during L2 lexical inferencing (adapted from p. 231)

I. **Linguistic Sources**	II. **Non-linguistic sources**
A. Intralingual sources 1. Target word level a. word morphology b. homonymy c. word association 2. Sentence level a. sentence meaning b. syntagmatic meaning c. paradigmatic relations d. grammar e. punctuation 3. Discourse level a. discourse meaning b. formal schemata B. Interlingual sources 1. Lexical knowledge 2. Word collocation	A. Knowledge of Topic B. Knowledge of Medical Terms

Huckin and Bloch's (1993) meta-categories, derived from their model, are termed *context clues* and *metalinguistic control steps*. Context clues are as follows:

- local linguistic constituents (e.g., syntactic or semantic collocations),
- global text representations (including text schemas and "permanent memory," that is, the translations up to that point)
- world knowledge (p. 161)

Metalinguistic control steps, or strategies, conversely, are represented in the form of thoughts a reader might entertain during the process of lexical inferencing: "Try to generate hypothesis, Test hypothesis?, Make do?, Need more context, and "Generate more context" (p. 169).

Nassaji's (2003) taxonomy, seemingly attempts to describe and identify the metalinguistic control steps hinted at by Huckin and Bloch (1993) with his use of the term *strategies*, and conversely, to integrate the concept of *knowledge sources* identified by previous researchers (Table 3).

Table 3. Nassaji's (2003) taxonomy of knowledge sources and strategies used during L2 lexical inferencing (adapted from p. 655-6)

Knowledge Source	Strategy
1. *Grammatical knowledge* (e.g., use of grammatical functions or syntactic categories, like verbs, adjectives, or adverbs) 2. *Morphological knowledge* (e.g., use of word formation, structure, derivations, inflections, word stems, suffixes, prefixes) 3. *World knowledge* (e.g., knowledge of content or topic that goes beyond the text) 4. *L1 knowledge* (e.g., using L1 to help determine the meaning of a word, like translating or finding a cognate) 5. *Discourse knowledge* (e.g., knowledge about the relation between or within sentences and the devices that make connections between different parts of the text)	1. *Repeating* (e.g., repeating any portion of the text, like words, phrases, or a sentence) 2. *Verifying* (e.g., checking the inferred meaning against the wider context) 3. *Self-inquiry* (e.g., self-questioning about the text, words, or inferred meaning) 4. *Analyzing* (e.g., inferring by means of analyzing a word into different parts) 5. *Monitoring* (e.g., display of conscious awareness of the problem or its level of ease/difficulty) 6. *Analogy* (e.g., inferring by means of sound or form similarity with (an)other word(s)

2.4.5 Expanding taxonomies which describe L2 learners' methods of lexical inferencing

As mentioned above, the goal of the current study is to search for terminology that may do a better job of denoting what L2 learners do during lexical inferencing with the interactive-constructive framework in mind, and as well to find new meta-categorical terms for classifying categories and sub-categories of inferences.

Along with difficulties in distinguishing between knowledge sources and strategies learners use during lexical inferencing, noticeably absent from each of the taxonomies presented above is any mention of students' use of visual inscriptions as facilitative aids during lexical inferencing. This may, of course be the result of the fact

that although each of these studies has used some form of expository text, none has used 'science' text or text that included a visual inscription. Thus a further goal is to use text adapted from a science textbook that includes visual inscriptions. It is hoped that the resultant taxonomy of learners' L2 inferencing methods will more accurately reflect the types and levels of literacy that are implied in lexical inferencing – with special attention given to the content area of science. Additionally, if learners do indeed exploit visual inscriptions during lexical inferencing, the goal of this study is to integrate these uses into a taxonomy of ESL middle school learners' lexical inferencing processes.

2.5 Summary

This chapter has identified areas for expansion in both the fields of science reading and L2 lexical inferencing, and has established the importance of vocabulary knowledge and visual inscriptions for successful comprehension of science text. In turn, it has recognized that very little research has examined these topics in relation to L2 learners in the content area of science. After establishing the key role played by vocabulary knowledge and lexical inferencing in both general and content-area L2 reading comprehension, a call has been made for research which identifies appropriate terminology for denoting what learners do during lexical inferencing and how to conceptualize the categorization of their inferences. As well, a call to include multiliteracies (e.g., the use of visual inscriptions) within these taxonomies of lexical inferences has been made.

In short, this chapter has articulated a research program which examines the crossroads at which science reading, vocabulary knowledge, visual inscriptions, and

lexical inferencing intersect – one that would focus specifically on middle school ESL learners.

Chapter 3 Methods

3.1 Overview

This chapter reviews the general design of the study. It provides information regarding: the study's approach to inquiry, the participants and setting of the study, the rationale for the selection and use of particular instruments, and the process of selecting an appropriate science reading passage. Following these descriptions, a detailed account of the data collection and transcription/translation procedures is provided. Finally, an account of how the researcher analysed the data is offered.

3.2 Research Design

This study was designed to explore and describe the tactics used by middle-school ESL students when inferring the meaning of specific, targeted content vocabulary items during a science reading task in their second language (English). A descriptive approach to inquiry (Seliger & Shohamy, 1989[3]) was selected as the basis for the investigation which includes both quantitative (SORS; VKS) and qualitative (Think-aloud protocols; open-ended interviews) methods of data collection. In addition, the use of a descriptive approach to inquiry allows for conversation between two approaches to inquiry that are often portrayed as incommensurate with one another.

3.3 Setting

The study took place at an independent school for girls in western Canada. An independent school was chosen over a public school based primarily on three important

---

[3] According to Seliger and Shohamy (1989), the purpose of descriptive research is "both heuristic and deductive" (p. 31). "Descriptive research involves a collection of techniques used to specify, delineate, or describe naturally occurring phenomena without experimental manipulation" though it "shares characteristics with both qualitative and experimental research designs" (p. 124).

logistical concerns. First, due to the fact that the School Board in this particular community has placed a limit on the number of researchers it allows to conduct research in public schools at any one time, the decision to approach an independent school was made with full knowledge of the socioeconomic limitations this would place on the data that would be collected. Secondly and perhaps more importantly, this particular school was chosen because it had a large population of prospective middle-school ESL student participants. Again, the decision was made with acknowledgement of the gender limitations this would have on the data that would be collected. Finally, this particular school was chosen as a result of the willingness of the administration and staff to participate in the study, to assist the researcher with participant recruitment, and to provide a space where data collection sessions could be carried out.

3.4 Participants

The study required that participants be middle-school aged, have first languages that were other than English, be designated as ESL students by their school, and be studying some form of science during the time the study was conducted. In most cases, these students were international boarding[4] students (from non-English speaking countries) attending school in western Canada. Gender, race, ethnicity, and class were not selective criteria in the initial search for participants. The fact that all ten participants were attending an independent school for girls limits the findings to a population which is not representative of the typical middle-school-aged population of ESL students both

[4] The term "boarding" here refers to a student who lives in a dormitory on the campus of the school they are attending. Though they may have relatives in Canada, their primary residence for the duration of the school year is on the school's grounds.

because of the limitation on gender and the limitation to a specific socioeconomic class of female ESL students.

Table 4 presents information pertaining to the ten students who participated in this study. The information was obtained through open-ended interviews, and was self-reported by each of the participants in this study. The column heading 'Grade now' refers to the grade level at which participants were studying *science* at the time of data collection. The school offers special transition programs for international ESL students. These transition levels are: Transition 2 (T2) – a class reserved solely for students with lower levels of proficiency; Transition 1 (T1) – a class reserved for students with intermediate English proficiency; Bridge 10 (Br. 10) – which mixes international and ESL students with monolingual native English speakers in content-area classes ; and Mainstream classes (10) which (supposedly) do not distinguish between ESL and monolingual native English speaking students. 'Grade before' is the grade completed by participants in their home country prior to studying in Canada. 'Time in Canada' is the number of years participants had been studying at the independent girls' school at the time of data collection, and 'Years of English' is the amount of time each participant reported having studied English up until the time of data collection. In Chai's case, this was since kindergarten; in Halla's, she reported having studied content area subjects in English (at a Foreign Language school) prior to coming to Canada. 'NSs in sci. class' indicates whether the student was in a science class that included monolingual (native-speaking) English learners. Information not included in the table relates to the home countries of each of the participants. Of the ten: four were from Hong Kong, two were from Taiwan, two were from Korea, one was from Thailand, and one was from Macau.

Table 4. Participants' self-reported background information

Pseudonym	Age	Grade now	Grade before	Time in Canada	Years of English	NSs in sci. class
Apple	15	T1	9	1 yr.	4	No
Bea	15	T1	9	1 yr.	3-4	No
Chai	15	Br. 10	9	2 yrs.	Since K	Yes
Deepa	15	Br. 10	10.5	1.5 yrs.	Since gr. 6-7	Yes
Elan	15	10	9	1.5 yrs.	Since gr. 7	Yes
Fera	15	10	9	1.5 yrs.	From age 8	Yes
Glyn	16	10	11	3-4 mos.	<10	Yes
Halla	15	T1	9	3-4 mos.	English school	No
Ishi	15	10	8.5	2 yrs.	3-4	Yes
Joni	15	T1	10.2	3-4 mos.	9-10	No

3.4.1 Responses to selected open-ended interview questions

The interview was used to elicit background information about participants, to discuss the reading demands of their science curriculum and their teacher's role in assisting them, and to elicit information that might help contextualize the other data collected during the study. Students' answers to selected questions are presented below.

Do you like science? This question elicited both direct and indirect answers from participants. Five out of the ten participants indicated that they did not like science (Apple, Deepa, Glyn, Halla, and Ishi). Three students indicated that they did like science (Chai, Elan, and Joni). The remaining two students indicated that they did not like science in their home country, but that they enjoyed the subject more now that they were studying in Canada (Bea, Fera).

Originally, this question was included in the interview because it was thought that participants' attitude toward the subject matter might affect the intensity with which they approached the lexical inferencing task. However, students' attitudes towards science have been included here because they may also have played a role in their self-reporting about anticipated reading strategy use.

How many times per week do you have a science class? The average number of science classes per week ranged from three to six; some students were enrolled in more than one science class and for this reason had six classes or a total of six hours of science each week. Others had only one science class and attended science class for a total of three hours.

How much time do you spend reading your science textbook each week? Direct responses to this question ranged from 'I don't read it' (Chai, Deepa), to a few minutes (Fera, Halla), to '15 -20 minutes' (Ishi), to 'only before tests' (Bea, Glyn), to between 30 minutes and two hours (Apple, Elan, Joni). Students' ability to *correctly* infer the meaning of unknown lexical items, though not controlled for in this study, may be related to the amount of time they spend actually attempting to read their science textbooks. Furthermore, the amount of time spent interacting with science text may also have an effect on the types or complexity of inferences made about unknown lexical items.

3.5 Instruments for Data Collection

3.5.1 The Survey of Reading Strategies

The SORS (SORS; Mokhtari & Sheorey, 2002) is presented in Appendix A. It was originally intending to "measure the type and frequency of reading strategies that adolescent and adult ESL students perceive they use while reading academic materials in English (such as textbooks, journal articles, class notes, etc.)" (Mohktari & Sheorey, 2002, p. 4). The SORS was developed to compare the reported strategy use of "native and non-native speakers of English" (Sheorey & Mokhtari, 2001, p. 436). Based on the Metacognitive Awareness of Reading Strategies Inventory (MARSI; Mokhtari & Reichard, 2002), the SORS is subdivided into the same three subscales: Metacognitive

Strategies (13 items), Cognitive Strategies (8 items), and Support Strategies (9 items) (Sheorey & Mokhtari, 2001[5]). The MARSI was validated using a native English speaking population of 825 students from middle school to college and had an overall reliability of 0.92[6]. The SORS was piloted and validated with a population of 147 students and was found to have "consistent results relative to the instrument's overall reliability (Cronbach's alpha = 0.89) indicating a reasonable degree of consistency in measuring awareness of or perceived use of reading strategies among native and non-native speakers of English" (Sheorey & Mokhtari, 2001, p. 436).

The SORS was chosen for use in this particular study because it has been demonstrated to be a valid and efficient means of obtaining participants' self-reports about the types of strategies they anticipate using during an academic (science) reading task. However, in order to modify the survey for use in this study, three important changes were required (Appendix B).

The first dealt with the layout of the survey. That is to say, the original layout of the SORS (Sheorey & Mokhtari, 2001) was deemed to be crowded and difficult to read. Each of the items was retyped in the same order but in a larger font, and was double-spaced in an attempt to maximize readability and to lessen the strain on participants' eyes. This meant that the items took up the front and back of an 8½ x 11 sheet of paper. As well, the rating scale was retyped, verbatim, onto another sheet of paper which accompanied the list of items in a larger, more readable font.

---

[5] In comparison with Sheorey and Mokhtari (2001), Mokhtari and Sheorey (2002) refer to the Metacognitive and Cognitive subscales of the SORS as "Global Reading Strategies" and "Problem Solving Strategies" (p. 4). There is little variation, however, in the descriptions of the subcategories offered by each respective publication.

[6] For a full description of the validation procedure and psychometric attributes of the MARSI, see Mokhtari & Reichard (2002).

The second change that was required was a minor modification to both the text that preceded the SORS and the instructions given to prospective survey takers. Whereas Mohktari and Sheorey (2002) indicated the purpose of the survey on their actual survey sheet, this chunk of text was removed since it was possible to verbally explain the purpose of the survey to each individual participant. In turn, the wording of the instructions was modified to emphasize that participants were to indicate which number applied to them as they read science textbooks. Finally, participants were instructed to ask the researcher for clarification if they were unsure about the meaning of any of the items on the survey. For a comparison of Mohktari and Sheorey's (2002) original and our modified versions of the SORS, please see Appendices A and B.

The third and final change involved removing one of the items from Mokhtari and Sheorey's (2002) original survey, and replacing it with an item that targeted participants' anticipated use of visual inscriptions to assist in inferring the meaning of unknown words or phrases. The rationale behind this decision was that the original survey lacked this type of specific item. The original survey did, however, include an item that targeted the use of 'tables, figures, and pictures in text to increase [one's] understanding'. It was felt this item would not elicit information specific enough to address our specific research question, and hence the added item was worded as follows: 'I use tables, figures, and pictures to help me guess the meaning of unknown words or phrases'. In turn, it was reasoned that this new item would allow for a juxtaposition of participants' responses to the original survey item regarding 'table, figures, and pictures', and would be of assistance in gathering information on participants' ability to discriminate between the

use of 'tables, figures, and pictures' to increase general understanding and to infer the meaning of unknown words or phrases.

The original survey item that was removed was: 'I ask myself questions I like to have answered in the text'. This item was identified for removal because, in the original piloting of this survey with non-study participants of the same age, it caused the greatest amount of confusion among survey-takers, and required multiple explanations for clarification. In Mokhtari and Sheorey's (2002) original version of the SORS, this item was categorized as a support strategy, and therefore the removal of this item caused the original number of items targeting 'Support Strategies' to be diminished by one. Additionally, this meant that the insertion of our new item in the survey increased the number of items that targeted 'Cognitive Strategies'. It was determined that this newly added item fell under the category of 'Cognitive Strategies' based on the similarity of its wording with another of the Cognitive Strategy items on the survey (e.g., "When I read, I guess the meaning of unknown words or phrases").

In the final analysis, the following three items from the modified SORS were considered as probes which would give some indication of participants' anticipated use of inferencing strategies or of visual inscriptions to assist with the comprehension of unknown lexical items.

- When I read, I guess the meaning of unknown words or phrases;
- I use tables, figures, and pictures in text to increase my understanding;
- I use tables, figures, and pictures to help me guess the meaning of unknown words or phrases.

3.5.2 The Vocabulary Knowledge Scale

According to Wesche and Paribakht (1996), "the [Vocabulary Knowledge Scale] *VKS* should be viewed as a practical instrument for use in studies of the initial recognition and use of new words" (p. 29; Appendix C). It requires those to whom it is administered to offer self-reports of their knowledge of a particular vocabulary item, and in turn to demonstrate this self-reported knowledge of the item in writing. In its original form, the five categories represented on the VKS "range from complete unfamiliarity, through recognition of the word and some idea of its meaning, to the ability to use the word with grammatical and semantic accuracy in a sentence" (p. 29).

Wesche and Paribakht (1996) tested the VKS for reliability with a sample group of 93 students and a sample set of 32 words, and was "administered twice…within a period of two weeks" (p. 32). Despite finding that (especially with regard to 'Category I') "a large proportion of learners may not recall having seen words that they have actually seen" (p. 32), the test-retest reliability for the remaining categories was .89. Based on these finding, Wesche and Paribakht deemed the VKS 'acceptably reliable' (p. 32). The original VKS also provides a scoring scheme that can be applied to rank the correctness of the self-reported and demonstrated understanding of specific items.

The VKS was chosen for use in the current study because it was reported to be a reliable tool for obtaining an understanding of each participant's knowledge of the target items prior to their actual participation in the think-aloud exercise. However, in Chapter 6 the reliability of the VKS as a measure of participants' prior knowledge of unknown words is called into question (subsection 6.5.2). Evidence from the transcript clearly indicates subjects did not know the did not know the meaning of the probed target words.

Since the purposes of this study were somewhat different from those of Wesche and Paribakht (1996), some modifications to the structure and administration of the VKS in its original form were necessary.

The first modification made was to alter the number of self-report categories from five to four. This was done for two reasons, and simply put, resulted in the amalgamation of categories four and five from Wesche and Paribakht's (1996) original VKS[7]. By amalgamating these categories, it was hoped that the ambiguity posed by five items would be lessened, and as well, that the participants would be able to save time during their completion of the VKS.

The second modification was to the layout of the VKS. For the purposes of readability and expedience, instructions on how to complete the scale, along with the four self-report categories, were printed on sheet of paper in a large and easy-to-read font. The list of vocabulary items was provided on a second sheet of paper, with enough space in between each item for participants to respond accordingly (Appendix D).

The final modification to the VKS was to eliminate the use of scoring categories for each of the items. Since our objective was not to rank the students' acquisition of vocabulary items, and because we did not employ a pre-/post-test research design, we felt this aspect of the VKS was unnecessary.

3.5.3 Verbal report /Concurrent Verbalization /Think-alouds (Ericsson & Simon, 1993)

Verbal reports (concurrent verbalizations / think-alouds) have been used for the collection of data in many studies of the lexical inferencing strategies employed by second language learners (e.g., Bengeleil & Paribakht, 2004; Haastrup, 1987; Huckin &

---

[7] In the original version of the VKS (Wesche & Paribakht,1996), students who choose category five are also asked to complete category four (Appendix C).

Bloch, 1993; Nassaji, 2003; 2004; Roskams, 1998, Swain & Lapkin, 2002; etc.). By asking individuals to think-aloud, or "to vocalize what is going through their minds as they are solving a problem or performing a task" (Gass & Mackey, 2000, p. 113), researchers are thought to be able to gain a window into individuals' problem solving processes. Since Ericsson and Simon's (1993) revised monograph on the subject is cited in much of this research, it is presumed that it is their work which informs the use of thinking aloud or talking aloud as methods for obtaining data. However, surprisingly few second language researchers treating verbal reports as data entertain lengthy discussions of the different types of verbalizing procedures or the methodological orientations these procedures presuppose (cf. Swain, 2006).

Ericsson and Simon (1993) outline different levels of "concurrent verbalization": Level 1, Level 2, and Level 3. A Level 1 or 'direct' verbalization is referred to as a "Talk Aloud", and is represented by information that is reproduced by an individual "in the form in which it was heeded" (p. 16). In this case, there are no processes mediating "attention to the information and its delivery" (p. 16). 'Encoded', or Level 2 and Level 3 verbalizations, have any one of a "number of intermediate processes between access and verbalization" which "may modify the information" (p. 16) that is relayed to the researcher. In the case of Level 2 verbalizations, these mediating processes usually involve the verbal encoding necessary to pass on coherent descriptions or information to another person. Level 3 verbalizations are 'encoded' insofar as researchers are looking for "socially motivated verbalizations" – that is, the verbalizations are mediated because researchers are seeking "explanations, descriptions, justifications, and rationalizations" (p. xiv). In Level 3 verbalizations, "the effects of [the researcher] directing verbalization do

not involve any magical influences but can be understood in terms of the changes induced in the associated cognitive process by the instructions" (p. xix).

Swain (2006) argues that an especially salient issue for second language researchers using verbal protocols to collect data is the theory of human cognition that informs their use and interpretation of these protocols. Swain offers two opposing possibilities, and further argues that "[t]he issue which underlies the debate is no less than the relationship between thought and language" (2006, p. 98). The first possibility views human cognition through the lens of information processing theory, and views the verbal protocol as "a direct encoding of the heeded thought" (Ericsson & Simon, 1993, p. 222). The second possibility views human cognition through a sociocultural theory of mind, where "verbalization is conceived of as a tool that enables changes in cognition", and where speech "(through a process of internalization) comes to regulate, organize, and focus an individual's own mental activities" (Swain, 2006, p. 100). For the purposes of this study, an awareness of these two approaches to verbal report data was important, though the collection of data was not approached explicitly from either of the two perspectives.

Another important issue to be considered in the collection of data using think-alouds or concurrent verbalizations is the use of probes. Probes are 'directed' or 'specialized' questions made by the researcher to the participant in an attempt to "help [participants] retrieve the desired information from memory and to induce greater completeness of the verbal reports" (Ericsson & Simon, 1993, p. 21). Published second language research that has used concurrent verbalizations as a method of collecting data makes very little mention of the use of probes – perhaps in an attempt to avoid

mentioning the effects these probes may have had on the data. Indeed, as Ericsson and Simon have indicated, these probes may be problematic insofar as there is no way to be sure "that the [probes] conform to the internal representations the [participants] are employing in their thought" (1993, p. 21). The effect a request for specific information can have on participants' perception of which parts of a task are important is also a cause for concern, as is the possibility that a participants' usual ways of approaching a task may be altered in order to provide the information they believe the researcher is searching for (Ericsson & Simon, 1993, p. 22). Thus, in an attempt to maintain a balance between eliciting 'desired information', not leading participants, and not influencing their perception of or approach to the inferencing task, variations of three different probes were sometimes used following participants' inferences: (1) How do you know that?, (2) What would make you guess that?, and (3) What do you mean?.

Prior to justifying the use of concurrent verbalization as a method of collecting data in this study, some of the shortcomings of this procedure deserve mention. Haastrup (1987) specifies three shortcoming and three problems that can arise from the use of think-aloud protocols during data collection. Shortcomings include: (1) incomplete reporting (e.g., due to language proficiency; due to whether an item is easy/difficult or is placed early on or late in a text), (2) think-alouds that are difficult to interpret during analysis, and (3) socio-psychological variables (e.g., researcher-participant relationship; participant personality; setting, etc.). Possible problems that could arise range from: (1) participants focusing on 'getting it right' – which could have unfavourable effects on their awareness of process, to (2) participants' lacking an understanding of what the

researcher has asked them to do, to (3) socio-psychological variables interacting with cognitive variables.

Finally, think-alouds have been chosen as a method of data collection for the following reasons: (1) a substantial amount of research on ESL learners' reading strategies and lexical inferencing processes has successfully employed this method (e.g., Bengeleil & Paribakht, 2004; Haastrup, 1987; Huckin & Bloch, 1993; Nassaji, 2003; 2004; Roskams, 1998, Swain & Lapkin, 2002; etc.), (2) the majority of this think-aloud research has been done with populations of adult ESL learners (cf. Haastrup, 1987), and (3) Moore and Scevak (1997) used think-alouds to investigate the use of 'visual aids' to facilitate comprehension of materials in science textbooks with monolingual native English speaking students.

3.5.4 Open-ended interviews (Appendix E[8])

The final method of data collection used in this study was open-ended interviews. The interview was used to elicit background information about participants (Table 4), to discuss the reading demands of their science curriculum and teacher's role in assisting them, and to ask about problems and tactics for solving those problems during science reading tasks. The unstated goal of these interviews was to give the participants the chance to speak about their beliefs and practices with regard to reading in science, and to acquire information which could be used to aid in the analysis of verbal report data.

3.5.5 The 'think-aloud' passage (Appendix G)

Students were asked to read a short passage (494 words) on the topic of 'Measuring Earthquakes' / 'Seismographs'. The passage was adapted from *Science Probe*

[8] These interview questions are good indicators of the general types of questions that were posed to participants, but were not the only questions posed during the course of each interview.

10 (Bullard *et al.*, 1996, pp. 285-287), and was accompanied by three of the text's original visual inscriptions (Figs. 13.7, 13.8, and 13.9; Bullard *et al.*, 1996, pp. 285, 287).

This particular chunk of text was chosen based on three major factors: timing and similarity with the participants' school's curriculum, visual inscriptions accompanying the passage, and its success in an informal piloting phase.

The passage was chosen after consulting the school science teachers to ensure that the participating students would not yet have been exposed to the textbook passage at the time the data collection phase of the research began. Choosing an appropriate passage based on the school's curriculum was also difficult because participants did not belong to a single science class. Thus, a decision was made to use the textbook used by students in the highest level (Mainstream) science class. Given the interest of the researcher in students' use of visual inscriptions as aids for inferring the meaning of unknown words, it was also necessary to find a chunk of text that was accompanied by a suitable number of inscriptions and in which a good number of lexical items could be identified as potential target words. Finally, this particular chunk of text was chosen because when it was piloted informally with eight students who did not participate in the study, it generated the best of list of target words (TWs) for which students were required to make some kind of inference, and students made some use of inscriptions during the inferring. The text had a Flesch-Kincaid reading level of 10.0.

Final selection of specific TWs was made after asking 8 other middle school students unconnected to the research participants to read the test passage and indicate unfamiliar words. The words most commonly identified as unfamiliar were included as target words in the study passage.

After choosing the text, some modifications were necessary in order to control its length, distinguish it from the textbook, and clearly identify the lexical items for which participants would be asked to infer meaning. First, parts of the text that were considered superfluous to the basic information regarding Seismographs were omitted. This was done with the intention of keeping the text as short as possible, yet still comprehensive enough to cover necessary information and to be comprehendible. The text was then typed out using Microsoft Word, and scanned versions of the inscriptions were embedded in the text. During this process, an attempt was made to stay as true as possible to the original textbook layout. While the end product is similar to the textbook, it uses a larger font, has different spacing, and uses black and white (as opposed to colour) versions of the textbook inscriptions.

3.5.6 Visual inscriptions in the reading passage

As mentioned in subsection 3.5.5, the reading passage contained three visual inscriptions, each of which was borrowed from Bullard *et al.*'s (1996) text.

The first depicted one of the first mechanisms used to detect earthquakes, and is dubbed "Chinese earthquake detector" (Bullard *et al.*, 1996, p. 285; Appendix G, Fig. 13.7). This inscription is introduced in the text after an assertion about the importance of 'measuring and comparing' earthquakes, to indicate that the practice of measuring earthquakes is not a new one. The main textual information provided is a short paragraph outlining when the instrument was invented, what its capabilities were, how it was constructed, how it functioned, and what its limitations were. The visual inscription is also accompanied by a caption offering further explanation of how the instrument functioned and what indications it would give to its users if the ground were shaking.

Three specific TWs were chosen from the paragraph of text specifically related to this visual inscription: faint (adj.), jarring (adj.), and vibrations (n.). This inscription is a cut-away representation of the Chinese instrument mentioned in the text; that is, it depicts two large jars sliced into halves so that viewers may observe the workings of the pendulum within each jar. This particular inscription does not make explicit reference to any of the TWs in the passage.

The second inscription is situated within a larger section entitled "The Seismograph", and its purpose is to provide a representation of the concept of 'amplitude' (Bullard *et al.*, 1996, p. 287; Appendix G, Fig. 13.8. The main textual information is comprised of 68 words: readers are first asked to imagine they are the 'ant' in the picture; the concept of 'amplitude' is then introduced, and the importance of a 'stationary reference point' for measuring amplitude is emphasized. This inscription is a labelled line drawing which partially replicates ideas mentioned in the text (e.g., amplitude). The labels that accompany the inscription also make explicit reference to two of the TWs associated with this inscription (e.g., amplitude, stationary). This visual inscription is also accompanied by a caption, which reiterates that a 'reference point' is needed to measure ground motion (amplitude). Given the specific purpose of this inscription in the larger section, three TWs in the paragraph specifically related to this inscription were chosen: tremor (n.), amplitude (n.), and stationary (adj.).

The final visual inscription portrays a 'seismograph' (Bullard *et al.*, 1996, p. 287; Appendix G, Fig. 13.9), and occurs at the very end of the reading passage as the culmination of the section entitled "The Seismograph". The information within the main text of the reading passage refers to specific parts of the seismograph, and offers an

explanation of how the seismograph functions during an earthquake to produce a record of the ground's movement. The caption accompanying this inscription reads only: "A simple seismograph" (Bullard et al., 1996, p. 287). Given that this inscription occurred at the end of the reading passage, only one TW was identified in the paragraphs specifically related to this inscription: anchored (v.). This inscription is a labelled diagram which depicts an instrument mentioned earlier in the text; the name for this instrument is also a TW (e.g., seismograph). Unlike Figures 13.7 and 13.8, this inscription does not replicate ideas mentioned in the text.

3.6 Data Collection Procedure

Following the completion of the Human Research Ethics Review Board's application, permission to conduct research was received in May of 2006. Given the dependency of this research on having middle school volunteer participants, actual data collection was postponed until late November and early December, 2006. During the time between May and November, various logistic and administrative requirements needed to be met.

First, letters requesting permission to conduct research were sent to the principals of two independent schools (Appendix G). After receiving permission from one of these school's principals, a liaison from the school was designated and assisted with the task of devising a protocol for recruiting volunteer participants and obtaining students' parents' or guardians' acknowledgement that they were participating in the study. Eighteen students showed initial interest in participating; due to various logistical or personal reasons, however, eight of the students did not qualify to participate in the study. Thus, ten interested students remained as potential participants. Meeting times were scheduled

with each of these remaining students, and the data collection process began in late November, 2006.

Table 5 outlines the procedure that occurred at meetings with each volunteer participant.

Table 5. Procedure during meetings with volunteer participants

Task	Time
(a) Explain project and Consent Form	5-10 minutes
(b) Survey of Reading Strategies	5-8 minutes
(c) Vocabulary Knowledge Scale	5-10 minutes
(d) Open-Ended Interview	10-15 minutes
(e) Think-Aloud practice	8-10 minutes
(f) Think-Aloud exercise	10-15 minutes

Data was collected in individual sessions that lasted between 45 and 60 minutes, and each session was held in a quiet room at the students' school. All sessions were conducted in person by the researcher.

At the beginning of each session, participants were informed of the purpose of the study, and then were asked to sign a consent form indicating their voluntary consent in the project (Appendix H). They were then asked to complete the SORS, and after doing so were asked to complete the VKS. These three stages took an average time of about 20-25 minutes. Following completion of the VKS, they participated in a short open-ended interview which was designed to elicit personal information and in an attempt to blur relationships participants might have perceived between the SORS and VKS items and the think-aloud task. After the interview, participants were asked to partake in a short training session to introduce them to thinking aloud. Following Nassaji (2003), participants were first given instructions (Appendix I) and asked to use pictures and a practice text to gain experience with thinking aloud. When participants indicated they

were comfortable with the task, and had demonstrated their ability to verbalize about their reading, they were given the science reading passage and asked to read it out loud. Upon encountering TWs (which were highlighted in the text), students were instructed to infer the meaning of each, and to verbalize their thoughts as they did so. Occasionally, probes were required to remind the students to verbalize or to request clarification about something that they had said.

3.7 Analysis

3.7.1 The SORS

Descriptive statistical analysis of selected information obtained by the SORS was carried out and is presented in the later part of Chapter 5. The results of the SORS are specifically meant to address the question: (1) Are inferencing and the use of visual inscriptions among the general reading comprehension strategies middle-school ESL students anticipate using during a science reading task? Thus, the following three survey items were identified as specifically addressing this question:

- I use tables, figures, and pictures to help me guess the meaning of unknown words or phrases.
- When I read, I guess the meaning of unknown words or phrases.
- I use tables, figures, and pictures in text to increase my understanding.

Given that the survey consisted of 30 items, participants' completion of it carried the added bonus of providing general information about the perceived use of reading strategies by middle school students. This more general information is not of significant relevance to this study, but was not removed in an attempt to mitigate a specific focus by participants on the items relating to lexical inferencing and the use of visual inscriptions.

3.7.2 The VKS

The Vocabulary Knowledge Scale provided information about participants' perceived prior knowledge of the TWs, and provided a further context with which participants' inferences could be interpreted. Since the question 'What kinds of inferencing and comprehension strategies do middle school ESL students employ when they encounter unknown vocabulary in passages containing science content?' includes the phrase 'unknown vocabulary', the VKS was used with the hope that it would provide information concerning the extent to which the TWs chosen for this study were 'unknown' to the participants. VKS scores are not reported for a score of different reasons. These reasons, along with the method that was then used to measure the extent to which TWs were unknown to participants prior to the study, are discussed further in Chapter 6 (subsection 6.5.2).

3.7.3 Verbal report data: Concurrent verbalizations -Think-alouds

The data obtained via the think-aloud exercise was meant to address two questions: (1) What kinds of inferencing and comprehension strategies do middle school ESL students employ when they encounter unknown vocabulary in passages containing science content?, and (2) How do visual inscriptions influence ESL students' inferences when they encounter unknown vocabulary in passages containing science content?

To begin, participants' think-aloud verbalizations were transcribed, and the researcher then began to read through the data. Using the constant comparison method (Glaser & Strauss, 1967) to guide this process, an initial set of categories that explained what participants were doing during lexical inferencing began to emerge during this read through. It is important to note that this initial set of categories, although reached

inductively, had (to some extent) to have been based on categories that had been identified by previous research[9]. According to Lincoln and Guba (1985), the constant comparison method consists of four steps: (1) comparing episodes that can be applied to each category, (2) incorporating categories and their traits, (3) defining limits for a theory, and (4) explicating the theory (p. 319). For the most part, the recursive use of steps one and two have been relied upon for the purposes of this study.

Due to the awareness that some of the sub-categories that emerged after the initial read through resembled those delimited by previous research, it was felt that the responsible next step would be to determine the similarities and differences between the initial sub-categories developed and those of previous researchers. This was a long process, partly because previous researchers provided little explication of the means by which they arrived at their specified sub-categories in those publications, and also in part due to the cross-study differences in research context, age of participants, text types, etc. It was soon realized that a comparison at the level of sub-categories was trumped by two more important differences between previous researchers' taxonomies and the one that was emerging from the data set obtained in this study. These differences had to do with the ways learners' lexical inferences were being described by previous literature and research on the topic.

The first major difference had to do with the overall way in which readers' relationships to the text they were reading was conceived. Previous taxonomies had referred to what readers did during lexical inferencing as drawing on 'contextual cues', using metalinguistic control steps (e.g., Huckin & Bloch, 1993), appealing to 'knowledge

[9] 'Inductive' here should be understood to mean without the categories developed by other researchers within eyesight, yet acting as lenses through which the data was being read.

sources' (Bengeleil & Paribakht, 2004; Haastrup, 1987; Nassaji, 2003), and using 'strategies' (Nassaji, 2003) to better facilitate their guesses. Since none of these ways of understanding what readers were doing during lexical inferencing seemed adequate in relation to the data set in this study, the term *moves* was chosen to replace the previous terms. For the current study, the term *moves* did a better job of connoting the socially mediated aspects of verbal report data collection. Not only did the readers in this study make moves as they interacted with text, these moves were inherently affected/effected by both the researcher's presence and, as Swain (2006) has suggested, by the participants' own processes of verbalizing about their reading. Furthermore, the term *moves* was chosen because it connotes that interaction between the reader and the text is ongoing, and that (as was fitting for the data from this study) readers seemed to be using these moves to continuously (re)position themselves in relation to the text they were reading. Finally, the term was chosen because it was, in the end, extremely difficult to distinguish between the array of different terms previous research had used to characterize what readers were doing. In short, the term *move* is meant to incorporate the seemingly disparate notions connoted by earlier terms and to bestow a sense of agency upon the text – which has hitherto been conceived of as an entity which is relatively stable.

The second major difference had to do with the meta-categories that had been used to delineate specific moves made by readers during lexical inferencing. Previous research had used a variety of terms: linguistic and non-linguistic (Bengeleil & Paribakht, 2004); strategies and knowledge sources (Nassaji, 2003); initial identification and strategic response (Roskams, 1998); and Contextual, Intralingual, and Interlingual

(Haastrup, 1987). Once again, terms from existing research were insufficient to best describe the data collected in this study. Additionally, since this data insisted the socially mediated aspects of verbal report data collection needed to be considered during the categorization of readers' 'moves' to comprehend unfamiliar words, the terms *Regulatory* and *Heuristic* were selected to differentiate between the general types of moves readers made.

Given the fact that the terms 'move', Regulatory', and 'Heuristic' were decided upon primarily through the use of the constant comparison method (Glaser & Strauss, 1967), and with the theoretical notions of metacognition (Flavell, 1978) and interactive-construction (Valencia & Pearson, 1987) in mind, however, direct comparison of these terms with terms found in previous research can remain only hypothetical. This being said, the function of the meta-category entitled *Regulatory moves* shares some similarity with Huckin and Bloch's (1993) 'metalinguistic control steps' and with Nassaji's (2003) 'strategies'. Whereas Huckin and Bloch's term referred to the 'conscious' steps readers used to make or test hypotheses or to ponder possible contextual nuances (p. 169), Nassaji's term refers to "conscious cognitive or metacognitive activities that the learner used to gain control over or understand the problem without any explicit appeal to any knowledge source as assistance" (p. 655). Three main differences exist between Huckin and Bloch's and Nassaji's terms and the term Regulatory moves as it is used in the current study. The first is that in the current study it was not required that Regulatory moves be consciously carried out by learners, nor was an attempt made to define what 'conscious' referred to. The second is that readers in the current study were characterized as using Regulatory moves to *position themselves in relation to* the 'problem'; that is, the

main function served by Regulatory moves for the learners in the study was mediational in nature. The third is that the 'problem' was interpreted as being posed not only by the TW, but also by the inferencing task and the research context.

The function of the meta-category dubbed *Heuristic moves* also shares some similarities with the meta-categorical delimitations in taxonomies produced by earlier research (e.g., 'knowledge sources' in Nassaji, 2003; 'strategic response' in Roskams, 1998), and amalgamates different meta-categories defined by other studies (e.g., 'Linguistic' and 'Non-Linguistic' from Bengeleil and Paribakht, 2004; 'Contextual', 'Intralingual', and 'Interlingual' from Haastrup, 1987). Heuristic moves as meta-category is meant to delimit inferences which appear to be made based on linguistic or prior knowledge awareness.

After these terms to refer to the meta-categorical level of the taxonomy had been chosen, it was then time to begin the recursive process described by steps one and two in the constant comparison method. After numerous readings through the data, multiple incarnations of categories and sub-categories were developed until one taxonomy seemed to best describe the data that had been collected. This taxonomy is presented in Chapter 4.

3.7.4 Open-ended interviews

Interviews with participants were transcribed, and the information obtained was categorized using an inductive method that resembles constant comparison. The information was then used to used to help contextualize and interpret the data obtained from the think-aloud task.

3.8 Summary

This chapter began by outlining the design, setting, and participants involved in the

current study. It next provided a comprehensive review of research related to the data collection instruments and methods adopted in the current study. Following a detailed description of the development of the reading passage and an explanation of the procedure followed during the pre-gathering and data gathering portions of the study, an account of the process of data analysis was given. Chapter 4 will present, with examples, the categories and sub-categories into which readers' inferencing moves were classified.

Chapter 4 Findings

In each of the transcript excerpts that are presented in this Chapter, text which is underlined indicates text from the reading passage that is being read aloud. *Italicized* font is used to highlight the reading move being exemplified in the excerpt. **Bolded** font, finally, is used to flag specific TWs. The use of **bolded** font will be used throughout the remainder of the entire text when reference to specific TWs is made.

4.1 Analysis of Verbal Reports

Participants' verbal reports were analysed according to the constant comparison technique (Glaser & Strauss, 1967). Two meta-categories, six categories, and 20 sub-categories of reading moves emerged through this process. Some of the categories of moves were labeled using terms from previous research. (e.g., Bengeleil & Paribakht, 2004; Nassaji, 2003, Roskams, 1998); however, the category labels are intended to reflect the character of the verbal reports made by participants in the current study. Table 6 provides an overview of category labels.

Table 6. A taxonomy of middle school ESL readers' regulatory and heuristic reading moves during a lexical inferencing task

Regulatory moves	***Heuristic moves***
Text-based 1. repeating 2. sounding out 3. skipping 4. auditing 5. backtracking 6. recasting 7. assessing **Context-based** 1. physical signalling 2. questioning the researcher 3. hedging	**Word level** 1. using collocation 2. using morphology 3. using parallels **Sentence level** 1. using sentence context 2. using grammar **Discourse level** 1. using discourse context 2. using visual inscriptions **Prior knowledge level** 1. using content awareness 2. using L1 awareness 3. using world awareness

4.1.1 Development of categories of reading moves

Explanation of each of the meta-category and category headings, and exemplification of each of the sub-categories will be presented below, along with brief discussion of similarities and differences they may share with existing taxonomies which describe L2 learners' lexical inferencing.

4.2 Regulatory moves

The meta-category *Regulatory moves* describes readers' methods of positioning themselves for the purpose of inferring a word's meaning according to specific TWs, cognitive load, or the research context. These moves served to regulate learners' management of the task(s) of inferring meaning. Within the meta-category regulatory moves there are two major categories: text-based and context-based.

4.2.1 Text-based moves

Text-based moves describe the techniques, whether conscious or unconscious, used by the reader to manage the reading and inferencing task they had been asked to complete. The seven types of sub-categories of text-based moves are: *repeating*, *sounding out*, *skipping*, *auditing*, *backtracking*, *recasting*, *assessing*.

Repeating was demonstrated by participants in three different ways in the data, and served a regulatory function that was not uniform for all participants. In the first example, Bea is attempting to infer the meaning of the TW 'stationary'. She repeats both the TW and a phrase from the sentence in which the TW is situated:

Ex. 1[10]

(1) Bea: ...<u>you would need a **stationary** reference point, such as a point on the floor, to measure</u>
(2) <u>your motion using an instrument that is fastened to the ground</u>... *stationary*... *stationary*
(3) is...mmm...something that mmm...that can...*reference point*...like the main points...

The regulatory function served by Bea's repeating of the TW (line 2) and the phrase 'reference point' (line 3) is to allow time for further thought prior to her inferring 'main point' (line 3).

In example two, Chai is also attempting to infer the meaning of the TW **stationary**, and repeats both the TW (line 3) and a phrase from the sentence in which the TW is situated (line 4):

Ex. 2

(1) Chai: <u>To do that, you would need a **stationary** reference point, such as a point on the floor, to</u>
(2) <u>measure your motion using an instrument that is fastened to the ground</u>...I think, uh,
(3) *stationary* means like some measurements for you to measure something...because here
(4) it say that *to measure your motion*...so I think maybe stationary is something that you
(5) use to measure...something...

What distinguishes this example from the first is the regulatory function served by Chai's repeating of the phrase 'to measure your motion'. In this case, the repeating of that phrase (line 4) is Chai's way of justifying the inference she will eventually make on line 5.

The final example of repeating is unique because Elan repeats large chunks of the sentence in which the TW **principle** is embedded. It is further unique because the repetition of these sentence chunks serves a different regulatory function than those illustrated thus far.

---

[10] In each of the excerpts that follow, text which is <u>underlined</u> indicates text from the reading passage that is being read aloud. *Italicized* font is used to highlight the reading move being exemplified in the excerpt. **Bolded** font, finally, is used to flag the target word.

Ex. 3

(1) Elan: <u>You can demonstrate a **principle** that solves this problem in the following…way</u>
(2) …mmm…*principle…solve this problem in the following way*…mmm…*you can*
(3) *demonstrate*…you can describe a principle…*that solve this problem in the following*
(4) *way*…uh…maybe mmm…I think principle here maybe means…the…main solving
(5) a…like…uh…the way to solve it… or…kind of mmm…I don't know…*you can*
(6) *demonstrate a principle that solve this problem*

The regulatory function of Elan's repetition of larger chunks of the sentence (lines 2, 3-4, and 5-6) is to attempt to generate sentence level contextual clues that will assist her in inferring the TW's meaning. After using what she believes is a synonym to help generate contextual clues ('describe' for 'demonstrate'; line 3), she infers the meaning as 'main solving' (line 4) and then recasts it as 'the way to solve it' (line 4). This is followed by the realization that the word 'way', which appears in her recasted inference, occurs at the end of the sentence and ends in her hedging about the recasted inference she has made (lines 4-5).

In L2 research, the use of the term 'repeating' can also be found in Nassaji (2003), where it characterizes a strategy readers used during lexical inferencing. Nassaji defines it as "repeating any portion of the text, including the word, the phrase, or the sentence in which the word has occurred" (p. 657). While the use of the sub-category repeating in the current study is similar in taxonomic function to that of Nassaji's (what readers do), it is distinct in its explanatory function (interpretations of why readers do what they do).

The move *sounding out* was identified when participants broke the target word down into syllables or phonic units while reading the text. In the first example of sounding out, Apple is attempting to infer the meaning of the TW **cylindrical**. She has not read the word aloud before, and so she tries out two variations while pronouncing the initial phoneme (line 1). Following her sounding out of the TW, and since the sentence

following the TW exemplifies what a 'cylindrical object' is like ('a pencil or a piece of chalk'), Apple infers the meaning of the TW as 'long and thin' (line 3).

Ex. 4

(1) Apple: Place a smooth, *see...psy...**lindrical*** object …like a pencil or piece of chalk on top of a
(2) sheet or paper on your desktop… like a pencil or piece of…on top of… paper on your
(3) desktop…mmm… something that is, like, long…and thin…

The regulatory function of sounding out in this instance is primarily to complete the task that she has been given by the researcher. While in this case the sounding out of the TW has not impeded Apple's ability to infer a meaning for it, it has not aided her in making an inference which captures all of the qualities that are implied by the TW **cylindrical**.

The second excerpt illustrates Ishi sounding out and attempting to infer the meaning of the TW **inertia**. This TW, unlike the adjective cylindrical, is a technical word that describes a concept integral to understand the measurement of earthquakes.

Ex. 5

(1) Ishi: You have just demonstrated a principle known as *in-eri-...**iner-ti-a**?...inert-...ia*…
(2) (laughs out loud)…I never heard of this before but…I think it's a k-…it's a kind of
(3) principle...or yeah …kind of theory…

Like Apple (Ex. 4), Ishi has not read this word aloud before and thus makes three attempts at sounding out the word (line 1). After doing so, she realizes that this is not a word she has ever heard before (line 2). Thus, the regulatory function of sounding out is twofold in this instance. In the first case, Ishi is making this move, like Apple, as a way to complete the task given to her by the researcher. In the second, she is attempting to elicit, through sounding out, an aural memory of a word that she has heard before but not ever seen. Again, similar to Apple's case, the use of this move by Ishi does not hinder her ability to infer a meaning, however vague, for the TW (lines 2-3).

Little previous research has identified this type of move as being salient to the process of ESL learners' inferring of meaning of unknown words. Roskams (1998) has written that the learners' in his study "attempt[ed] to pronounce the word" during the process of identifying unknown lexical items in a reading task (p. 70). Unfortunately, Roskams does not provide specific examples of this process occurring, so it was necessary for the current study to coin a term which would adequately describe this phenomenon.

The third text-based move is *skipping*. This move was observed when a learner, whether explicitly (Apple) or non-explicitly (Glyn), decided to forego inferring the meaning of a given TW and continue on to the next one. The regulatory function of this move is to maintain the continuity of the reading task. In the first example of skipping, Apple is attempting to infer the meaning of the TW **inertia** – which, due to her unfamiliarity with the word, she opts not to even attempt to pronounce or sound out (line 1):

Ex. 6

(1) Apple: You have just demonstrated a principle known as…defined as the tendency of a mass
(2) to stay at rest or continue moving unless the state of rest or motion is changed
(3) by…(whispers the sentence to herself again)…don't know…*I will skip*…I don't think
(4) that's important…

Following her decision not to sound out the word (itself a form of skipping), Apple continues reading the sentence in order to look for clues that might help her infer the TW's meaning (lines 1-2). When she has read what she feels is enough, she repeats the sentence one last time to herself (line 3) in a last attempt, and then explicitly indicates that she intends to skip the TW (line 3) and continue with the reading task.

In the second example of skipping, Glyn is attempting to infer the meaning of the same TW – **inertia**. Unlike Apple, Glyn looks beyond the borders of the sentence which contain the TW in an attempt to locate some kinds of clues that might help her infer its meaning:

Ex. 7

(1) Glyn: You have just demonstrated a principle known as…in…**inertia**, defined as the
(2) ten…tendency of a mass to stay at rest or continue moving unless the state of rest or
(3) motion is changed by external force…in this case, a stationary object the pencil tended
(4) to stay… stationary even when another body the surface it rests on suddenly
(5) moves…we can say that a pencil is showing inertia…the greater the mass, the greater is
(6) its inertia…you can…experiment with this concept yourself using more massive objects
(7) such as…cylinders of metal or…var-… varying weight…and so…inertia…means…uh
(8) *…means I don't know…*
(9) Res: Mmm…
(10) Glyn: Uh, it's a noun and…*I really don't know…*
(11) Res: OK…
(12) Glyn: And…tended…means, uh…

After encountering the TW an additional two times in the lines of the paragraph surrounding it (lines 5-6), Glyn is unable to make a guess about the word's meaning. That Glyn will skip this TW is indicated non-explicitly first in line 8; even though she is later able to determine the grammatical role played by the TW in the sentence and paragraph (line 10), she again non-explicitly indicates that due to her inability to guess she will skip this particular TW (line 10). Following this she moves on to the next TW 'tended' (line 12) in an attempt to continue with the reading task.

Roskams (1998) has named one of what he calls learners' "strategic response[s]" to unknown vocabulary items "Move on", but does not provide detailed examples of this response from his think-aloud protocols. For this reason, despite the fact that there is probably some similarity between what Roskams has described and what has been observed in the data, here a decision was made to use the term *skipping*.

Auditing is a reading move characterized by 'meta-talk' regarding the reading task, and was observed in the data in three distinct ways: (1) when participants gave reasons for being unable to infer the meaning of a TW, (2) when participants made explicit mention of the processes they were following in their attempts to infer a TW's meaning[11], and (3) when participants indicated that an aspect of their prior knowledge about a TW had been transformed. In each case, the regulatory function of this move was to help readers complete what they perceived the task (or researcher's probes) to be asking of them.

In the first example of auditing, Deepa is attempting to infer the meaning of the TW **anchored**:

Ex. 8

(1) Deepa: The rest of the instrument is…**an-chored**…to the strong con…crete
(2) foundation…anchored… how to pronounce?...ancho-red?...
(3) Res: If I tell you that…
(4) Deepa: Oh...maybe I'll know...The rest of the instrument is…foundation
(5) foundation…oh…(murmurs something inaudible)…the rest of the instrument
(6) is…something something…to a strong concreted…ah…*too man-...too many words*
(7) *unknown so it's hard to guess this one…*

It is clear from Deepa's first turn (lines 1-2) that she is encountering this word for the first time, and likewise that she is actively seeking the researcher's assistance. It is also clear, from her response to the researcher's refusal to help (line 3), that she is keenly aware of the rules of the task ('Oh…maybe I'll know'; line 4). It appears, from her repetition of the word 'foundation' (lines 4-5), that she does not know the meaning of this word either. The instance in which auditing occurs (lines 6-7), gives evidence for the

[11] Ironically, it is precisely readers' explicit mention of what they are doing as they are doing it that is described in Ericsson and Simon's (1993) account of ideal 'concurrent verbalization' or 'thinking aloud'. Not only does this understanding of concurrent verbalization place too high a value on the information processing model of human cognition (Swain, 2006), examples from recent L2 research provide few examples of this type of 'meta-talk', and place a higher interest on interpreting strategies and sources of knowledge on which learners' inferences occur based on the discourse they have produced.

interpretation that had she known the word 'foundation' she may have been able to make an inference about the TW **anchored**. It is also clear that the regulatory function of Deepa's use of auditing is to explain why she is unable to infer the meaning of the TW.

In the next two examples of auditing the regulatory function served by participants' use of this move is identical for each of the participants, despite the fact that the use of the move occurs under different circumstances. In each case, the participants are making explicit mention of the processes they are following during their attempts to infer different target words.

Ex. 9

(1) Bea: The rest of the instrument is **anchored** to a strong concrete foundation…
(2) anchored…anchor...
(3) Res: While you're thinking about the meaning of this word what are you doing?
(4) Bea: Mmm…*I…thinking about that I read before and look at the picture…*

In Bea's case, after repeating the TW **anchored** in different forms (lines 1-2), the researcher asks her to describe what she is 'thinking about' (line 3). This results in Bea's meta-talk concerning previous text and the visual inscription that follows the paragraph in which the sentence containing the TW occurs (line 4). Notably, Bea's use of auditing in this excerpt is elicited as a direct result of the researcher's probe question. This is not the case in the example that follows.

Ex. 10

(1) Elan: Trying to measure the distance the ground moves during a **tremor**…presents a
(2) challenging problem…mmm…(whispering)…trying to measure the distance (trails
(3) off)…trying to measure the distance the ground moves during the tremor present a
(4) challenging problem…I think…tre-mor…uh…uh…I think some noun, and I couldn't
(5) guess the meaning, so *maybe I read the following sentence...*

Following Elan's repetition of both the TW **tremor** and large chunks of the sentence in which it occurs (lines 2-3), she identifies the grammatical role played by the TW in the sentence and indicates this is not sufficient enough information for her to make

an inference (line 4). She then, unlike Bea, states on her own what she will do in order to try and locate more clues that will help her to make an inference (line 5).

The final example of auditing is unique because Glyn speaks explicitly about how her understanding of the meaning of the TW **stationary** has changed as a result of her encounter with it in the context of the reading passage.

Ex .11

(1) Glyn: And...you would need a **stationary** reference point...ohm...*I know that stationary is*
(2) *kind of like pencil, pen...but I think...in here it means very steady...*
(3) Res: OK...Did y-
(4) Glyn: *...-Don't move...*
(5) Res: Did you know this meaning before or are you guessing?
(6) Glyn: *I get...um...I know it, but I never think of it...I really always think it's a pencil/pen...or*
(7) *something...*

In lines 1-2 of this example, Glyn 'know'(s) that the TW is a thing that is used for office or study related tasks, although this is the result of the fact that she has confused the spelling of the TW with that of 'stationery'. This may also be a reference to the fact that she is recalling her definition of the TW on the VKS as 'stationery'. Nonetheless, what is clear from her meta-talk in this excerpt is that her understanding of the TW has been transformed (lines 1-2; 6-7), and is indicative of a regulatory function for the move auditing which is qualitatively different from those presented in the previous examples.

In some ways, the move auditing coined for use in this study resembles Nassaji's (2003) inferencing strategy entitled "Monitoring". However, auditing is distinct from 'Monitoring' insofar as it is much broader, and as well because it demonstrates that readers do more to monitor their reading during lexical inferencing than show a "conscious awareness of the problem or the ease or difficulty of the task" (p. 657). This is illustrated by the differing regulatory functions served by participants' use of auditing in the current study.

Backtracking refers to instances where readers returned to a previously skipped TW to infer its meaning, and clearly indicates that some readers kept observational notes of their performance. In this first example, Deepa is initially attempting to infer the meaning of the TW **principle**:

Ex. 12

(1) Deepa: You can demonstrate the **prin-ci-ple** that solves this problem in the following
(2) way…you can demonstrate a principle…hmm…*I cannot guess what principle here*
(3) *means…*
…
(4) Deepa: You have just demonstrated a principle known as **inertia**…*so principle might be a...*
(5) *effect?...*

Deepa, after repeating a small phrase from the sentence which includes the TW, indicates that she is unable to infer what the TW means in this context (lines 2-3). Following this, and upon encountering the TW **principle** a second time in a different sentence which included a different TW (**inertia**), Deepa is able to make a guess about the meaning of **principle** (lines 4-5). This example lends itself to the notion that the number of occurrences a TW makes in a given reading passage, the greater the chance of guessing it (Nation, 2001, p. 243; cf. *Ex. 7* above). In this case, the regulatory function served by Deepa's backtracking is to make sure that she has completed the task; this is also the case in the following example.

In the next example, Glyn is attempting to infer the meaning of the TW **inertia**:

Ex. 13

(1) Glyn: You have just demonstrated a principle known as…in…**inertia**, defined as the ten-…
(2) tendency of a mass to stay at rest or continue moving unless the state of rest or motion
(3) is changed by external force…in this case, a stationary object the pencil tended to
(4) stay… stationary even when another body the surface it rests on suddenly moves…we
(5) can say that a pencil is showing inertia…the greater the mass, the greater is its
(6) inertia…you can…experiment with this concept yourself using more massive objects
(7) such as…cylinders of metal or…var-… varying weight…*and so...inertia...means...uh*
(8) *...means I don't know...*
(9) Res: Mmm…
(10) Glyn: Uh, it's a noun and…*I really don't know…*

...
(11) Glyn: The rest of the instrument is...**an-chored** to a strong...con-srete...concrete
(12) foundation...during a tremor, the susp-...the suspending mass tends to stay in one
(13) place as the ground...vee-...vi-, vibrates under it... because of its iner-...inertia, the
(14) mass become the stationary reference point...sensors measure the difference in
(15) movement between the ground and the stationary mass...the amplitude of motion is
(16) electron-...electronically...magni-field up to...one hundred thousand times and recor-
(17) ...recorded by the vib-...vibrations of pen over a roll of paper...
...(Glyn infers the meaning of **anchored** here)...
(18) Glyn: Yeah, and now, uh...*maybe I can guess what inertia-...*
(19) Res: Inertia is...
(20) Glyn: And...it's um...*it's a...physical property...*

Unlike Deepa, Glyn reads to the end of the paragraph in search of clues that will assist her ability to infer the meaning of the TW (lines 1-7). Though she encounters the TW twice more (lines 5 and 6) during her search, and is able to identify the grammatical function of the word in the paragraph (line 10), she is unable to generate an inference for the word (lines 8 and 10). In the omitted transcript (between lines 10 and 11), Glyn infers the meaning of two further TWs (**tended** and **masssive**) and, after reading another full paragraph (lines 11-17) and inferring the meaning of yet another TW (**anchored**; between lines 17-18), she backtracks to the TW **inertia**. She has encountered this word yet again in the new paragraph (line 13), which has both reminded her of the TW (line 18) and perhaps given her the context she required to make an inference about the word (line 18). Like Deepa, Glyn backtracks in order to best complete the task she has been given by the researcher.

Roskams (1998) coined the term "delayed reprocessing" – a "strategic response" to unknown vocabulary employed by readers – that may be similar to our backtracking. We have chosen not to employ Roskams' term in our taxonomy due to the fact that Roskams does not provide examples of delayed reprocessing in his paper and therefore the use of his label may not be appropriate.

Recasting was a common type of reading move in the data obtained in this study. The term recasting refers to the act of providing more than one version of an inference for a word – whether that version is similar to or different from the original. In the first example, Elan infers the meaning of the TW **jarring**:

Ex. 14

(1) Elan: It consists of an in-tri-cate arrangement of levers…and wheels that…released a ball in
(2) response to any kind of **jarring** movement… mmm…I think jarring means, maybe,
(3) *bounce* …or uh, like *move up and down…*

Elan gives her initial guess about the meaning of the TW (line 3; 'bounce'), but then recasts it as 'move up and down' (line 3). In this case, although the general sense of her inferred meaning is derivable from both versions of her inference, Elan has altered her initial inference to provide what she believes to be a more appropriate version to connote the meaning of the TW **jarring**. In Elan's case, the regulatory function of recasting is as a device through which she can modify or provide what she believes are more appropriate alternatives for her original inference, and in doing so, to regulate (what she believes to be) proper completion of the task. Additionally, it appears that Elan is using her recast to help generate a more cohesive and comprehensive picture of how the TW fits into the sentence context (and perhaps the global text).

In the next example, Ishi is inferring the meaning of the TW **devastating**:

Ex. 15

(1) Ishi: Although some are **devastating**, others may go unnoticed…although some
(2) are…(breathes in)…some are devastating…maybe this one… the devastating is…*some*
(3) *are greater than others*…maybe something like that…
(4) Res: Greater than others…how are you guessing the meaning of that?...
(5) Ishi: Uh…I'm just guessing…like…like from the sentence…
(6) Res: OK-
(7) Ishi: So maybe…or like, kind of…*different from others* – like…*greater than others* or, *kind of*
(8) *really have small amount…or…big amount…*

After repeating a phrase from the sentence (lines 1-2) containing the TW, Ishi makes her initial inference (lines 2-3; 'some are greater than others'). She indicates that the sentence context has assisted this inference (line 5), but then goes on to recast her initial inference (line 7; 'different from others'), repeat her initial inference (line 7), and recast again as 'really have small amount' (lines 7-8) and 'big amount' (line 8). Similarly to Elan, Ishi uses recasting to modify or provide alternatives for her original inference. However, in Ishi's case, recasting is also a means for her to indicate either: (1) her uncertainty about which is the better or more suitable inferred meaning for the TW ('greater than others' vs. 'different from others'), or (2) the fact that she is under the impression, given the sentence context, that more than one meaning is possible for this TW ('small amount' vs. big amount').

Assessing refers to the type of reading move participants made when they embedded their inferred meaning for a TW into a larger chunk of text from the immediate context (e.g., phrase or sentence), or embedded their inferred meaning in a paraphrased version of the sentence (Fera). The regulatory function of this type of reading move was to evaluate the inferred meaning of the TW, and based on this evaluation, to decide whether the task had been suitably completed or whether another attempt at inferring needed to be made.

The first example is of Ishi inferring the meaning of the TW **tremor**.

Ex. 16

(1) Ishi: So…trying to measure…the distance the ground moves during a **tremor** presents…a
(2) challenging problem…(whispering)…trying to measure the distance the ground
(3) moves…(out loud)…during a tre-mor…presents a challenging problem…imagine you
(4) are (trails off)…tremor presents…tremor…I don't understand the meaning…
(5) Res: Mmm…um…OK, maybe-
(6) Ishi: Maybe tremor presents…a challenging problem…tremor…(whispering sentence to
(7) herself)…mmm…*during a…earthquake presents* maybe?...
(8) Res: OK-

(9) Ishi: Maybe tremor is ear-…earthquake or something like that?

After repeating the majority of the sentence in which the TW occurs (lines 2-3), Ishi expresses that she doesn't 'understand the meaning' of the TW (line 4). She then repeats both a phrase from the sentence and the TW again (lines 6-7), and generates 'earthquake' as a guess for the TW (line 7). By embedding her inferred meaning 'earthquake' into the phrase in which the TW originally occurred (line 7), she assesses her inferred meaning. After doing so, Ishi suggests that 'earthquake' might be a suitable replacement for the TW in this instance (line 9). Since she does not attempt to infer again, nor does she demonstrate the use of any other moves following her suggested meaning 'earthquake', it must be presumed that she believes she has satisfactorily completed the task.

In the second example, Fera is also attempting to infer the meaning of the TW **tremor**.

Ex. 17

(1) Fera: Trying to measure the distance the ground move during a **tremor** presents a challenging
(2) problem…mmm…tremor …Imagine you are an …ant…hanging on-…to a rope…
(3) mmm…You would certainly know you were moving from side to side, but… would be
(4) unable to measure the amplitude of… that motion…ah...(to herself) distance
(5) ground…tremor presents…trying to measure the distance ground moves during a tre-
(6) mor… (loudly)…ah!...ground moves during a…ah!... small?...wait…mmm…ground
(7) shaking?...
(8) Res: OK…and what makes you guess that?
(9) Fera: Read!...to measure the distance the ground …mmm…I think just…it's about ground
(10) shaking…
(11) Res: OK…why do you think so – or how do you…
(12) Fera: *'Cause its hard to…measure the distance…* yeah…*during the ground shaking…*

Fera begins by reading to end of the sentence in which the TW occurs, at which point she pauses and repeats the TW (line 2). She then continues reading (from 'Imagine') in an attempt to generate clues from the context outside the immediate sentence that may assist with her inference (lines 2-4). She again repeats the entire sentence in which the TW is included (lines 5-6), which culminates in her insertion of her first inference ('small') into

the phrase originally containing the TW (line 5). This act of inserting the inferred meaning into the sentence allows her to assess her initial inference as insufficient; she then quickly recasts her initial inference as 'ground shaking' (lines 6-7). When pressed by the researcher the first time (line 8), Fera's response and her repetition of a chunk of the sentence indicate that the sentence context has played a role in her inference (lines 9-10). When pressed a second time (line 11), she assesses the suitability of her recast by paraphrasing a large chunk of the sentence and including her inferred meaning (line 12). Confident that she has completed the task, Fera moves on to the next TW.

Nassaji (2003) has referred to what may be considered a similar lexical inferencing strategy called "verifying" – in which readers check 'the appropriateness of the inferred meaning…against the wider context' p. 655-6). The major difference between Nassaji's characterization of this phenomenon and the one put forth in the current study lies in the regulatory function served by assessing (verifying). Although Nassaji does indicate the possibility that this strategy (move) is used to judge the suitability of the inferred meaning, he does not consider the possibility that participants' use of this move (strategy) serves also to regulate whether inferencing for a particular TW ceases or continues. In short, he does not consider the relation of this move (strategy) to the overall inferencing task. Additionally, Bengeleil and Paribakht (2004) have referred to a similar type of knowledge source they dub "paradigmatic relations". Using paradigmatic relations "involves using familiar words that c[an] replace the TW in the sentence when inferring its meaning" (p. 233). At first glance, Bengeleil and Paribakht's paradigmatic relations appears quite similar to the move dubbed *assessing* as it is defined in the current study. There are, however, subtle differences. Bengeleil and Paribakht have

characterized participants' use of paradigmatic relations as an appeal to a specific knowledge source, which does not serve any type of regulatory function – either for assessing the suitability of the inferred meaning or for assessing to what extent the task has been completed. Furthermore, their very characterization of this knowledge source depends on the correctness of the participants' inference.

4.2.2 Context-based moves

Context-based moves were interpreted as being directly linked to the socio-contextual aspects of both reading and the research context; namely, reading moves that were the specific result of the process of producing/eliciting verbal reports and the reading task. If an 'other' (in this case the researcher) was not present then it is presumed that these moves would not have been used or at least would not have the character they do in this specific research context. These context-based moves are: *physical signalling*, *questioning the researcher,* and *hedging*. Previous research on the subject of lexical inferencing for L2 learners has yet to include any categories of moves that are related to these socio-contextual elements of reading or of 'thinking aloud'.

Physical signalling refers to instances where participants used hand gestures to assist with the conveyance of a meaning or point to an area in the text during the process of inferring.

In example 18, Chai is attempting to infer the meaning of the TW **seismograph**:

Ex. 18

(1) Chai: Mmm…um…like a wave graph…like this? (*makes a wave with her fingers*)…

Not only has Chai (erroneously[12]) interpreted root portion of the TW 'graph' to be an important clue for inferring its meaning, she has used a physical signal following her inference (line 1). This use of physical signalling has been interpreted as a direct result of the research task, as it is unlikely Chai would have gestured in a similar way were she reading alone. As such, the regulatory function implied by the use of this move is twofold. Not only is Chai supplementing or reinforcing her inferred meaning 'wave graph' by using this physical signal, she is also banking on the fact that the use of this signal will replace the cognitively more taxing task of verbally explaining to the researcher what a 'wave graph' actually is.

The next example sees Halla attempting to infer the meaning of the TW **amplitude**:

Ex. 19

(1) Halla: (silence)....**amplitude**...it's this (*pointing to the inscription* and laughing)...it's from
(2) the picture...
(3) Res: From the picture, so...then what is amplitude...if you had to guess...
(4) Halla: The height from the ground...from the ground to the thing that can move...

In this example, Halla first uses a physical signal in place of a verbal inference (line 1). The physical signal is to a visual inscription that accompanies the text – which is made clear by her statement 'it's from the picture' (lines 1-2). Based on this statement, it is obvious that she is relying on the visual inscription that accompanies the text to construct a meaning for the TW, but more importantly, that she has used a physical signal to avoid the more difficult task of providing a verbal inference for the TW. When pressed by the researcher for a verbal inference (line 3), Halla is able to describe her interpretation of what the inscription depicts as **amplitude** (line 4). The fact that she is able, at the

[12] 'Seismograph' is the instrument that measures ground motion during and earthquake. Seismo*gram*, conversely, is the 'wave graph' that indicates the amplitude of ground motion during an earthquake.

researcher's request, to provide this verbal inference serves as further evidence that she has used a physical signal in a regulatory way – namely to evade the task of verbally describing the meaning of the TW.

Questioning the researcher was a type of reading move observed in the verbal report data when readers phrased their inferences in the form of questions directed to the researcher. This reading move was classified as regulatory because learners knew the researcher would not provide a direct answer to their questions, and yet their inferences were made in question form in the attempt to elicit a reaction from the researcher. In the first example, Joni is attempting to infer the meaning of the TW **devastating**.

Ex. 20

(1) Joni: Although some are **de-va-stating**...oh...other may go..un-... noticed...*is it like,*
(2) *um...found by some scientist?...*

After sounding out the TW (line 1), Joni infers the meaning of devastating as 'is it like, um... found by some scientist?' (lines 1-2). Her use of the question form here is neither coincidental nor accidental. It is an indication, albeit subtle, that she is searching for some kind of assistance from the researcher.

The same subtle indication is present in the second example, which is of Bea's attempt to infer the meaning of the TW **vibrations**.

Ex. 21

(1) Bea: ...this device could not distinguish between large and small vibra...**vibrations**...*small*
(2) *details?...*

Similarly to Joni, Bea phrases her inferred meaning in the form of a question (lines 1-2). Again, she is searching for some kind of clue, either from the researcher's physical response to her inference or from the researcher's tone in responding verbally to her inference, about the quality of her inferred meaning.

The type of reading move dubbed *hedging* refers to situations in which participants were careful to include uncertainty markers with or alongside their inferred meanings for TWs. Hedging is distinct from instances in which learners declared explicitly that they did not know the meaning of a TW; it denotes only those situations in which learners had already made an inference, and then outwardly verbalized uncertainty about that inference.

In the first example, Glyn is attempting to infer the meaning of the TW **massive**.

Ex. 22

(1) Glyn: And…**massive**…is a large amount…
(2) Res: And you know this word?…
(3) Glyn: Um…yeah, kind of…
(4) Res: What do you mean, kind of?
(5) Glyn: Like, I…I've written this word and I've seen this word before *but I'm not sure what it means*….

After her inference of a 'a large amount' (line 1), the researcher asks if Glyn is familiar with the TW (line 2). She indicates that she is 'kind of' familiar with it (line 3), and when asked to elaborate on what is meant by this statement (line 4), Glyn indicates that in spite of her inference, and the fact that she has both written and seen the word before, she is still 'not sure what it means' (line 5). The regulatory function of Glyn's use of hedging here, despite her reported familiarity with the TW, is as a mechanism to counterbalance the possible social stigma of having made an erroneous inference in the presence of the researcher. Thus her hedge is meant to alert the researcher to her self-consciousness with regard to successful completion of the task she has been given.

In the second example, Elan is attempting infer the meaning of the TW **cylindrical**.

Ex. 23

(1) Elan: Place a smooth, **cylindrical** object like a pencil or a piece of chalk on top a sheet of
(2) paper on your desktop...mmm... cylindrical...I guess this one is means...something
(3) that is like a cylin-...uh...cylin-...der...*I don't know*... just...the shape is like a
(4) pencil...

After repeating the TW (line 2), Elan realizes the morphological similarity between the TW and the word 'cylinder' and thus infers the TW's meaning as 'something that is like a cylinder' (lines 2-3). She then hedges ('I don't know'; line 3), and refers directly to the sentence context to recast her initial inference as 'the shape is like a pencil' (line 3). The regulatory use of hedging here indicates Elan's dissatisfaction with her initial inference, and shows her desire to provide a more suitable inferred meaning for the TW. Moreover, the use of hedging in this instance is meant to indicate to the researcher that despite knowing what the TW means, Elan is unable to describe what it means using language she feels is adequate for the completion of the task.

Nassaji (2003) includes a lexical inferencing strategy called "self-inquiry" in his taxonomy, which refers to instances in which readers "self-questioning about the text, words, or the meaning already inferred" (p. 657). The instances observed in the data from the current study are distinct from those identified by Nassaji insofar as they suggest that self-inquiry (read: hedging) is a strategy (read: move) that helps readers position themselves in relation to the researcher as well as in relation to the text.

4.3 Heuristic moves

The meta-category *Heuristic moves* classifies readers' means of inferencing based on their attention to language based word- and sentence-level characteristics, to text-structure, and to the relationship between their experiences and the text. Within the meta-

category heuristic moves there are four major categories: *word level, sentence level, discourse level, and prior knowledge level.*

4.3.1 Word level moves

At the word level, three different types of moves were identified: *using collocation*, *using morphology*, and *using parallels*. These moves occur at the word level because they are specific to the TW for which the inference was being made.

The type of reading move dubbed *using collocation* was observed when participants attached the TW to another word or phrase during their attempt to infer its meaning. In the first example, Deepa is attempting to infer the meaning of the TW **tended**.

Ex. 24

(1) Deepa: In this case… stationary object…the pencil…**tended** to stay stationary…Oh!...now
(2) I…I-… *tend to* means…is more likely to…

Deepa's use of collocation is displayed here when she mentions the TW in the phrasal verb form 'tend to' (line 2). When one considers that the additional word 'to' was not included as part of the original TW, and her inferred meaning 'is more likely to' (line 2) in conjunction with her mention of the phrasal verb form, it is clear that Deepa is using collocation to assist with her guess about the meaning of this TW.

The second example comes from Ishi's attempt to infer the meaning of the TW **principle**.

Ex. 25

(1) Ishi: **principle**…is like…I heard of this word, like…*principle of math*…but I think it's totally
(2) different use…

It is clear from this excerpt that Ishi has at least 'heard' the TW before (line 1). She then uses collocation to contextualize where she has heard the word before

('principle of math'; line 1), but is unable to make a connection between her knowledge of the TW in the collocated phrase 'principle of math' and the sense in which it is used in the reading passage (lines 1-2; 'but I think it's totally different use').

Previous researchers have used similar notions to classify the types of knowledge sources (Bengeleil & Paribakht, 2004; Haastrup, 1987) and inferencing processes (Roskams, 1998) drawn upon by students during lexical inferencing. Bengeleil and Paribakht have dubbed their notion "syntagmatic meaning", and use it to refer to instances where learners "looked at one or two words immediately surrounding the TW that might have a collocational relation with it" (p. 233[13]). Roskams' uses the actual word "collocation" in his taxonomy as follows: "Guess using association or collocation knowledge (i.e., a clue word)" (p. 71). Roskams does not, despite his provision of an example of a learner displaying collocational knowledge, explain what the "clue word" is or how the learner is using it. In the context of the current study, using collocation is meant to denote instances in which learners relied on the addition of any word, from the surrounding context (Deepa) or otherwise (Ishi), to the TW to assist with their attempt to infer.

Using morphology was exemplified when participants utilized structural features of the TW to assist their inferencing processes (e.g., prefixes, suffixes, root words, or word stems). In the first example, Chai is attempting to infer the meaning of the TW **massive**.

---

[13] Bengeleil and Paribakht (2004) have another category that makes use of the notion of collocational knowledge. The category is called "word collocation", and refers to learners' use of "knowledge of which words are often used together in L1" (p. 235). Clearly, this is different from the sense implied by the use of the word in the current study, as the learners used their collocational knowledge in their L2 English.

Ex. 26

(1) Chai: You can experiment with this concept yourself using more **massive** objects, such as
(2) cylinders of metal or vary…varying weight… this word means some heavy subjects…
(3) Res: OK. Do you know this word, or…?
(4) Chai: *Actually, I don't know this word at first, but if I like cover 'ive' then I know it's*
(5) *mass…so it say something about like…the weight…*

Chai makes an assertive inference about the meaning of the TW ('some heavy subjects'; line 1). Her use of morphology on becomes apparent when asked by the researcher whether she had prior knowledge of the TW's meaning (line 3). She responds by saying that she knows the TW 'say something about the weight' (lines 4-5), and that this is based on her ability to cover the 'ive' suffix that is attached to the root word 'mass'.

The second example of using morphology is an instance in which Joni was attempting to infer the meaning of the TW **seismograph**.

Ex. 27

(1) Joni: The **see-mograph**…An instrument that is used to measure the ground motion…resulting
(2) from earthquakes is known as a see-mograph… (whispering the sentence to herself)…*is*
(3) *it a graph that shows how the ground move*?...
(4) Res: Uh…how do you know that?
(5) Joni: Because I think the *graph* is, like…um… representing some information…like some
(6) line…up and down…
(7) Res: Mm-hmm…have you seen this word before, or?...
(8) Joni: No…

It becomes clear that the TW is unknown to Joni as a result of her mispronunciation of that word on two occasions during her initial read-through of the sentence (lines 1-2). She also repeats the sentence (line 2) prior to making her inference ('is it a graph that shows how the ground move?') in the form of a question directed at the researcher (lines 2-3). The very act of asking if it is a 'graph' (lines 2-3), and her repetition of the word 'graph' (line 5) are evidence that Joni is working with the root portion of this word in order to assist her inference, and that she has used morphological awareness to assist with her inference about the word.

Previous research has found the use of a word's morphological features to be a salient knowledge source (Bengeleil & Paribakht, 2004; Haastrup, 1987; Nassaji, 2003), strategy (Nassaji, 2003), and inferencing process (Roskams, 1998) relied upon by second language learners during lexical inferencing. Nassaji (2003) names the strategy "Analyzing", and indicates that it is exemplified when readers infer by means of analyzing a word into different parts (p. 657). The knowledge source from which this strategy emerges, conversely, is called "Morphological knowledge", and refers to instances in which learners rely on "word formation and…structure, including …derivations, inflections,…stems, suffixes and prefixes" (Nassaji, 2003, p. 656). The use of the notion of morphology in the current study is different from Nassaji's because the categories "strategy" and "knowledge source" are neither adopted nor differentiated from one another. The all encompassing notion of move allows for the combination of strategy and knowledge source into one category. The basic premise, however, is for all intents and purposes, the same as Nassaji's. Similarly, Bengeleil and Paribakht have used the moniker "word morphology" to define situations where learners use "knowledge of word derivations (stems, prefixes, and suffixes)" (p. 231) – a guideline which seems very similar to the one used in the current study. Roskams (1998) has lumped "similarity or morphological knowledge" in one category called "guess using visual form" (p. 71). Roskams' mode of classifying the use of morphological features during inferencing is different from the one used here insofar as learners in the current study used "visual form" in an altogether different way than they did morphology (e.g., *using parallels*).

Using parallels were observed when participants drew on what they believed be a homophonic or homographic relationship between the TW and a known word in their

existing vocabulary. The examples obtained from this data set were limited to three target words in particular: (1) **principle**, (2) **stationary**, and (3) **varies**.

Examples 28, 29, and 30 illustrate the use of parallels by participants when inferring the meanings of the TWs **stationary** and **principle**.

Ex. 28

(1) Fera: To do that…would you need a sta-…oh…(laughs)…**stationary** reference point… such
(2) as a point on the floor, to measure your motion using an instrument that is fastened to
(3) the ground…ugh!...to do that would you need a …ah…yeah!...like *ruler*…or…like
(4) mea-...like *object to measure something*?...
(5) Res: Object to measure something…OK, and what makes you guess that? Have you seen-
(6) Fera: 'Cause-
(7) Res: -word before, or-
(8) Fera: No..uh, yeah!...I think so…
(9) Res: OK…
(10) Fera: Yeah…yeah…like *pencil*, or…

The most plausible explanation for Fera's inferences 'ruler' (line 3), 'object to measure something' (line 4), and 'pencil' (line 10) is that she is unaware that a different spelling of the TW (e.g., station*e*ry) is possible. She repeats a phrase ('to do that you would need'; line 3) and recasts (lines 4, 10) during the process of making an inference for this word, but these other moves are trumped by her use of the homophonic parallel 'station*e*ry'.

Ex. 29

(1) Joni: You can demonstrate…a…**principle**…that solve this problem in following ways…*the*
(2) *people who ask you to…do this…*
(3) Res: OK…how are you guessing the meaning of this word?
(4) Joni: I don't know – because…*principle is the head of the school…*

In Joni's case, a similar phenomenon can be observed. Her inference 'the people who ask you to do this' (lines 1-2), and justification for her inference 'principle is the head of the school' (line 4) are clear indications that she has used the homophonic parallel 'princip*a*l' as the primary basis for her inferred meaning.

Like Fera and Joni, Glyn demonstrates the use of a homophonic parallel while she infers the meaning of the TW **stationary**.

Ex. 30

(1) Glyn: And…you would need a **stationary** reference point…ohm…I know that *stationary is*
(2) *kind of like pencil/pen*…but I think…in here it means very steady...
(3) Res: OK...Did y-
(4) Glyn: …-Don't move…
(5) Res: …-Did you know this meaning before or are you guessing?
(6) Glyn: I get…um…I know it, but I never think of it…*I really always think it's a pencil/pen*…

Unlike Fera (Ex. 28) and Joni (Ex. 29), however, Glyn is aware of the different meaning taken on by the TW in the context of the sentence (line 2). Since she mentions that 'stationary is a kind of…pencil, pen' (lines 1- 2, 6), and does not refer to the spelling of the word, her use of homophonic parallel is implicit in her attempt to infer the meaning of this TW.

In the case of the TW **varies**, a different phenomenon emerged. Three participants mispronounced the word while reading it, and in the context of the current study, this phenomenon could be interpreted in more than one way. Two instances of this mispronunciation will be illustrated in the examples below.

Ex. 31

(1) Deepa: The strength of earthquakes…ah…*various* greatly. Although some are deva…stating
(2) (laughs), others may go unnoticed…It is important to be able to…(trails
(3) off)…mmm…the strength –
(4) Res: So if you-
(5) Deepa: No, I'm trying to explain here…(quietly)… the strength of earth…(trails off)…like
(6) change

A first possible interpretation is that Deepa has replaced the unfamiliar TW in the original reading passage (**varies**) with a word that she does know ('various'; line 1) and that in her mind fits the overall sense of the sentence – better allowing her to infer the meaning of the TW as 'change' (line 6). A second possible interpretation may be that

Deepa has confused the grammatical role played by **varies** in the sentence, and has thus read the TW as the adjective 'various' (line 1). The final possible interpretation is that Deepa has heard the word 'various' but has not seen it spelled, and has thus read the original TW **varies** as 'various' (line 1).

Ex. 32

(1) Joni: The strength of earthquakes…uh…the strength of earthquakes *var-ties* greatly…um…means… um…there's a species…got a lot of kinds…

Not only is there some confusion about which word Joni is actually using to replace the original TW (e.g., whether she intends to say 'varieties'), her reading of the original TW **varies** as 'varties' (line 1) is also open to a couple of different interpretations. Like Deepa, she may be replacing the original TW with a word that is more familiar and which fits the meaning she derives from the sentence – allowing her to infer the meaning as 'there's a species' and recast it as 'got a lot of kinds' (line 2). Indeed, the relationship between her inferred meanings and the word 'varieties' stands out. Alternatively, and again like Deepa, Joni may be confused about the grammatical role played by the original TW in the sentence, and thus have replaced it with her version of the noun 'varieties' (line 1).

In the final analysis, however, it is clear that Fera, Joni, Glyn and Deepa have drawn on what they believed to be an auditory or orthographic similarity between the TWs and words they already know – and hence have used parallels in an attempt to assist their inferences. Roskams (1998) has identified the use of visual similarity and "phonological similarity" by readers during a lexical inferencing task (p. 71), but provides neither examples nor a sufficient explanation of how these similarities are actually used by the learners in his study. Nassaji (2003) has used the term "analogy" to

describe a reading "strategy" employed by learners during an inferencing task – meaning that they base their inferences on "sound or form similarity with other words" (p. 657). Likewise, Bengeleil and Paribakht (2004) have used the term "word homonymy" to describe readers' using "knowledge of phonetic or orthographic similarity between the TW and another familiar word" (p. 232). Both Nassaji's (2003) and Bengeleil and Paribakht's (2004) examples and explanations of learners' reading moves are similar to those observed in the verbal report data collected in this study. Rather than choosing between what Nassaji has called a strategy, and what Bengeleil and Paribakht have called a knowledge source, the term *parallel* has been used to describe readers' use of what they believe to be similarities (either phonetic or orthographic) to assist with their inferences. In addition, the term *using parallels* has also been chosen as a result of the different ways in which the data could be interpreted. These types of contingencies did not receive mention in either Nassaji's (2003) or Bengeleil and Paribakht's (2004) studies.

4.3.2 Sentence level moves

At the sentence level, participants in this study relied on two different types of moves in the verbal report data: *using sentence context* and *using grammar*. What each of these types of reading moves has in common is the use of some aspect of the immediate sentence in which the TW was embedded to assist with inferencing.

Using sentence context is a general type of sentence level reading move that sees readers explicitly or non-explicitly use specific words (Glyn) or phrases (Glyn; Bea) from the sentence containing the TW, or use meaning derived from the general sentence context (Ishi) to assist their inferencing processes. It has been referred to in previous literature on the topic of L2 inferencing as "sentence meaning" (Bengeleil and Paribakht,

2004), "a single word from the immediate context" and "the immediate context" (Haastrup, 1987), and "local context" (Roskams, 1998).

In the first example, Glyn is attempting to infer the meaning of the TW **faint**.

Ex. 33

(1) Glyn: And, uh…**faint**…means very small…very small and…maybe is unnoticed…
(2) Res: …so can you please explain how you know that?
(3) Glyn: Because it say…*it says here*...a…an instrument sensitive *enough* (emphasizes
(4) 'enough')...to de-…to detect *even* (emphasizes 'even') very faint ground motions…

Her first inferred meaning 'very small' is recast as 'is unnoticed' (line 1). When asked by the researcher for how she came to infer the meaning as such, she makes a non-explicit reference to the sentence context as the source of assistance ('it says here'; line 3). More specifically, during her repeat of a chunk of the sentence, she emphasizes the role of specific words in assisting her (lines 3-4).

In the next example, Bea is attempting to infer the meaning of the TW **devastating**.

Ex. 34

(1) Bea: Although some are **devastating**, others may go unnoticed …devastating…is…maybe
(2) like very scared or crazy?...
(3) Res: OK…and what, ho…uh…what would make you guess that?
(4) Bea: 'Cause at the end *it say like, others maybe like go unnoticed*, like, maybe don't know
(5) about it, or something like that.

Here she infers the meaning of the TW as 'very scared or crazy', in the form of a question directed at the researcher (lines 1-2). When asked upon what this inference is based (line 3), Bea makes a non-explicit reference to the sentence context ('it say like'; line 4), and more specifically, to the role of a specific phrase in the sentence ('others maybe like go unnoticed'; line 4).

The final example is drawn from Ishi's attempt to infer the meaning of the TW **jarring**.

Ex. 35

(1) Ishi: It consisted of an in-tri-cate arrangement of levers and wheels that released a ball in
(2) response to any kind of **jarring** movement... jarring is like...mmm...uh...heun-dul-li-
(3) neun[14]... like...uh...how to say...shaking movement...
(4) Res: Uh, do you know this or are you-
(5) Ishi: I don't know but *I just guess it from the sentence...*

In this example, Ishi's first inferred meaning occurs in her L1 (lines 2-3), and is later recast as 'shaking movement' (line 3). When asked how she has generated a meaning for the TW (line 4), she explicitly indicates having used the sentence context (line 5). This example indicates a different type of reference to the sentence context that those presented in Ex. 33 or 34.

Participants were *using grammar* in the verbal report data when they did one of two things: made explicit reference to what they believed to be the grammatical role played by the target word within the context of the sentence in which it was situated, or stated their inferred meaning for a TW using the same word form the TW was used in within the target text (Ex. 37; Ishi).

Glyn's use of grammar here is clear, as she refers explicitly to the role played by the TW **principle** in the sentence during her verbal report (line 1).

Ex. 36

(1) Glyn: ...so...a **principle**... *oh, I don't know it's a noun before...I think it's a adjective...*

Ishi's use of grammar while attempting to infer the meaning of the TW **anchored** is more subtle. Instead of making an explicit reference to the past tense form of the TW, Ishi demonstrates a use of grammatical awareness by reporting her inferred meaning in the same verb tense as the TW ('propped'; line 1).

[14] Ishi has used her first langauge here. The text is a romanization of the pronunciation of that word. This is also applicable to the word 'goo-surl' in line 11 of this example.

Ex. 37

(1) Ishi: The rest of the instrument is **anchored** to a strong…concrete foundation…it's *propped*
(2) on…

Much previous research has referred to the use of grammar as a knowledge source on which readers draw during lexical inferencing (e.g., Bengeleil & Paribakht, 2004; Nassaji, 2003). For example, Bengeleil and Paribakht identify a category in their taxonomy "Sentence-level grammar", but do not elaborate on the parameters of this category. They provide only an example in which a participant makes explicit reference to the grammatical role played by a TW in their reading passage (p. 233). Nassaji, conversely, has defined the use of "grammatical knowledge" as being demonstrative of a participants' "knowledge of grammatical functions or syntactic categories, such as verbs, adjectives, or adverbs" (p. 656). However, as the examples drawn from data in the current study clearly show, grammar is more than a source of knowledge participants can draw upon during inferencing – participants' used it (explicitly or implicitly) to clarify their relationship to a text (through a word). Glyn uses grammar to infer the meaning of the TW but also to transform her understanding of the word's possible roles in a sentence. Moreover, Ishi's knowledge of grammar remains uncertain; the fact, however, that her inference occurs in the same verb form as the TW suggests that she has some awareness of the TW's characteristics. For these reasons, it is the position of the current study that the uses of grammar described by the category in the current study are distinct from those outlined by both Nassaji (2003) and Bengeleil and Paribakht (2004).

4.3.3 Discourse level moves

At the discourse level, the verbal report data collected in this study indicated that participants used two different types of reading moves: *using discourse context*, and *using visual inscriptions*. The common thread between these two types of moves is that they involve aspects of the text that go beyond the borders of the sentence in which the TW was located.

Using discourse context was a reading move participants displayed when they inferred a meaning based on a sentence immediately prior to or following the sentence containing the target word (Ex. 38 and 39), or when they drew upon something they read previously in the text to assist with inferring a target word's meaning (Ex. 40).

In example 38, Chai is attempting to infer the meaning of the TW **devastating**.

Ex. 38

(1) Chai: Although some are **deva…stating**, other may go unnoticed. It is important to be able to
(2) measure and compare the size of different earthquakes…I think this one maybe means
(3) like…difficult to…to…predict something…
(4) Res: OK. What makes you say difficult to predict?
(5) Chai: *Because for the second statement is that it is important to…like…the reason why they*
(6) *are going to measure and compare the size of different earthquakes maybe can help*
(7) *them to predict what the earthquakes is coming…next.*

Chai's inferred meaning of the TW as 'difficult to predict' (line 3), when asked about how it was generated (line 4), is based largely on her interpretation of the 'second statement' (line 5) – which here is a direct reference to the sentence following the one which contains the TW. Chai has thus looking beyond the local sentence context for clues to assist her inference.

Example 39 chronicles Fera's attempt to infer the meaning of the TW **varies**.

Ex. 39

(1) Fera: The strength of earthquake **varies** greatly. Although some are devastating, other may go
(2) un-…unnoticed. It is important to be able to measure and…compare the size of
(3) different…different quakes…ah!...this is differences…
(4) Res: Uh…which?
(5) Fera: Varies…
(6) Res: OK…how do you know…do you know this word or are you guessing?
(7) Fera: I'm guessing…
(8) Res: How do you know…how are you guessi-
(9) Fera: *'Cause…uh…different…uh…it is important to be able to measure and compare the size*
(10) *of different quakes…from this sentence…*

Her inference 'differences' (line 3) for the TW comes with assistance 'from this sentence' ('it is important to be able to measure the size of different quakes'; lines 9-10). The sentence Fera refers to occurs two sentences after the sentence in which the TW is situated. Thus Fera, like Chai, has read beyond the sentence containing the TW and has located a clue which she could use to assist her inference.

The final example comes from Joni's attempt to infer the meaning of the TW **inertia**.

Ex. 40

(1) Joni: You have just demonstrate a…principle known as…**in-er-teria**…defin-…defined as the
(2) tendency of a mass to stay at rest or continues moving unless the state of rest or motion
(3) is changed by external force…is it the…the word means what it is doing?
(4) Res: What what is doing?
(5) Joni: *Use the pen and the paper?*
(6) Res: Interesting…how did you know that?
(7) Joni: Because it say demonstrate and known as… this thing…

After mispronouncing the TW (line 1), a sign that it is likely new to her, Joni's initial inference occurs as a direct question to the researcher ('the word means what it is doing?'; line 3). When asked to clarify (line 4), Joni refers to 'the pen and the paper' (line 5). She is directly referring to a passage from the previous paragraph in which a way students can demonstrate the meaning of **inertia** using a pen and a piece of paper is suggested. Specifically, the word *demonstrate* was used at the beginning of the preceding

paragraph and is also used in the beginning of the excerpt in example 40 (line 1). Thus Joni's explicit mention of the word 'demonstrate' and the phrase 'known as' (line 7) are clear indications that she is aware of the relationship between the text of the previous paragraph and the text of sentence in which the TW **inertia** occurs.

In research which has investigated knowledge sources, this phenomenon has been referred to as "a specific part of the context beyond the sentence of the test word" and "global use of the text" (Haastrup, 1987), as "discourse knowledge" (Nassaji, 2003), and as "discourse meaning" (Bengeleil & Paribakht, 2004). Roskams (1998), while investigating inferencing processes, has referred to this type of process as "use discourse context i.e. outside the sentence in which the word occurred (using forward or backward context)" (p.70).

Using visual inscriptions[15] is a reading move through which students use a 'Figure' that accompanies the text to assist their inferring the meaning of a target word. Since an important focus of this study was to describe how visual inscriptions influence ESL students' inferences about unknown vocabulary, six different instances of participants' using inscriptions will be presented in this section. The examples illustrate how *just one* visual inscription (Figure 13.7; Appendix F) was used by participants during the process of inferring the meaning of four different TWs.

In the first example, Apple is attempting to infer the meaning of the TW **faint**. Its purpose in the general passage is to describe the type of 'ground motion' the Chinese instrument was able to detect. Up until the point at which this TW occurs in the reading

---

[15] This section is largely a reprint from: Deschambault, R. (2007). "Actually I saw this picture before": A closer look at international students' uses of visual inscriptions in making meaning from science text. In G. Reis, K. Moore, and T. Pelton (Eds.), *Connections '07 Conference Proceedings*. University of Victoria, Victoria, BC, Canada.

passage, the text has not specified that the adjacent visual inscription's relation to the sentence being read. Apple is thus either reading ahead to the point where the text refers to the Figure or knows to look to the inscription to assist with the inferencing task.

Ex. 41

(1) Apple: The Chinese invented an instrument sensitive enough to detect even very **faint** ground
(2) motion...'oes that mean…is that mean that the direction that?
(3) Res: OK. Direction – you think faint means direction? Why do you guess that? Or why do
(4) you think so?
(5) Apple: Because *I have seen this thing before (points to Figure 13.7)* in the textbook and the
(6) sentence…say some enough to detect even very faint ground motion…so I, because
(7) I… that words is like, you can, you can know when there is an earthquake and which
(8) direction is the earthquake…so I guess that is direction.

Apple begins her reference to the visual inscription by explicitly mentioning having 'seen this thing before' and physically signaling to it (line 5) in the reading passage. She then indicates that it is this prior knowledge of the inscription, coupled with the context of the sentence (lines 5-8), that is the source of her inference for the TW. However, we believe it is Apple's prior knowledge of the inscription that plays a more prominent role in her inference for the meaning of **faint**. Despite the fact that Apple does not think it relevant to mention in which textbook (line 5) she has previously encountered this inscription, the similarity between her inference and the one made by Chai (Ex. 42 below) is striking and suggests that they had been exposed to the image in a textbook in their L1.

In examples 42, 43, and 44, each participant is attempting to infer the meaning of the TW **jarring**. Like the TW **faint**, the purpose of the TW **jarring** in the general passage is to describe the type of ground movement that is required for the pendulum inside the instrument to swing – and in turn to release the ball[16]. Each of the three

[16] It should also be pointed out that the visual inscription has, at this point, been alluded to in the text as an additional source of information regarding the instrument.

participants indicates having some prior knowledge of the visual inscription, though the source of this prior knowledge is clear only in Chai's case (Ex. 42). In addition, both Chai and Joni (Exs. 43 and 44) attempt to utilize the inscription to facilitate their inferences, but instead of having a facilitating effect, their use of the inscription seems to confound their ability to correctly infer the meaning of **jarring**.

Ex. 42

(1) Chai: It consisted of an intricate arrangement of levers and wheels that released a ball in
(2) response to any kind of **jarring** movement…mmm… that direction?...oh! I mean… is
(3) that means different movement?...
(4) Res: Different movement?
(5) Chai: Yeah.
(6) Res: OK. So, what would make you sort of…guess that?
(7) Chai: Actually, I saw this picture before, and then I know that these animals means each
(8) direction, so maybe…for each direction…maybe the movement is different…so that's
(9) why when the balls goes down to each, to each animals which means the movement is a
(10) little bit different…yeah…like…because I study in, uh, XX[17] before…and then we are
(11) learning about the…the XX history so actually I saw this before…

Chai begins by inferring the meaning of this TW as 'direction' (line 2), and then recasts her inference to 'different' (line 3). She explicitly indicates having seen the inscription prior to the think-aloud task, and clearly bases her inference on what she has learned about this inscription in the past (lines 7-10). When asked where she has seen the picture prior to now, Chai indicates that it was in her country of birth, and that she had encountered it in a completely different content-area and context than the current one (lines 10-11).

[17] The location of the participant's prior country of study has been altered to maintain her anonymity (lines 10-11).

Ex. 43

(1) Joni: It consist of an in-trite…arrangement of levers and…wheels that release a ball in
(2) response to any kind of…**jarring** movement… is it mean this one? *(pointing to Figure*
(3) *13.7)*
(4) Res: This one what…?
(5) Joni: This *(pointing to the 'pendulum' in Figure 13.7)*…um…*long things in the instrument…*
(6) Res: Uh…are you *pointing to this picture*?
(7) Joni: *Yeah…*
(8) Res: OK… how is it helping you guess the meaning of this?
(9) Joni: Because it say released a ball…when… (whispering sentence to herself)…when
(10) the…the… this thing in the earthquake move and then *the ball will come out…*

Joni makes two physical signals that evidence her use of the visual inscription to assist her inference (lines 2-3, 5). Upon a request from the researcher, she qualifies her physical signals by specifying, both physically and verbally, that she means the 'pendulum' – the 'long things in the instrument' (line 5); she also mentions using the sentence context (lines 9-10) to assist her. Because the inscription depicts the pendulum's movement as being responsible for the ball dropping from the mouth of the dragon into the mouth of the frog, Joni has interpreted the TW to be a word referring to the pendulum.

Ex. 44

(1) Ishi: It consisted of an in-tri-cate arrangement of levers and wheels that released a ball in
(2) response to any kind of **jarring** movement… jarring is like…mmm…uh…heun-dul-li-
(3) neun[18]… like…uh…how to say…shaking movement…
(4) Res: Uh, do you know this or are you-
(5) Ishi: I don't know but I just guess it from the sentence…but the thing is *I already know about*
(6) *this instrument*…so…
(7) Res: Which instrument…?
(8) Ishi: The Chinese ins-…instrument…
(9) Res: OK…OK…*so you're pointing at this picture (Figure 13.7)*…
(10) Ishi: *Yes*, so…so I'm just guessing and like…*this instrument* detect the movement
(11) and…the…(to herself) goo-surl?…uh, *the ball will drop off*…and it detect it, an-

Ishi initially turns to her first language to assist her process of inferring ('heun-dul-li-neun'; lines 2-3), and seemingly uses this as a foundation for her inference 'shaking' (line 3). However, she then indicates using the sentence context (line 5), and

[18] Ishi has used her first langauge here. The text is a romanization of the pronunciation of that word. This is also applicable to the word 'goo-surl' in line 11 of this example.

that she has some degree of familiarity with the instrument (lines 5-6)[19]. Thus her 'guess' from the sentence has also been aided by her awareness of the workings of the Chinese instrument. Moreover, she seems to be aware of the grammatical function served by the TW in the context of the sentence – and this may have allowed her to have made both her first and English language inferences in the same grammatical form as the TW (e.g., as an adjective).

In Example 45, Chai is attempting to infer the meaning of the TW **vibrations**. As a noun in this sentence, **vibrations** is used as a synonym for the previously used words 'quakes' and 'movement', and in place of the previously used phrase 'ground motion'. It is important to keep in mind that chronologically, Chai has already used this particular inscription to infer the meaning of the preceding TW, and also that her prior knowledge of its function played a role in her previous inference.

Ex. 45

(1) Chai: …this device could not distinguish between large and small vibra…**vibrations**…small details?...
(2) Res: Details…so vibration is details…
(3) Chai: Yeah…
(4) Res: …and what do you mean…or, how do you know?
(5) Chai: I means like…because actually, at that time all of the people will know that like…that
(6) earthquake is coming because the ball fall down to the frog's mouth…
(7) Res: Uh-huh…
(8) Chai: But maybe they don't know like…why the, why the earth…like how the earthquake is
(9) like…how do you say…like, uh…what does it make…the earthquake to build up…

In this example, Chai's only reference to the inscription is indirect – in that she describes what is depicted in the inscription (line 7). When coupled with her response to the researcher's probe (lines 6-7), however, it becomes clear that she is using the visual inscription to explain why she believes the TW **vibrations** means 'details' (lines 9-10).

[19] Though we have not clarified it here, Ishi's reported prior knowledge is in regard to the 'Chinese instrument' – not with this particular inscription.

To do so, she creates a narrative about the limits of the types of knowledge this device could provide for users. Information regarding these limits is not given directly or supported in any way by the text (and yet her narrative is not erroneous on its own). As mentioned above, the textbook authors have used the TW **vibrations** in place of the previously used words 'quakes' and 'movement', and in place of the previously used phrase 'ground motion' – a technique about which it appears Chai is unaware.

In the final example for visual inscriptions, Fera is attempting to infer the meaning of the TW **cylindrical**.

Ex. 46

(1) Fera: Place a smooth, cylindrical object…this is like…pencil or piece chalk…
(2) Res: OK…
(3) Fera: Like this kind of…*(points to the 'pendulum' in Figure13.7)*
(4) Res: OK…mmm you've seen this word before?
(5) Fera: I think…I know what is cylinder…
(6) Res: Cylinder? OK…
(7) Fera: Yeah…so cylinder…cylindercal…might be like a thing…kind of looks like cylinder…

She makes a physical signal to indicate that she is using the visual inscription to assist her inference (line 3), but what is interesting about this particular example is that Fera is using only a small aspect of the inscription to assist her. That is, despite 'thinking' she knows what a cylinder is (line 5), she can quickly and efficiently refer to the inscription to assist her inference, and at the same time, do so without having to search for adjectives to describe the qualities of a cylinder. At the end of her turn (line 7), Fera provides a verbal description of her initial silent inference – but since she has used the visual inscription to indicate what a 'cylinder' is, she has created a referent for the researcher and does not need to describe its qualities. In addition, her move to use the inscription occurs in conjunction with a move that involves using the word's morphology (line 7) during the inferencing process. Finally, since this TW occurs on the second page

of the reading passage and is not located in the immediate vicinity of the visual inscription to which she refers, Fera has demonstrated a creative use of this inscription in her decision to utilize it for a purpose (we believe to be) unintended by the authors.

4.3.4 Prior knowledge level moves

Prior knowledge level moves were manifest by participants at the following three levels: *using content awareness*, *using world level*, and *using L1 awareness*. Referral to these bases of information during lexical inferencing was indicative of reading moves that involved the use of knowledge that could not have been obtained from the text.

Previous research on knowledge sources has identified a similar phenomenon; for example, "knowledge of the world" (Haastrup, 1987), "world knowledge" (Nassaji, 2003), and "non-linguistic sources" (Bengeleil & Paribakht, 2004) all refer to readers' prior knowledge of a topic, knowledge of the world, or knowledge that goes beyond the text. Roskams (1998) also includes "extra-textual (thematic or world) knowledge" in his taxonomy of readers' inferencing processes. Our category here resembles each of these, but is most similar to Bengeleil and Paribakht (2004), insofar as it is further subdivided into three categories. Bengeleil and Paribakht subdivide their "Non-linguistic sources" into "knowledge of topic", and "knowledge of medical terms" (2004, p. 231). Since our types of texts were different, we have borrowed the notion that categories of prior knowledge can be classified according to different criteria, and have included learners' first languages among this prior knowledge.

Using content awareness was identified in the data when students appeared to have drawn on their existing knowledge of any aspect of the general content that was

presented in the text. The first example is drawn from Chai's attempt to infer the meaning of the TW **jarring**.

Ex. 47

(1) Chai: It consisted of an intricate arrangement of levers and wheels that released a ball in
(2) response to any kind of **jarring** movement…mmm… that direction?...oh! I mean… is
(3) that means different movement?...
(4) Res: Different movement?
(5) Chai: Yeah.
(6) Res: OK. So, what would make you sort of…guess that?
(7) Chai: *Actually, I saw this picture before, and then I know that these animals means each*
(8) *direction, so maybe...for each direction...maybe the movement is different...so that's*
(9) *why when the balls goes down to each, to each animals which means the movement is a*
(10) *little bit different...yeah... like...because I study in, uh, XX*[20] *before...and then we*
(11) *are learning about the...the XX history so actually I saw this before...*

In Chai's case, using content awareness meant using her prior knowledge of one of the visual inscriptions in the text to assist her inference about the TW **jarring**. Her understanding that the frogs at the base of the Chinese instrument represented the direction from which the earthquake was coming played a fundamental role in her inference about the TW. Since this information was not included in the reading passage (nor the text from which it was adapted), prior content awareness does not appear to have assisted Chai in her ability to correctly infer the meaning of the TW.

In the next example, Glyn is also attempting to infer the meaning of the TW **jarring**.

Ex. 48

(1) Glyn: …and jarring movements…I don't know what it mean but maybe means shaking…
(2) Res: OK…and how would you guess the meaning of that?...
(3) Glyn: …any kind of jarring movement…*because I know when a...when a earthquakes comes...the ground like shaking...and moving* so I'm guess maybe that means that…

Glyn explicitly mentions not knowing the meaning of the TW, and yet she is able to guess the meaning of the TW (line 1). When asked how she was able to make this

[20] The location of the participant's prior country of study has been altered to maintain her anonymity (lines 10-11).

guess (line 2), she repeats a portion of the sentence containing the TW ('any kind of jarring movement') and indicates that she knows what happens 'when an earthquake comes' (line 3). By referring to what she 'knows' about earthquakes, Glyn is using prior content awareness to assist with her inference.

Using world awareness was identified in the data when students drew on their life experience to assist them while inferring meaning of TWs. The first example is drawn from Glyn's attempt to infer the meaning of the TW **anchored**.

Ex. 49

(1) Glyn: The rest of the instrument is…**an-chored** to a strong…con-srete…concrete foundation
(2) …during a tremor, the susp-…the suspending mass tends to stay in one place
(3) as the ground…vee-…vi-, vibrates under it… because of its iner-…inertia, the mass
(4) become the stationary reference point…sensors measure the difference in movement
(5) between the ground and the stationary mass…the amplitude of motion is electron-
(6) …electronically…magni-fied up to…one hundred thousand times and recor-…recorded
(7) by the vib-…vibrations of pen over a roll of paper
(8) Res: OK…so anchored…
(9) Glyn: Um…it's…you…you put it on something and use something to make it stick…like a…
(10) you can use a hammer to make it stay…
(11) Res: OK…do you know this word or are you guessing?
(12) Glyn: I'm guessing…uh, yeah…um…*because I've done this kind of work before…*
(13) Res: You mean making a seismogram, or…?
(14) Glyn: *No, like…when we use a…automatic… pencil sharpener…*
(15) Res: Yeah-
(16) Glyn: You have to…anchor it on a foundation… and then you can use it…

After reading the entire paragraph, Glyn infers the meaning of the TW as 'you put it on something and use something to make it stick' (line 9). She indicates having no prior knowledge of the TW, but refers to her world awareness as being of assistance to her inference ('I've done this kind of work before'; line 12). She goes further and specifies what type of experience she has drawn on to assist the inference ('automatic pencil sharpener'; line 14), and indicates that it, like the seismograph, must be anchored 'on a foundation' (line 16).

The next example is taken from Joni's inferring of the TW **vibrations**.

Ex. 50

(1) Joni: Although it was more sensitive than human sense, this device could not…distinguish
(2) between large and small…**vibration**…um… like…how to say…um…*like a*
(3) *movement?... in a cellphone…*

Her inferred meaning for this TW 'like a movement', despite being made in the form of a question to the researcher (line 2), is supported by a reference to her cellphone (lines 2-3). Joni is referring to a ring setting on her cellphone called **vibration**. She knows that when she sets her cellphone to this mode, instead of ringing the phone vibrates. This world awareness has assisted her ability to infer the meaning of the TW.

Using L1 awareness was identified in the data when participants used their L1 to assist them in any way while inferring the meaning of a TW. The first example is taken from Apple's attempt to infer the meaning of the TW **anchored**.

Ex. 51

(1) Apple: The rest of the instrument is **anchored** to a strong concrete function...the rest of the is
(2) anchored to a strong concrete function…(begins the next sentence)…During a tremor,
(3) the suspended mass tends to stay in one place as the ground vibrates under it…
(4) (whispering to herself)…its anchored to a strong…I think its...*kkok-daeng*…
(5) Res: Is what? Sorry?
(6) Apple: *Kkok-daeng*.
(7) Res: Can you explain what that does? Or what it is?
(8) Apple: Like, I think its, its, like, uhmmm…like maybe like this (pointing to Figure 13.9),
(9) anchor this means, like this make it, like, doesn't move

After repeating the sentence which contains the TW (lines 1-2), Apple begins reading the next sentence to search for clues to assist her inference (line 2). She makes it part of the way through (lines 2-3), and again repeats a phrase from the initial sentence (line 4). She then infers a meaning for the TW in her L1 (''kkok-daeng'; lines 4, 6). When asked to try and explain what 'kkok-daeng' is a reference to (line 7) Apple hedges, uses a physical signal and the inscription accompanying the text (line 8), and is finally able to recast her L1 inference in her L2 English as 'make it, like, doesn't move' (line 9).

In the second example, Ishi is attempting to infer the meaning of the TW **varies**.

Ex. 52

(1) Ishi: The strength of earthquakes **varies** greatly… varies means different from others…like
(2) kind of there's a *dahn-ghay*…
(3) Res: OK…there's a dahn-ghay…how-…do you know this word or are you guessing…?
(4) Ishi: I know, but like I don't know how to express in English…so…

This example is different from the previous one insofar as where Apple moved from her L1 to her L2 English, Ishi moves from her L2 English to her L1. Ishi begins by inferring the meaning of the TW as 'different from others' (line 1), but immediately recasts it as 'dahn-ghay' (line 2) – suggesting that she is not satisfied with her L2 English inference. When asked to elaborate on her knowledge of the TW and her inference (line 3), she hedges by indicating that although she knows the TW she is unable to express accurately what it means in her L2 English (line 4).

The use of L1 during lexical inferencing has been referred to as an "Interlingual" (Bengeleil & Paribakht, 2004; Haastrup, 1987) or "L1" knowledge source (Nassaji, 2003) in previous taxonomies of readers' sources of knowledge during lexical inferencing. Nassaji (2003) defines the use of L1 knowledge as "attempting to figure out the meaning of the new word by translating or finding a similar word in the L1" (p. 656); Haastrup (1987) defined "Interlingual" cues as "cues based on L1, loanwords in L1 or knowledge of foreign languages other than English" (p. 199). Finally, Bengeleil and Paribakht (2004) refer to two types of "Intralingual" knowledge sources – one which draws on students' uses of "lexical knowledge" or "word collocation" in their L1. The category in the current study most resembles Nassaji's (2003) categorization of this phenomena, however minor differences still exist.

Whereas Nassaji has referred to students' L1 as a knowledge source, in the current study students used this knowledge source in strategic ways, and in turn they used it in conjunction with other reading moves (or knowledge sources or strategies). This is apparent in the example from Apple's transcript, where she clearly uses the visual inscription to support her first language inference, and the combination of the two produces an inference about the TW's meaning in English. Thus the categorization of this phenomenon by the current study is distinct from Nassaji's (2003) categorization.

4.4 Summary

This chapter has offered a description and explanation of the different types of lexical inferences identified in the verbal report data generated by participants in the current study. In doing so, it has provided at least two examples of each type of inferencing move, and has attempted to indicate the ways in which these categorizations are similar to and distinct from previous research on the same topic. Chapter 5 will present some of the different patterns that were discernible once these categories had been identified and enumerated.

Chapter 5 Patterns in the Data

The objective of the first section of this chapter is to investigate the overall frequencies and percentage of uses of moves made by participants in this study. To do this, a comparison of regulatory and heuristic moves is made (subsection 5.1.1). This is followed by a comparison of the overall use of Text- and Context-based moves (subsection 5.1.2), and then of Word, Sentence, Discourse, and Prior Knowledge level moves (subsection 5.1.3). Given the researcher's interest in participants' use of visual inscriptions during lexical inferencing, subsection 5.1.4 presents the types and frequencies of moves used in conjunction with visual inscriptions. Subsection 5.1.5 examines the mean numbers of moves made by individual participants.

The second section (5.2) of this chapter deals with group uses of moves. This entails a presentation and analysis of the trends in group uses of categories of moves (subsection 5.2.1), an analysis of the trends in the use of sub-categories of moves between (subsection 5.2.2) and within (subsection 5.2.3) groups.

The third section (5.3) of this chapter presents results that are related to students' anticipated use of lexical inferencing and visual inscriptions in a science reading task, as they were obtained through the use of the SORS. The final section (5.4) offers a summary of the chapter.

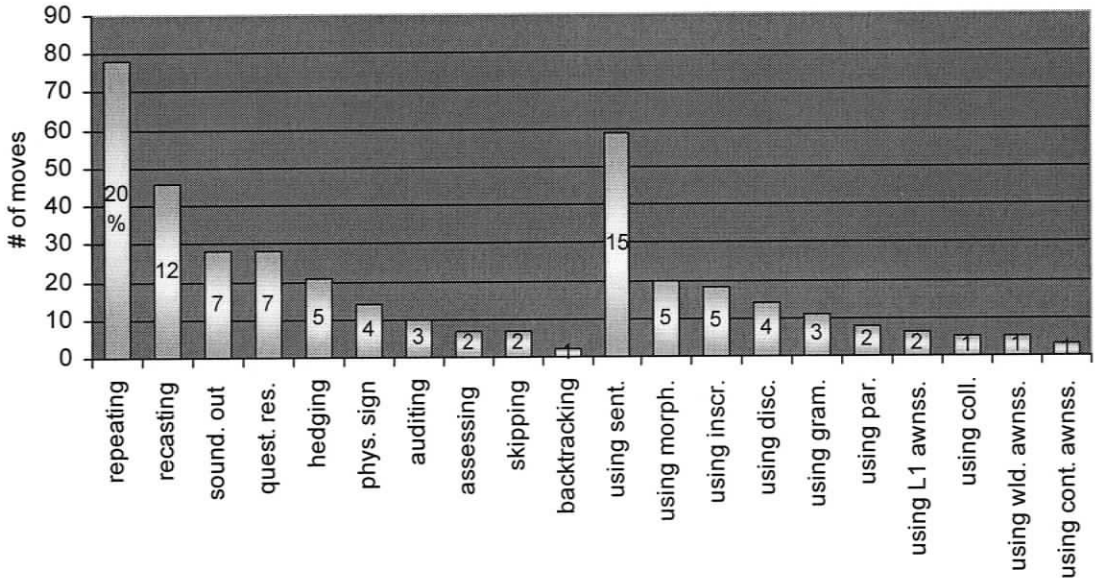
5.1 Overall frequencies and percentages of uses of moves

5.1.1 Regulatory vs. heuristic moves

Figure 1 below visually represents the frequency of use (y-axis) of each type of *Regulatory* (x-axis, left side) and *Heuristic* move (x-axis, right side), and the percentage of overall use (%) of each type of move among the total number of moves (both

regulatory and heuristic). Percentages were calculated by dividing the frequency of each reading move by the total number of reading moves (390) and then multiplying by 100. All percentages are rounded, and thus may not total exactly 100.

Figure 1. Overall frequency and percentage of use of types of regulatory and heuristic reading moves



Repeating (78; 20%) was the most often used type of regulatory reading move, followed by *recasting* (46; 12%), *sounding out* (28; 7%), *questioning to researcher* (28; 7%), *hedging* (21; 5%), *physical signalling* (14; 4%), *auditing* (10; 3%), *assessing* (7; 2%), *skipping* (7; 2%), and *backtracking* (2; 1%).

The frequencies of heuristic reading moves, conversely, were: *using sentence context* (59; 15%), *using morphology* (20; 5%), *using inscriptions* (18; 5%), *using discourse context* (14; 4%), *using grammar* (11; 3%), *using parallels* (8; 2%), *using L1 awareness* (6; 2%), *collocating* (5; 1%), *using world awareness* (5; 1%), and *using content awareness* (3; 1%).

Overall, the participants in this study used more Regulatory (241; 62%) than they did Heuristic (149; 38%) moves. Among the top ten most frequently used moves were six regulatory (*repeating, recasting, sounding out, questioning the researcher, hedging, and physical signalling*) and four heuristic moves (*using sentence context, using morphology, using inscriptions, and using discourse context*).

5.1.2 Text-based vs. context based moves

Overall, text-based moves were used much more frequently (178; 46%) than were context-based moves (63; 16%). Specifically within the meta-category regulatory moves, text-based moves accounted for almost three quarters (178; 74%) of the total moves, whereas context-based moves accounted for just over one quarter (63; 26%).

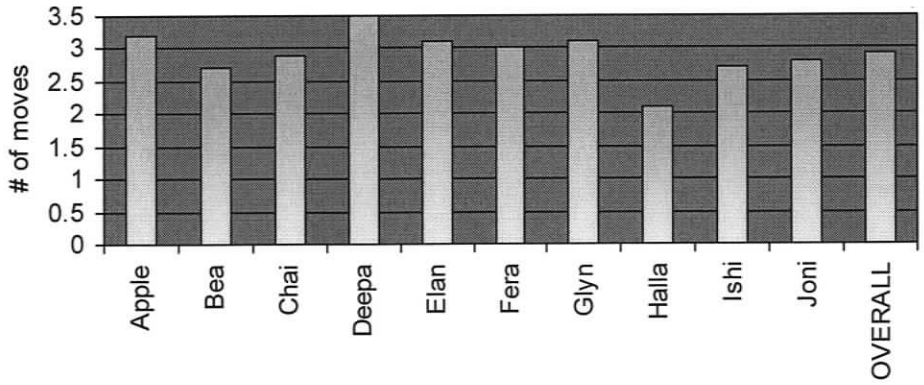
5.1.3 Word level vs. sentence level vs. discourse level vs. prior knowledge level moves

Overall, sentence level moves (70; 18%) were used most often by participants, followed by word level (33; 8%), discourse level (32; 8%), and prior knowledge level moves (14; 4%). Specifically within the meta-category heuristic moves, sentence level moves accounted for almost half of the total moves (70; 47%). These were followed by word level (33; 22%), discourse level (32; 21%), and prior knowledge level moves (14; 9%).

5.1.4 Numbers of moves made by individual participants

While it was the case that some participants used single moves to infer the meaning of a TW, in most cases participants relied on several different moves (two to seven) to assist their guessing the meaning of an unknown TW. Figure 2 illustrates the mean number of moves made by each of the participants in the study per TW.

Figure 2. Mean number of moves per TW by individual participants



As the figure indicates, the mean number of moves made by each of the participants in the study was strikingly similar, with the overall mean number of moves being slightly less than three (2.8). This relative uniformity was puzzling, especially given that the groups of participants had been placed in different classes at their school according to proficiency in their L2. Thus, analysis based on this placement was carried out in an attempt to compare and look for trends in individual and group uses of moves at the level of category and sub-category.

Regulatory moves. Table 7 shows the number of sub-categories of regulatory moves made by each individual participant in the study, and segregates the participants into different groups so that they may be referred to during the analysis of group moves.

Table 7. Uses of sub-categories of regulatory moves

	Mainstream class						***Transition class***			
Regulatory moves	Chai	Deepa	Elan	Fera	Glyn	Ishi	Apple	Bea	Halla	Joni
Text-based										
repeating	*4*	*7*	*12*	*7*	*13*	*7*	*12*	*8*	*2*	*6*
sounding out	*2*	*4*	*2*	*1*	*3*	*6*	*3*	*2*	*3*	*2*
skipping	*1*	*0*	*1*	*0*	*2*	*1*	*2*	*0*	*0*	*0*
auditing	*1*	*3*	*2*	*1*	*2*	*0*	*1*	*0*	*0*	*0*
backtracking	*0*	*1*	*0*	*0*	*1*	*0*	*0*	*0*	*0*	*0*
recasting	*7*	*5*	*5*	*6*	*4*	*4*	*4*	*5*	*3*	*3*
assessing	*0*	*1*	*1*	*1*	*0*	*1*	*0*	*0*	*0*	*3*
Context-based										
physical signalling	*3*	*1*	*0*	*1*	*0*	*1*	*3*	*1*	*3*	*1*
questioning the res.	*6*	*4*	*1*	*3*	*1*	*7*	*3*	*2*	*1*	*0*
hedging	*1*	*0*	*3*	*5*	*2*	*2*	*1*	*2*	*0*	*5*
Individual Totals	***25***	***26***	***28***	***25***	***27***	***29***	***29***	***20***	***12***	***20***
Group Total	***160***						***81***			

The distribution of uses of regulatory moves among individuals appeared fairly even for *repeating*, *sounding out*, *recasting*, *physical signalling*, *questioning the researcher*, and *hedging*. Repeating was used a minimum of twice by each participant, as was sounding out. In the case of *questioning the researcher*, only one of ten participants

did not make use of this move; two of ten participants did not make any use of *hedging* or *physical signalling*. For each of the moves *skipping*, *auditing*, *backtracking*, and *assessing*, however, the distribution was substantially uneven due to the fact that four or more of the ten participants were not observed making use of these particular moves in the verbal report data.

A comparison of the total number of regulatory moves made by all participants reveals that the range of moves demonstrated by all participants was between 12 and 29, suggesting either individual preferences for regulatory moves or differences in the level of L2 proficiency among participants.

Heuristic moves. Table 8 shows the number of sub-categories of heuristic moves made by each individual participant in the study, and segregates the participants into different groups so that they may be referred to during the analysis of group moves.

Table 8. Uses of sub-categories of heuristic moves

	Mainstream group						***Transition group***			
Heuristic moves	Chai	Deepa	Elan	Fera	Glyn	Ishi	Apple	Bea	Halla	Joni
Word level										
using collocation	*0*	*1*	*0*	*0*	*2*	*0*	*1*	*0*	*0*	*1*
using morphology	*4*	*1*	*4*	*2*	*0*	*2*	*1*	*0*	*4*	*2*
using parallels	*2*	*1*	*0*	*1*	*1*	*2*	*0*	*1*	*0*	*0*
Sentence level										
using sent. context	*3*	*4*	*8*	*6*	*8*	*6*	*6*	*9*	*5*	*4*
using grammar	*0*	*2*	*1*	*0*	*6*	*0*	*0*	*0*	*0*	*2*
Discourse level										
using disc. context	*2*	*2*	*1*	*2*	*1*	*1*	*1*	*2*	*1*	*1*
using vis. inscriptions	*2*	*1*	*2*	*1*	*1*	*2*	*3*	*2*	*2*	*2*
Prior know. level										
using cont. awareness	*1*	*0*	*0*	*0*	*0*	*0*	*1*	*0*	*0*	*1*
using L1 awareness	*0*	*0*	*0*	*2*	*0*	*0*	*2*	*0*	*0*	*2*
using wld. awareness	*0*	*0*	*0*	*0*	*2*	*1*	*1*	*0*	*0*	*1*
Individual Totals	***14***	***12***	***16***	***14***	***21***	***14***	***16***	***14***	***12***	***16***
Group Total	***91***						***58***			

Where heuristic moves were concerned, the distribution of moves among individuals appeared fairly even for *using morphology, using sentence context, using discourse context,* and *using visual inscriptions*. Only two of ten participants were not observed *using morphology* in the verbal reports. All participants were observed *using sentence context* on three or more occasions in the data; *using discourse* context and *using visual inscriptions* were both used at least once by all participants in the study. *Using collocation, using parallels, using grammar, using content awareness, using L1 awareness*, and *using world awareness*, however, were not as evenly distributed. In the case of each of these moves, four or more participants failed to display use in the verbal report data.

A comparison of the total number of heursitic moves made by all participants reveals that the range of moves demonstrated by all participants was between 12 and 21, suggesting either individual preferences for heuristic moves (e.g., Glyn's six uses of grammar) or differences in the level of L2 proficiency among participants.

5.2 Group uses of moves

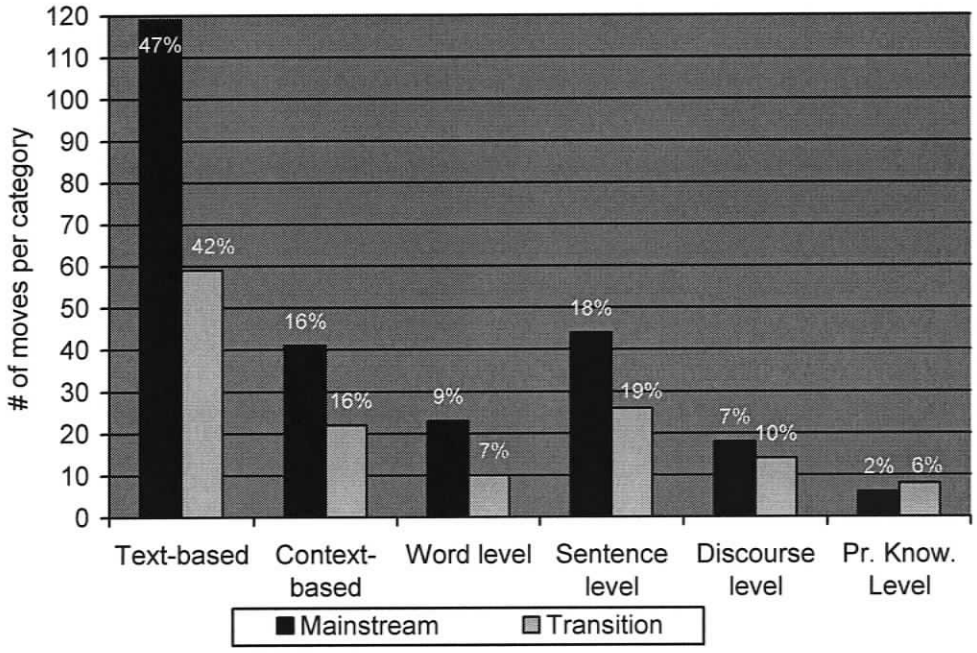
5.2.1 Group uses of categories of moves

Two important points about the division of participants into groups deserve mention. The first is that was presumed that students' placement in either the Mainstream or Transition class occurred on the basis of language proficiency. The second is that it so happened that each of the participants in the Transition group had been studying in Canada for a year or less at the time data was collected, and thus had a shorter length of residence in Canada than had the students in the Mainstream class. Each of the

mainstreamed students (aside from Glyn[21]), conversely, had been studying in Canada for at least 1.5 years or more at the time data was collected.

Figure 3 illustrates both the number of moves (y-axis) in each category (x-axis) made by the different groups of participants, as well as the proportional percentages (%) of use for each of the groups. Proportions were used to mitigate potential distortions in comparisons resulting from differences in group size, and were calculated by dividing the total number moves made by a group in a particular category (e.g., Text-based moves) by the total number of moves made by the same group overall.

Figure 3. Group uses of categories of moves



The rank order of use of categories of moves for the Mainstream group was as follows: text-based (47%), sentence level (18%), context-based (16%), word level (9%), discourse level (7%), and prior knowledge level (2%). The order for the Transition group

[21] Glyn, who, despite having studied in Canada for only 3-4 months at the time data was collected, was placed in a mainstream class.

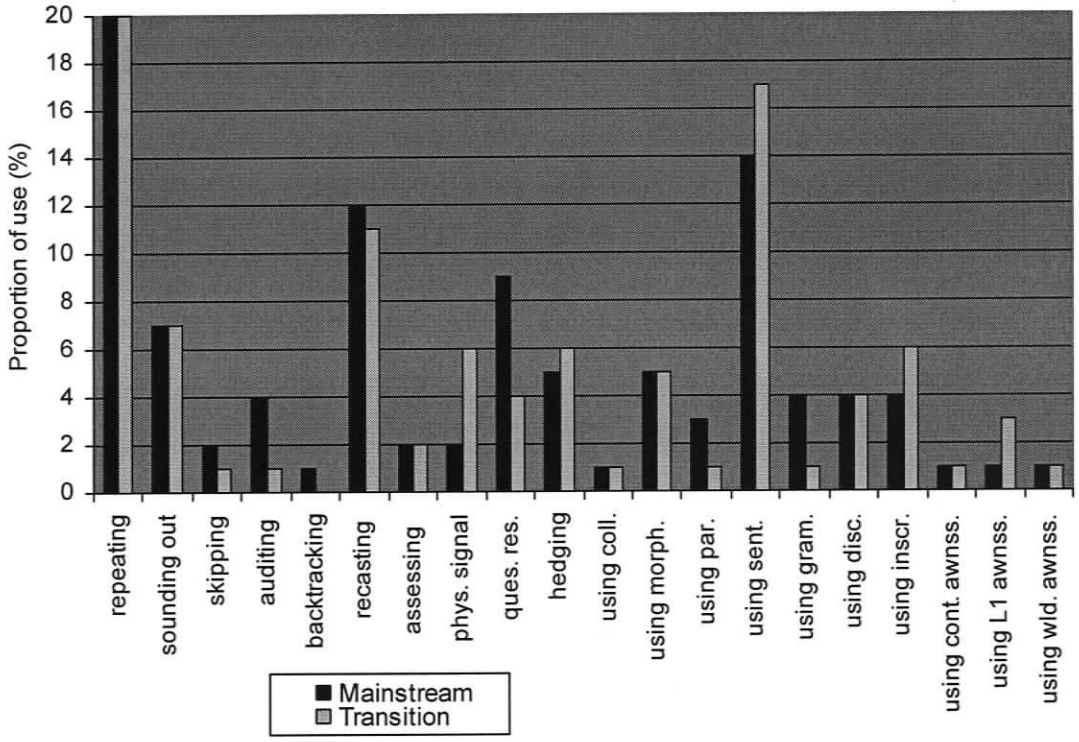
was: text-based (42%), sentence level (19%), context-based (16%), discourse level (10%), word level (7%), and prior knowledge level (6%).

In contradistinction to the remarkably similar order of use of categories of moves between the two groups, discrepancies in the order of use of word and discourse level moves, as well as differences in the proportion of use of prior knowledge level moves, prompted an examination of trends at the sub-categorical level.

5.2.2 Trends in the use of sub-categories of moves between groups

To further investigate for trends in uses of moves, proportions were calculated to compare the use of sub-categories of moves between groups. Again, proportions were used to mitigate potential distortions in comparisons resulting from differences in group size, and were calculated by dividing the number of uses of a sub-category (e.g., repeating) by the total number of overall moves made by the group. Figure 4 shows a comparison of the group proportions (for moves ≥5%) of uses moves at the sub-categorical level.

Figure 4. Proportion of use of sub-categories of moves by groups



The rank order of use of sub-categories of moves (≥5%) for the Mainstream group was as follows: *repeating* (20%), *using sentence context* (14%), *recasting*, (12%), *questioning the researcher* (9%), *sounding out* (7%), *hedging* (5%), and *using morphology* (5%). For the Transition group, the order was: *repeating* (20%), *using sentence context* (17%), *recasting* (11%), *sounding out* (7%), *physical signalling* (6%), *hedging* (6%), *using visual inscriptions* (6%), and *using morphology* (5%).

Noticeably absent from the Transition group's list of moves is *questioning the researcher*; likewise, absent from the Mainstream group's list of moves are *physical signalling* and *using visual inscriptions.* All other moves in these two lists, despite some minor differences in proportions of use, are identical.

5.2.3 Trends in the use of sub-categories of moves within groups

Regulatory moves. A comparison of the total number of regulatory moves made by the individuals in each respective groups (Table 7) reveals that the range of moves for the Mainstream group was between 25 and 29, and for the Transition group was between 12 and 29.

For the Mainstream group, proportions of use of regulatory were calculated to compare the differences in uses of moves by members of similar groups. These calculations were made by dividing the number of moves made by an individual member by the total number of regulatory moves made by the group (160). Ishi had the highest proportion of moves among the group (18%), followed by Elan (18%), Glyn (17%), Deepa (16%), Fera (16%), and Chai (16%)[22]. These proportions suggest that no large differences in the use of regulatory moves existed between the members of this group.

For the Transition group, proportions were calculated by dividing the number of moves made by an individual member by the total number of regulatory moves made by the group (81). In this group, Apple had the highest proportion of moves (36%), followed by Bea (25%), Joni (25%), and Halla (13%). These proportions suggest that only Bea and Ishi used regulatory moves to similar extents. The proportions also suggest differences in the use of moves between: Apple and Bea/Joni, Bea/Joni and Halla, and Apple and Halla.

Heuristic moves. A comparison of the total number of regulatory moves made by the individuals in each respective groups (Table 8) reveals that the range of moves for the Mainstream group was between 12 and 21, and for the Transition group was between 12 and 16.

---

[22] When totaled, these proportions add to 101. This is due to the rounding of proportions to the nearest whole.

For the Mainstream group, proportions were calculated by dividing the number of moves made by an individual member by the total number of regulatory moves made by the group (91). Glyn made the highest proportion of heuristic moves (23%), followed by Elan (18%), Chai (15%), Fera (15%), Ishi (15%), and Deepa (13%).

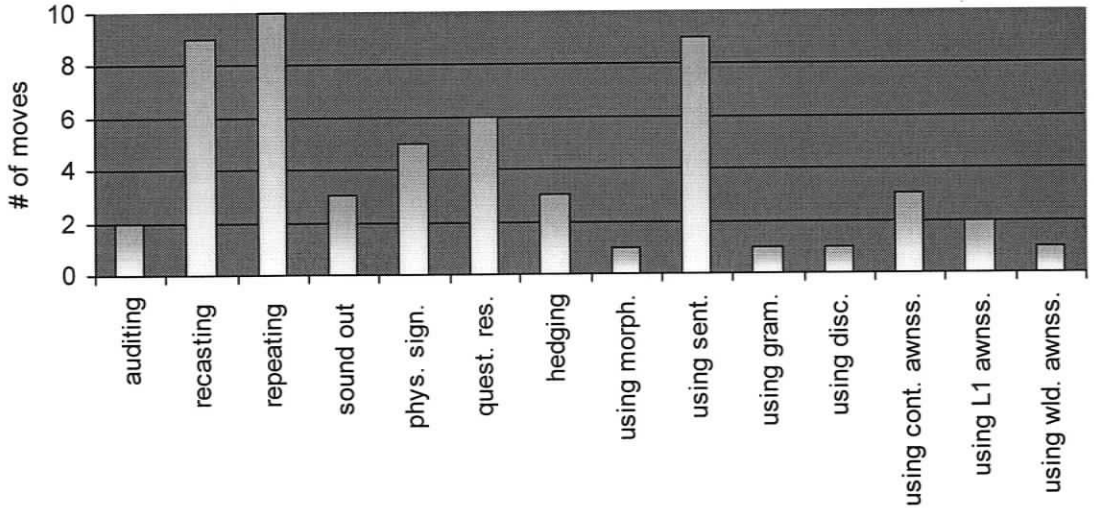
For the Transition group, proportions were calculated by dividing the number of moves made by an individual member by the total number of regulatory moves made by the group (58). Apple and Joni made equally high proportions of heuristic moves (28%), and were followed by Bea (24%) and Halla (21%).

5.3 Uses of moves with visual inscriptions

5.3.1 Type and frequency of moves used in conjunction with visual inscriptions

Given the salience of visual inscriptions in the current study, it was important to examine which types of moves, and with what frequency, were used in conjunction with visual inscriptions during participants' lexical inferencing.. Figure 5 illustrates these types (x-axis) and frequencies (y-axis).

Figure 5. Type and frequency of moves used in conjunction with visual inscriptions



As reported in subsection 5.1.1, a total of 18 uses of visual inscriptions were counted in the verbal report data. In each of these instances, participants also used between two and six other moves in conjunction with one of the visual inscriptions accompanying the text in their attempt to infer a TW's meaning. Overall, 55 moves were used in conjunction with an inscription when attempting to infer the meaning of a TW.

Repeating was the most common move used in conjunction with inscriptions (10; 18%). This was followed by *using sentence context* (9; 16%), *recasting* (9; 16%), *questioning the researcher* (6; 11%), *physical signalling* (5; 9%), *sounding out* (3; 5%), *hedging*, (3; 5%), *using content awareness* (3; 5%), *auditing* (2; 4%), *using L1 awareness* (2; 4%), *using morphology* (1; 2%), *using grammar* (1; 2%), *using discourse context* (1; 2%), and *using world awareness* (1; 2%).

5.4 SORS data relating to lexical inferencing and the use of visual inscriptions

Three items from the SORS targeted participants' anticipated use of lexical inferencing and visual inscriptions as facilitative aids during a science reading task. The mean, median, and mode for each of these items are presented below.

5.4.1 Guesses about the meaning of unknown words or phrases

Table 9 illustrates that this item elicited responses ranging from 3 to 5. The most reported score was 3 – indicating that the participant 'sometimes did this'. However, six of ten participants indicated a score of 4 or above.

Table 9. Responses to SORS item targeting lexical inferencing

Mainstream group						***Transition group***				***OVERALL***		
Chai	Deepa	Elan	Fera	Glyn	Ishi	Apple	Bea	Halla	Joni	Mean	Med.	Mode
3	*4*	*5*	*4*	*3*	*3*	*5*	*5*	*3*	*4*	*3.9*	*4*	*3*

5.4.2 Use of tables, figures, and pictures in text to increase understanding

Table 10 illustrates the range of responses to be between 2 and 5, and again that the most reported score was 3. Four participants reported a score of three however, while scores of 2, 4, and 5 were all reported by two participants.

Table 10. Responses to SORS item targeting the use of visual inscriptions

Mainstream group						***Transition group***				***OVERALL***		
Chai	Deepa	Elan	Fera	Glyn	Ishi	Apple	Bea	Halla	Joni	Mean	Med.	Mode
2	*3*	*4*	*4*	*2*	*5*	*5*	*3*	*3*	*3*	*3.4*	*3*	*3*

5.4.3 Use of tables, figures, and pictures to help guess the meaning of unknown words or phrases

Table 11 indicates responses ranging from 1 to 5. The most reported score for this item was 4, with two responses occurring above it and four occurring below. Overall, six of ten participants reported 'usually' or 'always' using visual inscriptions for the explicit purpose of helping them infer the meaning of unknown lexical items in science text.

Table 11. Responses to SORS item targeting the use of visual inscriptions to assist with lexical inferencing

Mainstream group						***Transition group***				***OVERALL***		
Chai	Deepa	Elan	Fera	Glyn	Ishi	Apple	Bea	Halla	Joni	Mean	Med.	Mode
1	*4*	*4*	*5*	*2*	*5*	*4*	*4*	*2*	*3*	*3.4*	*4*	*4*

5.5 Summary

This chapter has responded, in its own way, to the research questions laid out in Chapter one (section 1.3).

Sections 5.1 and 5.2 presented patterns in the categories of moves made by participants in this study. This response to the second guiding research question revealed

that: regulatory moves were used more often that heuristic moves overall; all participants used a similar number of moves per TW; the order of use of categories of moves between groups was virtually identical; the top three sub-categories used by either group were identical to those used most frequently overall, and that differences between groups regarding questioning the researcher, physical signalling, using visual inscriptions existed; some within group differences existed in the cumulative use of regulatory and heuristic moves.

Section 5.3 presented the types of moves used in combination with visual inscriptions, responding in short to the second guiding research question. It was found that the most frequently used moves with inscriptions mirrored the most frequently used moves overall.

Finally, section 5.4 responds to the first guiding research question by discussing participants' responses to the SORS items relating to the use of lexical inferencing.

Chapter 6 Discussion and Implications

6.1 Overview

This first part of this chapter is divided into sections based on the research questions used to guide the description of ESL middle school learners' lexical inferencing moves and uses of inscriptions when interacting with science text. Section 6.2 presents the findings relevant to research question #2 "What kinds of inferencing and comprehension moves do middle school ESL students employ when they encounter unknown vocabulary in a science textbook passage?", section 6.3 focuses on the findings relevant to research question #1 "How do visual inscriptions influence ESL students' lexical inferences when they encounter unknown vocabulary in science textbook passages?", and section 6.4 focuses briefly on the findings relevant to research question #1 "Are lexical inferencing and the use of visual inscriptions among the general reading comprehension strategies middle-school ESL students anticipate using during a science reading task?".

The second part of this chapter offers suggestions for future research (section 6.5) and provides a brief discussion of the pedagogical implications of this research (section 6.6). Following this, some final thoughts about the research are given (section 6.7).

6.2 Research question #2: What kinds of inferencing and comprehension moves do middle school ESL students employ when they encounter unknown vocabulary in a science textbook passage?

In order to address this question qualitatively, a taxonomy was developed that categorized the moves participants made during lexical inferencing. This taxonomy (Table 6) consisted of two meta-categories, six categories, and 20 sub-categories of moves that were identified in participants verbal report data, and was developed as a

device to aid the description of how middle school ESL learners coped with unknown vocabulary during a science reading task. An important result of the creation of this taxonomy of moves was the identification and development of five sub-categories of moves that have hitherto remained unidentified in taxonomies purporting to describe L2 lexical inferencing. These sub-categories are: (1) recasting, (2) physical signalling, (3) questioning the researcher, (4) hedging, and (5) using visual inscriptions.

In order to address the above question through a quantitative lens, orders of use and proportions were calculated at the meta-category, category and sub-category levels.

6.2.1 Overall use of moves

The overall high frequency of use of *repeating* by participants in this study is consistent with the findings of previous lexical inferencing research (Nassaji, 2003) and previous work on the comprehension monitoring strategies of EFL learners (Katib, 1997). The overall high frequency of *using sentence context* is also consistent with previous research on lexical inferencing (Bengeleil & Paribakht, 2004; Huckin & Bloch, 1993).

Notably, all five of the sub-categories of moves that are unique in this current description of lexical inferencing occurred among the top ten most frequently used moves. Most frequent among these five was *recasting*, followed by *sounding out*, *questioning the researcher*, *hedging*, *using visual inscriptions*, and *physical signalling*. Of particular interest are the Context-based moves – since the current study argues that they are uniquely linked to the social nature of reading, the research context, and the data collection method.

Physical signalling was shown to stand in place of a verbal description of the meaning of the TW (sub-section 4.2.2, Ex. 19), and alternatively, as a mode of

augmenting an inferred meaning so as not to have to explain further (Ex. 18). In both of these cases, use of signal would not occur if an 'other' – namely the researcher – was not present. Halla (Ex. 19) would most likely have referenced the picture visually as opposed to physically; Chai (Ex. 18) would not likely have gestured to herself to reinforce the meaning of her own inference.

Questioning the researcher (subsection 4.2.2, Ex. 20-21) occurred despite the fact that participants were instructed that the researcher would not answer direct questions about the veracity of an inferred meaning. This suggests that participants were attempting to tap the social context in which reading was occurring – in this case as a lexical inferencing task in a research study – to look for contextual clues with which they could regulate what they felt to be a suitable completion of the task. Through observation of the researcher's physical reactions to an inferred meaning, or through close attention to the researcher's tone of voice in response to an inference or during the use of probes, participants could obtain non-verbal feedback with which they could evaluate the suitability of their inferred meaning. Further evidence that supports this interpretation comes from the open-ended interviews; the second most reported answer in response to the question '*What strategies do you use to solve science reading problems?*' was to seek assistance from a more competent peer or their teacher. It is likely that the researcher, given the situation, represented the more competent peer in this situation. Moreover, the most reported strategy in the open-ended interviews – using an electronic dictionary – was not permitted during the reading task.

Hedging (subsection 4.2.2, Ex. 22-23) was used even though learners were aware that they were not being assessed on the goodness-of-fit of the inferences they made. As

such, it was a move used to indicate self-consciousness about correct completion of the task (Ex. 22), or alternatively as an outward indication of being exasperated by the inferencing task (Ex.23). In either case, it is clear that the use of this move presupposes the presence of an 'other', and thus is indicative of participants' subtle use of social context to assist in the (self-conscious) completion or regulation of the lexical inferencing task.

Regulatory and heuristic moves. Overall, individuals in this study used a greater number of regulatory moves than they did heuristic moves. The greater use of regulatory moves was likely a result of participants consistently needing to position themselves in relation to the problem they had been given; that is, the use of regulatory moves was the way participants figured out how to best approach not only the TW but the inferencing task and the research context as well. The high number of regulatory moves was not, however, strictly the result of the use of moves that were related to devising and analysing guesses about TWs; rather, the high frequency was related to a "word-based approach to lexical inferencing" (Nassaji, 2003, p. 663), the provision of multiple versions of inferences, and attempting to interact with the researcher regarding their inferred meanings.

The more frequent use of regulatory as opposed to heuristic moves suggests that lexical inferencing may have been a relatively new or somewhat difficult task for participants.

The 'relatively new' interpretation is supported by the fact that all students, during the open-ended interviews, admitted using their electronic dictionaries before resorting to any other means when they encountered an unknown word during science

reading. While previous literature in the field of L2 lexical inferencing has shown that it is a favoured strategy for guessing the meaning of unknown words while reading among adult learners (Paribakht, & Wesche, 1999; Fraser, 1999) – this was clearly not the case for learners in this study. The findings of this study imply that age plays a role, as do a number of other factors (e.g., experience reading expository text[23]) in the preference for using this method of dealing with unknown lexical items during reading.

The 'somewhat difficult' interpretation is supported by the fact that despite the mode score of 3 for the SORS item 'When I read, I guess the meaning of unknown words or phrases' – the majority of participants anticipated some use of lexical inferencing during the task. The more frequent use of some regulatory strategies may be related to L2 proficiency or participants' development thereof; more effort was needed to manage the task than to actually work with the overall meaning of the TWs in relation to the text. In concert with the likelihood that lexical inferencing is still a developing skill amongst the participants in this study, the comparatively low overall use of heuristic moves by the participants also suggests that they are still in the developmental stages of becoming 'skilled L2 readers'. Skilled L2 readers, as Nassaji (2003) defines them, possess refined "lower level word identification processes and higher level syntactic and semantic processes" (p. 646). While word identification processes were definitely put to use by participants, only sparse use of prior knowledge, grammar, or other word level skills (e.g., collocation) was demonstrated in the verbal report data.

---

[23] This idea was harvested from a study by Craig and Yore (1992), in which they suggest that the sparse use of visual inscriptions by learners to solve problems during reading is mitigated by the relative lack of exposure to expository text. It is the idea of limited exposure that is being borrowed here for application to the use of lexical inferencing as a strategy for dealing with new vocabulary during reading.

Overall use of categories of moves. Overall, order of frequency of use for categories of moves was as follows: (1) text-based, (2) sentence level, (3) context-based, (4) word level, (5) discourse level, and (6) prior knowledge level. This order was largely due to participants' frequent use of *repeating* and *recasting* (text-based) and *using sentence context* (sentence level) in the verbal reports.

Specific to the current study, the common use of Context-based moves alludes to the salient role played by the research context or data collection method in the elicitation of moves during lexical inferencing, and provides further evidence of the social nature of a data collection method which has in the past been used to portray inferencing as a primarily individual task. That is to say, previous taxonomies of what readers do during lexical inferencing have yet to include categories of strategies or knowledge sources that refer to the ways participants exploit the social aspects of this particular data collection method to assist their inferences. Swain (2006), for example, has questioned this 'cognitivist' orientation of the concurrent verbalization or think-aloud data collection method, arguing that through the very act of inferring out loud (in the presence of researchers or other participants[24]) readers are constructing and reconstructing their understanding both of given target words and the overall text.

6.2.2 Individual and group uses of multiple moves

Individual participants in the current study used an average of almost three moves for each TW about which they made an inference, a finding which echoes those of Bengeleil and Paribakht (2004). This finding illustrates the complexity of online L2 vocabulary knowledge construction. and is further evidence of the interactive nature of

[24] Swain's (2006) paper is based on research that used paired think-alouds to investigate the inferring of meaning of unknown words.

the relationship between reader and text in the construction of lexical meaning. Other variables that research suggests are implicated in this relationship are vocabulary knowledge (Nation, 2001; Saville-Troike, 1984), L1 reading ability and L2 oral proficiency (Bernhardt & Kamil 1995), and the ability to use contextual clues (Valencia & Pearson, 1987). A more manageable area for future investigation might be to consider the frequency of use of sub-categories of moves in relation to one another – with the hope of identifying relationships between specific types of moves and specific kinds of TWs.

In contrast to Bengeleil and Paribakht (2004), however, the findings from the current study indicated that the 'less proficient' (Transition) group of participants did not use a wider variety of moves than the 'more proficient' (Mainstream) group. It is likely the case that these differences are attributable to age and experience, since the participants in Bengeleil and Paribakht's study were of college age, had more experience different types of expository text, and may well have had broader and deeper vocabulary knowledge bases from which to read. For this reason, more research is needed which describes the developmental stages of adolescent ESL learners' uses of lexical inferencing to cope with unknown words during online processing. It may be that the differences in age and proficiency between the learners in each of the respective groups in this study were not wide enough to elicit significant differences in the type or variety of use of different moves. Furthermore, research in this vein would be a welcome change in light of transmigration and the internationalization of education, and would also widen the scope of the current L2 lexical inferencing lens.

6.2.3 Uses of categories and sub-categories of moves between groups

Categories. Regardless of remarkably similar proportions, the sole difference in the rank order of categories of moves by Mainstream and Transition groups was in relation to word and discourse level moves (Figure 5). Word level moves ranked higher for the Mainstream group, where discourse level moves ranked higher for the Transition group. Explanations for these differences were sought in the comparison of uses of sub-categories of moves between groups, since it was suspected that differences between group uses of specific moves might be the cause of these differences.

Sub-categories. At the sub-categorical level, despite minor differences in the proportion of use, the order of use was identical between groups for *repeating*, *using sentence context*, and *recasting*. This repeated the order of the overall frequency of moves, and was to be expected given the similarities between groups at the category level. This finding suggested that the use of these moves was not related to the criteria upon which the Mainstream and Transition groups were segregated. Katib (1997) also found that Thai EFL learners of differing proficiency levels used six comprehension strategies in similar orders – making this finding not unprecedented in the literature.

Both groups also had a similar remaining array of moves (occurring at proportions of ≥5%), and in spite of the fact that the rank order between groups was not the same, proportions of use were. Minor differences between groups did emerge in relation to *questioning the researcher*, *physical signalling*, and *using visual inscriptions*.

The absence of *questioning the researcher* in the list of most frequently used moves by the Transition group suggests that it is related to L2 proficiency or length of study in Canada for the participants in this study. Interestingly, it appeared as though

participants were keeping a watchful eye for the reaction of the researcher in these situations – so that they might derive a clue about the status of their inferred meaning.

The fact that *physical signalling* was included among the top ranking moves for the Transition group, but was not for the Mainstream group, suggests that for the learners in this study the use of this move may also be related to L2 proficiency or to length of study in Canada. However, physical signalling to avoid the task of verbally inferring a word's meaning implies the use of a different type of proficiency – one that most second language learners utilize to cope or 'survive' in contexts which demand oral or vocabulary-related skills beyond their level of proficiency.

Using visual inscriptions was also among the top ranking moves for the Transition group, but was not for the Mainstream group, and will be discussed in greater detain in the next section (6.3). For now, however, it suffices to say that the higher proportion of *using inscriptions* by the Transition group provides an explanation for the comparatively higher ranking of discourse level moves by the Transition group (sub-section 6.2.3; 'Categories').

6.2.4 Trends in the use of sub-categories of moves within groups

It is necessary to make a few short comments concerning the use of sub-categories of moves among individuals in the same groups. Tables 7 and 8 presented this information in Chapter 5 (subsection 5.1.4), and later in the analysis proportions were calculated (subsection 5.2.3).

Regulatory moves. The Mainstream group did not appear to have any differences between its participant members, whereas the Transition group had quite substantial differences. This suggested that for members of the Mainstream group, the use of

regulatory moves was similar in scope and in application. For the Transition group, however, the differences between participant members required further interpretation. Joni and Halla self-reported that they had been studying in Canada for three to four months at the time of data collection, whereas Apple and Bea both self-reported having studied in Canada for a year at the time of data collection – ruling out length of study in Canada as an explanation. It may be that within this group, a wider range of proficiency was represented than within the Mainstream group.

Heuristic moves. Where heuristic moves were concerned, the proportions of use of moves by the participant members of both respective groups showed large enough differences to warrant interpretation.

For the Mainstream group, Glyn had been in Canada the shortest amount of time among all participants, and thus her high proportion of moves could not be attributed to her length of study in Canada. Deepa's low proportion of heuristic moves was not accounted for by the fact that she had been in Canada longer than Glyn (1.5 years). Perhaps Glyn's case can be explained by the fact that she was observed *using grammar, collocation*, and *world awareness* more often than other participants. This suggests either that certain members have preferences for specific sub-categories of heuristic moves or that the use of specific moves is reserved for a few more proficient learners.

The differences between the members of the Transition group were proportionately smaller than those between members of the Mainstream group, however still required interpretation. Due to the fact that Apple and Joni had been studying in Canada for differing lengths of time when data was collected, length of study in Canada could not be used to explain why these two participants used a higher proportion of

heuristic moves than did Bea or Halla. Similar to the case with regulatory moves, it is likely that within this group, certain individuals have a preference for heuristic moves or conversely that individual members have differing levels of L2 proficiency. For example, both Apple and Joni were observed *using content awareness, L1 awareness, and world awareness*, where as Bea and Halla were not.

6.3 Research question #3: How do visual inscriptions influence ESL students' lexical inferences when they encounter unknown vocabulary in science textbook passages?

6.3.1 Moves made in conjunction with visual inscriptions

The examples provided in Chapter 4 (subsection 4.3.3) and the enumeration of type and frequency of moves used together with visual inscriptions (Chapter 5, subsection 5.3.1; also Figure 5) demonstrate the tandem use of this particular reading move in conjunction with other regulatory and heuristic reading moves, and allude to the pivotal role played by inscriptions in ESL students' meaning making processes in the content area of science.

Repeating, along with *using sentence context* and *recasting*, were likely the most often used moves in conjunction with inscriptions for the sole reason that they were the three most frequently used moves by participants overall. In fact, a similar supposition can also be made with regard to the use of *questioning the researcher*, *sounding out*, and *hedging* in conjunction with an inscription; these three moves also occurred in the top six overall most frequently used moves.

There were two notable anomalies when a comparison of most frequent moves overall and most frequent moves in conjunction with an inscription was undertaken, however. Whereas overall *physical signalling* occurs 9th on the list of overall frequency

of use, it was the fourth most common move used in conjunction with inscriptions. This suggests that the presence of inscriptions in the reading passage played a sizeable role in the use of physical signals during lexical inferencing. In addition, whereas overall *using content awareness* was rare, each use occurred in conjunction with a visual inscription. This can be explained by the fact that in each of these three cases, participants had some familiarity with one of the visual inscriptions included in the reading passage (Chapter 4, subsection 4.3.3).

6.3.2 Proficiency and the use of inscriptions during lexical inferencing

First, it is clear that the students who participated in this study used visual inscriptions in the attempt to facilitate their guesses about the meaning of unknown words while reading in science. The relationship between participants' L2 proficiency and their use of inscriptions, however, is not so clear.

As mentioned above (subsection 6.2.3), *using visual inscriptions* was among the top ranking overall moves for the Transition group, but was not for the Mainstream group, which implies that the less proficient students among participants in this study were more apt to employ inscriptions to facilitate lexical inferences than were their more proficient counterparts. However, given the questionable reliability of these groupings as indicators of proficiency, the finding is merely anecdotal. Additionally, the demonstrated use of inscriptions by participants in both groups occurred in spite of the fact that they were presented in black and white (as opposed to in colour) in the reading passage. This relative absence of visual appeal may also have played a role in the frequency of use of inscriptions by participants in this study, and further detracts from the viability of the

suggestion that the use of inscriptions is related to membership in either the Mainstream or Transition group.

Given the lack of a sizable difference in proficiency among the participants in this study, a more plausible explanation for the demonstrated use of inscriptions may be that because ESL students require efficient lower level textual processing for effective comprehension (Nassaji, 2003), and may not have the same resources as would monolingual students in this area, they depend on visual inscriptions to assist with this processing. Levie and Lentz (1982), for example, have suggested that inscriptions serve a compensatory function for lower-level monolingual readers. Monolingual science reading research that has examined the use of inscriptions to foster general comprehension of text argues that the ability to make use of visual inscriptions is linked to age and development (Moore & Scevak, 1997). Moore & Scevak (1997) reported that students in their study had developed a somewhat sudden awareness of how to use visual inscriptions to help them comprehend science text by the time they were 15 years old. Prior to this age (at 11 and 13), students were not as focused on inscriptions as useful mechanisms for assisting with text comprehension. Given the uniformity of age of participants in this study, a direction for future research could be to compare the use of inscriptions among ESL learners of different ages. It may be that ESL learners develop an awareness of the facilitative nature of inscriptions at a younger age than do monolingual learners as a means of compensating for limited proficiency in the language of the text.

Other researchers dispute the interpretation that inscriptions are used to as compensatory devices, and suggest that inscriptions are more effectively used by cognitively more able students. Hannus & Hyona (1999) make the claim that students

need to know when, at which inscription, and at what within the inscription to look during reading to use them effectively as aids for comprehension. Additionally, students then need to know how to incorporate what they are seeing and reading into a coherent representation. The findings from the current study suggest that inscriptions can be effectively used by students at the same time that they are being used as compensatory devices. When Fera (subsection 4.3.3, Ex. 46) uses the 'pendulum' to create a referent for the researcher, which stands in place of her inability to find the requisite adjectives to describe a cylinder, she is demonstrating the fact that she is a cognitively more able student in each of the ways Hannus and Hyona claim are important.

6.3.3 Prior knowledge and the use of inscriptions during lexical inferencing

Science reading research conducted with monolingual learners has often claimed the use of prior content knowledge to make meaning from science text is a strategy which distinguishes expert from novice readers (e.g., Dole, Duffy, Roehler & Pearson, 1991; Yore, 2000). Indeed, these claims are often qualified by the disclaimer that the use of prior knowledge must be assessed for its importance and used skillfully to 'reorganize knowledge structures' (Yore, 2000) where appropriate.

At the level of vocabulary, the use of prior knowledge of inscriptions played a confounding role in the abilities of at least two learners in our study (Apple, sub-section 4.3.3, Ex. 41; Chai, Ex. 42, 45) to correctly infer the meaning of words they did not know. Not only were Apple and Chai unable to correctly infer the meaning of the TWs, they were oblivious to the possibility that there were different connotations implied by their prior knowledge of the Chinese instrument than those implied by the text. This is where the importance of assessing prior knowledge (Yore, 2000) becomes a key factor. Not

only did Apple and Chai need to be able to reorganize their knowledge structures, they needed the requisite vocabulary knowledge even to be able to begin the process. Had Apple known the meaning of the TW **faint**, for example, she may not have drawn on her prior knowledge in the same way she did; the same is true for Chai – had she known the word **jarring** to begin with, she may have come to understand that the same instrument or inscription was being used in to explain something unrelated to what she already knew about it.

6.3.4 Vocabulary knowledge and visual inscriptions

Since L2 research has shown how vocabulary knowledge is crucial to ESL students' content area learning (Nation, 2001; Saville-Troike, 1984), general reading comprehension (Nassaji, 2003), and reading comprehension in science (Fang, 2006) – there is a need for further research on the role played by visual inscriptions in ESL learners' construction of vocabulary knowledge. Given that "technical vocabulary" and "ordinary words with non-vernacular meanings or usages" in science textbooks are often obstacles to the ESL students' successful comprehension of content (Fang, 2006, p. 494-5), further investigation of the problems caused by these and other problem vocabulary items could lead to advances in textbook design. Perhaps more calculated design strategies, or a more culturally sensitive integration of inscriptions with key vocabulary items in science texts would allow international ESL readers (*and* monolingual English readers) to make better use of inscriptions as facilitative (as opposed to confounding) aids while reading in science.

6.3.5 Taxonomies of L2 lexical inferencing and visual inscriptions

None of the existing taxonomies of strategies (Nassaji, 2003), knowledge sources, (Bengeleil & Paribakht, 2004; Haastrup, 1987; Nassaji, 2003), or 'processes' (Roskams, 1998) describing L2 learners' lexical inferences habits have included the *use of inscriptions*. This may be a symptom of the fact that visual inscriptions have not yet been included in the reading passages used to collect data. Thus, the demonstrated use of visual inscriptions during lexical inferencing by the international ESL students in this study, combined with the fact that these uses were bound to other linguistic and contextually-based reading moves, offers promising directions for developments in both research and theory concerned with L2 lexical inferencing and L2 content-area research.

6.4 Research question #1: Are lexical inferencing and the use of visual inscriptions among the general reading comprehension strategies middle-school ESL students anticipate using during a science reading task?

Based on the data generated by the SORS, which indicated that six out of ten participants reported scores of 4 or 5 for both of the items that were directly related to lexical inferencing, the tentative answer to this question is 'yes'. The small number of participants that took part in the study, however, along with the rating scale and the limited number of items that addressed the use of lexical inferencing and the use of inscriptions – make it difficult to be certain of the extent to which either of these strategies are high on the list of participants anticipated methods for dealing with unknown words during science reading.

Perhaps a new survey, based on the moves identified in this study, can be created to better assist in contributing to our general understanding of the developmental nature of lexical inferencing for middle school aged ESL learners. In addition (or in contrast),

the different successes and difficulties faced by the learners in this study might serve as guidelines upon which survey items to probe ESL middle school students' anticipated uses of visual inscriptions during content-area reading can be developed.

6.5 Suggestions for further research

6.5.1 Taxonomies of L2 lexical inferencing

Future research using verbal reports as data should be wary of and include Context-based characteristics that result from the data collection methods and interactions between researcher and participant. Not only would this acknowledgement have ramifications for the approach to reading through which lexical inferencing is conceptualized (cf. Swain, 2006), it would then also affect the description of what readers do at the meta-categorical, categorical, and sub-categorical levels. This study conceptualizes the meta-category regulatory moves as referring to moves that participants used to position themselves in relation to the text and the task. At the level of category, 'context-based' refers to moves made specifically as a result of the data collection method and the presence of the researcher; the sub-categories *physical signalling*, *questioning the researcher*, and *hedging* refer to and provide examples of moves that participants made for these reasons.

6.5.2 Problems with the VKS as a measure of vocabulary knowledge prior to the think-aloud

It is important to note the likelihood that participants' prior knowledge of the TWs in this study may not have been be accurately accounted for by the VKS. There are two reasons this is likely to be the case. The first deals with homography. Since no clues regarding the grammatical function served by each of the TWs were included in the VKS,

students may have answered a score of three or four under the preconception that the TW was serving a particular grammatical function – when in the context of our reading passage it was serving another (e.g., **relative**, **faint**, **varies**). The second deals with homophony. It was apparent from participants' self-reports on the VKS that at least three of the TWs (e.g., **principle**, **stationary**, **varies**) were confused with like pronunciation but different spellings (e.g., princip*al*, station*e*ry, vari*ous*/varie*ty*).

Not only do is it likely that the effects of homonymy influenced students' self-reports of their knowledge of TWs, they may also have played a role in the inferences students made about specific TWs during the think-aloud task. In addition, it may also have been the case that when students indicated on the VKS (by answering a score of three) that they had 'seen a word before' and thought it meant ____, that they were already inferring the meaning of that particular word – and had seen only a variant of the word prior to that time. Not only do these issues provide evidence to support the notion that vocabulary knowledge plays a central role in L2 reading comprehension in the content-areas, they pose questions about the validity of the VKS as a tool for probing knowledge of vocabulary items out of their context of use.

The qualitative nature of the current study, and in particular the interaction that occurred between researcher and participant in the transcripts, allowed for a confirmation of the fact that TWs were unknown to participants during the lexical inferencing task.

6.5.3 Types of moves, types of text

Given that the use of visual inscriptions by ESL learners during lexical inferencing has until now remained absent from research findings, the possibility for new types of inscription-related moves to emerge remains. This might be especially true if the

range of texts used to map L2 readers' lexical inferences were expanded to include multimodal texts as well as texts from a range of content-areas or academic disciplines. Additionally, texts of different structural compositions might also be useful for eliciting previously uncharted lexical inferencing moves.

6.5.4 L2 learners' uses of visual inscriptions during lexical inferencing

Since the current study's foremost aim was only to describe the reading moves used by international ESL learners, a fruitful direction for both monolingual science reading research and L2 content-area research would be to explore the frequencies and contexts of uses of visual inscriptions by monolingual and second language learning students in more comparable research settings. Not only would this provide a balance in the focus of science reading research, the findings of this type of research could be used to develop explicit instruction about the complex nature of using inscriptions to facilitate comprehension.

6.6 Pedagogical implications

Possible pedagogical implications of this research involve the design of textbooks and explicit reading instruction.

In the open-ended interviews, many students mentioned embedding definitions for important content words in the text; given participants' difficulties with homonymy, it might also be beneficial to include definitions for polysemic words – as these proved to be a source of difficulty for readers in this study. Moreover with advances in text analysis, it would also be useful for publishers to compile lists of frequently used words, collocations, or specialised vocabulary that could accompany textbooks and serve as resources for all students. Where visual inscriptions are concerned, there is no easy

solution. It suffices to say that in light of increasing levels of linguistic and cultural diversity in North American schools and classrooms, textbook designers must be reminded of the two important considerations: (1) that inscriptions can play pivotal roles in the construction of meaning at lexical and global comprehension levels, and (2) that inscriptions which are appropriated from different sociocultural, linguistic, or content-area contexts may confound (as opposed to facilitate) comprehension of science texts at lexical and possibly global levels.

Where the development of explicit instruction is concerned, the findings of this study raise questions about the theoretical underpinnings of science reading instruction which is based on the identification of strategies used by 'expert' monolingual readers. Not only does instruction for diverse groups of learners which is based on expert habits betray the interactive-constructive theory in which it is grounded, it falls short of recognizing that the notion of expert is contingent upon access to "communities where members share many of the same assumptions, preconceptions, and commonsense understandings about what the world is like" (Roth & McGinn, 1998, p. 51). It is likely that until a threshold level of sharing in these assumptions, preconceptions, and commonsense understandings can be developed over time and through experience, the applicability of explicit science reading instruction based on the habits of expert learners will be of only of occasional benefit to ESL middle school learners.

Part of gaining access to these communities begins at the level of vocabulary and language-level processing, which strategy instruction based on the habits of monolingual experts often overlooks. Thus, explicit instruction for ESL learners needs to make learners aware of the importance of vocabulary knowledge for their academic success,

and of specifically linguistic moves they can make to cope with the vocabulary demands of science texts (e.g., Nation, 2001, pp. 256-259). The need for explicit instruction in the use of linguistic moves is supported by the fact that participants in this study made infrequent use linguistically related Heuristic moves (e.g., using grammar, using collocations, using morphology). Additionally, encouraging students to practice using the less frequently used Regulatory moves (e.g., backtracking, auditing, assessing) identified in this study might also foster the development of more skilled language level processing.

Moore and Scevak (1997) have called for explicit instruction which is aimed at generating awareness among learners about how to make meaningful links between text and visual inscriptions. Certainly these meaningful links, as mentioned above, are contingent upon learners developing a certain threshold of proficiency in the learners' L2s, the language of the content area (e.g., science), and the language of inscriptions. At very least, explicit instruction could allow ESL learners the opportunity to practice using inscriptions as facilitative devices when reading different types of texts – and in different contexts and content-areas. At best, this type of instruction will foster the enculturation of ESL learners into the practice of reading visual inscriptions in scientific text in their L2.

6.7 Final thoughts

The participants in this study were keenly aware of the problems caused for them by the 'lexical and syntactic' (Craig & Yore, 1992) difficulties in their science textbook. This was exacerbated by the fact that most participants reported spending no more than 20 minutes reading their science textbook each week. Despite the fact that many researchers have found that for college age readers lexical inferencing is a commonly relied upon method for guessing the meaning of unknown words in context, the findings

of this study indicate that it was only in its developmental stages for the ESL middle school participants in this study. Furthermore, the use of visual inscriptions as facilitators during the process of lexical inferencing has received little attention in the literature.

Given the shift from 'learning to read' to 'reading to learn' that begins in the middle grades (Chall, 1996; Shorzman & Cheek, 2004), and the relative lack of explicit instruction or support in learning how to read received by middle years students from ESL specialists or mainstream classroom teachers (Fang, 2006; Roessingh, Kover, & Watt, 2005; Zen, 2001), lexical inferencing is a technique that must be brought to the attention of younger ESL learners. The same might be said for the use of visual inscriptions as facilitative devices during meaning construction.

Paradoxically for ESL learners, however, the ability to successfully infer meaning in science text or to use visual inscriptions to assist in the process of inferring is a developmental ability which is directly related to one's amount of experience with expository text, their vocabulary knowledge and L2 oral proficiency – each of which require access to specific communities of linguistic or discursive practice. Thus, apprenticing or acculturating students into these communities, while working explicitly to build the language-level skills they already possess, is necessary to maximize the potential of lexical inferencing as a technique for assisting middle school ESL students in constructing meaning for unknown lexical items.

References

Alexander, P.A., & Kulikowich, J.M. (1994). A secondary analysis: Learning from physics text. *Journal of Research in Science Teaching, 31*, 895-911.

Ametller, J., & Pinto, R. (2002). Students' reading of innovative images of energy at secondary school level. *International Journal of Science Education, 24*(3), 285-312.

Bengeleil, N.F., & Paribahkt, T.S. (2004). L2 reading proficiency and lexical inferencing by university EFL learners. *The Canadian Modern Language Journal, 61*, 225-49.

Bernhardt, E.B., & Kamil, M.L. (1995). Interpreting relationships between L1 and L2 reading: Consolidating the linguistic threshold and the linguistic interdependence hypotheses. *Applied Linguistics, 16*(1), 15-34.

Bernhardt, E., Hirsch, G., Teemant, A., & Rodrigues-Munoz, M. (1996). Language Diversity and science: Science for limited English proficiency students. *The Science Teacher*, February, 25-7.

Bullard, J., Cloutier, F., Flood, N., Gore, G., Grace, E.S., Gurney, B., Hirsch, A.J., Hugh, D., Madhosingh, C., Millett, G., & Wootton, A. (1996). *Science probe 10 [Nelson Edition]*. Toronto, ON: Nelson Canada.

Carrell, P.L. (1989). Metacognitive awareness and second language reading. *The Modern Language Journal, 73*(2), 121-34.

Carrier, K. (2005). Supporting science learning through science literacy objectives for English language learners. *Science Activities, 42*(2), 5-11.

Chall, J. (1996). *Stages of reading development* (2nd ed.). New York: Harcourt Brace.

Chamot, A. U., & O'Malley, J.M. (1987). The cognitive academic language learning approach: A bridge to the mainstream. *TESOL Quarterly, 21*, 227-49.

Council of Ministers of Education, Canada. (1997). A vision for scientific literacy in Canada. In *Common framework of science learning outcomes*. Retrieved July 10th, 2007 from http://www.cmec.ca/science/framework/pages/english/cmec%20eng.html

Craig, M.T., & Yore, L.D. (1992). *Middle school students' metacognitive knowledge about reading and science text: An interview study*. ERIC Reproduction Service No. 356135

Cummins, J. (1980). The entry and exit fallacy in bilingual education. *NABE Journal, 4*, 25-60.

Dole, J.A., Duffy, G.G., Roehler, L.R., & Pearson, P.D. (1991). Moving from the old to the new: Research on reading comprehension instruction. *Review of Educational Research, 61*, 239-64.

Ericsson, K. A. & Simon, H.A. (1984/1993). *Protocol Analysis: Verbal reports as data* (revised edition). Cambridge, MA: MIT Press.

Fang, Z. (2006). The language demands of science reading in middle school. *International Journal of Science Education, 28*, 491-520.

Fergusson-Hessler, M.G.M., & de Jong, T. (1990). Studying physics text: Differences in study processes between good and poor performers. *Cognition and Instruction, 7*, 41-54.

Flavell, J. H. (1978). Metacognitive development. In J. M. Scadura & C.J. Brainerd (Eds.). *Structural Process theories of complex human behavior* (pp.213-245). The Netherlands: Sijthoff and Noordhoff.

Flood, J, (1986). The text, the student, and the teacher: Learning from exposition in middle schools. *Reading Teacher, 39*, 784-791.

Gass, S.M. & Mackey, A. (2000). *Stimulated recall methodology in second language research.* Mahwah, NJ: Lawrence Erlbaum.

Gee, J.P. (2004). Language in the science classroom: Academic social languages as the heart of school-based literacy. In E.W. Saul, (Ed.), *Crossing borders in literacy and science instruction: Perspectives on theory into practice* (pp. 13-32). Newark, DE: International Reading Association.

Glaser, B. G. & Strauss, A. L. (1967). *The discovery of grounded theory: strategies for qualitative research.* New York: de Gruyter

Haastrup, K. (1987). Using thinking aloud and retrospection to uncover learners' lexical inferencing procedures. In C. Faerch & G. Kasper (Eds.), *Introspection in second language research* (pp. 197-212). Clevedon: Multilingual Matters.

Hadamenos, G., Heires, N., & Young, R. (2004). Teaching science to newcomers: ESL students learn science by working with an advanced physics class. *The Science Teacher*, February, 27-31.

Halliday, M.A.K., & Martin, J.R. (1992). *Writing science: Literacy and discursive power.* London, UK: The Falmer Press.

Han, J., Roth, W-.M., Pozzer-Ardenghi, L. (2005). Layered Inscriptions: Do they bridge

the gap between world and language. In Roth, W.-M., Pozzer- Ardenghi, L., & Han, J. (Eds). *Critical graphicacy: Understanding visual representations in school science* (pp.1-37). Dordrecht, The Netherlands: Springer-Kluwer.

Hannus, M., & Hyona, J. (1999). Utilization of illustrations during learning of science textbook passages among low- and high-ability children. *Contemporary Educational Psychology, 24*, 95-123.

Harp, S.F., & Mayer, R.E. (1997). The role of interest in learning from scientific text and illustrations: On the distinction between emotional interest and cognitive interest. *Journal of Educational Psychology, 89*, 92-102.

Huckin, T., & Bloch, J. (1993). Strategies for inferring word-meanings from context: A cognitive model. In T. Huckin, M. Haynes, & J. Coady (Eds.), *Second language reading and vocabulary learning* (pp. 153-38). Norwood, NJ: Ablex.

Iding, M.K. (1997). Can questions facilitate learning from illustrated science texts? *Reading Psychology: An International Quarterly, 18*, 1-29.

Jewitt, C. (2005). Multimodality, "reading", and 'writing" for the 21st century. *Discourse: studies in the cultural politics of education, 26*(3), 315-31.

Katib, A. (1997). A descriptive study of Thai EFL students' comprehension monitoring strategies when reading in English. Unpublished doctoral dissertation, University of Victoria, Victoria, BC, Canada.

Kress, G., & van Leeuwen, T. (1996). Reading images: The grammar of visual design. New York: Routledge.

Kress, G., Ogborn, J., & Martins, I. (1998). A satellite view of language: Some lessons from science classrooms. *Language Awareness, 7*, 69-89.

Lee, O. (1999). Learning to do science: Influences of culture and language. *Communication Disorders Quarterly, 21*, 50-64.

Lee, O. (2003). Equity for linguistically and culturally diverse students in science education: A research agenda. *Teachers College Record, 105*, 465-89.

Lemke, J. (1998). Multiplying meaning: Visual and verbal semiotics in scientific text. In J. Martin and R. Veel (eds.), *Reading science: Critical and functional perspectives on discourses of science* (pp. 87-113). New York: Routledge.

Levie, W.H., & Lentz, R. (1982). Effects of text illustrations: A review of research. *Educational Communication and Technology, 30*, 195-232.

Lincoln, F., & Beller, C. (2004). English language learners in the science classroom. *Science Scope, 28*(1), 28-31.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Newbury Park, CA: Sage.

Martins, J. (2002). Visual imagery in school science texts. In In J. Otero, J.A. Leon, & A.C. Graesser (Eds.), *The psychology of science text comprehension* (pp. 73-90). Mahwah, NJ: Lawrence Erlbaum & Associates.

Mayer, R.E., Steinhoff, K., Bower, G., & Mars, R. (1995). A generative theory of textbook design: Using annotated illustrations to foster meaningful learning of science text. *Educational Technology Research and Development, 43*(1), 31-43.

Mayer, R.E., Bove, W., Bryman, A., Mars, R., & Tapango, L. (1996). When is less more: Meaningful learning from visual and verbal summaries of science textbook lessons. *Journal of Educational Psychology, 88*, 64-73.

Mohan, B. (1986). *Language and content*. Reading, MA: Addison-Wesley.

Mohan, B. (2001). The second language as a medium of learning. In B. Mohan, C. Leung, and C. Davison (Eds), *English as a second language in the mainstream: Teaching, learning, and identity* (pp. 107-26). London, UK: Longman.

Mohktari, K. & Reichard, C. (2002). Assessing students' metacognitive awareness of reading strategies inventory. *Journal of Educational Psychology*,

Mohktari, K., & Sheorey, R. (2002). Measuring ESL students' awareness of reading strategies. *Journal of Developmental Education, 25*(3), 2-10.

Moore, P.J., & Scevak, J.J. (1997). Learning from Texts and visual aids: a developmental perspective. *Journal of Research in Reading, 20*(3), 205-23.

Nassaji, H. (2003). L2 vocabulary learning from context: Strategies, knowledge sources, and their relationship with success in L2 lexical inferencing. *TESOL Quarterly, 37*, 645-70.

Nation, I.S.P. (2001). *Learning vocabulary in another language*. Cambridge, UK: Cambridge University Press.

National Research Council. (1996). *National science education standards*. Retrieved July 10th, 2007, from http://www.nap.edu/readingroom/books/nses/

Norris, S. & Phillips, L. (2003). How literacy in its fundamental sense is central to scientific literacy. *Science Education, 87*, 224-40.

Paribakht, S., & Wesche, M. (1999). 'Incidental' vocabulary acquisition through reading: A hierarchy of text-related exercise types. *The Canadian Modern Language Review, 52*(2), 155-78.

Pearson, P.D., Roehler, L.R., Dole, J.A., & Duffy, G.G. (1992). Developing expertise in reading comprehension. In S.J. Samuels & A.E. Farstrup (Eds.), *What research has to say about reading comprehension* (pp.145-99). Newark, DE: International Reading Association.

Reif, F., & Allen, S. (1992). Cognition for interpreting scientific concepts: A study of acceleration. *Cognition and Instruction, 9*, 1-44.

Roessingh, H., Kover, P., & Watt, D. (2005). Developing cognitive academic language proficiency: The journey. *TESL Canada Journal, 23*(1), 1-27.

Roskams, T. (1998). What's a guess worth? Chinese students' inferencing strategies for unknown words while reading. *Hong Kong Journal of Applied Linguistics, 3*(2), 65-102.

Roth, W-M. (in press). Toward a dialectical concept and praxis of scientific literacy. *Journal of Curriculum Studies*.

Roth, W-M. & Barton, A.C. (2004). *Rethinking scientific literacy*. New York: Routledge-Falmer.

Roth, W.-M., & Lawless, D. (2002). Science, culture, and the emergence of language. *Science Education, 86*, 368-385.

Roth, W-.M., & McGinn, M. (1998). Inscriptions: Toward a theory of representing as social practice. *Review of Educational Research, 68*, 35-59.

Saville-Troike, M. (1984). What really matters in second language learning for academic achievement? *TESOL Quarterly, 18*, 199-219.

Schleppegrell, M. (2004). *The language of schooling: A functional linguistics perspective.* Mahwah, NJ: Lawrence Erlbaum.

Schorzman, E.M., & Cheek, Jr., E.H. (2004). Structured strategy instruction: Investigating an intervention for improving sixth-graders' reading comprehension. *Reading Psychology, 25*, 37-60.

Schnotz, W., Bannert, M., & Seufert, T. (2002). Toward an integrative view of text and Picture comprehension: Visualization effects on the construction of mental models. In J. Otero, J.A. Leon, & A.C. Graesser (Eds.), *The psychology of science text comprehension* (pp. 385-415). Mahwah, NJ: Lawrence Erlbaum & Associates.

Seliger, H.W., & Shohamy, E. (1989). *Second language research methods*. Oxford, UK: Oxford University Press.

Sheorey, R., & Mokhtari, K. (2001). Differences in the metacognitive awareness of

reading strategies among native and non-native readers. *System, 29*, 431-49.

Swain, M. (2006). Verbal protocols: What does it mean for research to use speaking as a data collection tool? In M. Chaloub-Deville, M. Chappelle, and P. Duff (Eds.), *Inference and generalizability in applied linguistics: Multiple research perspectives.* Amsterdam: Benjamins.

Swain, M., & Lapkin, S. (2002). Talking it through: Two French immersion learner's response to reformulation. *International Journal of Educational Research, 37*, 285-304.

Thier, M. (2002). *The new science literacy: Using language skills to help students learn science*. Portsmouth, NH: Heinemann.

Unsworth, L.(1997). Some practicalities of a language-based theory of learning. *Australian Journal of Language and Literacy, 20*, 36-52.

Unsworth, L.(2001) *Teaching multiliteracies across the curriculum: Changing contexts of text and image in classroom practice*. Philadelphia, PA: Open University Press.

Valencia, S., & Pearson, P.D. (1987). Reading assessment: time for a change. *Reading Teacher, 40*, 726-32. (1987).

Wandersee, J.H. (1988). Ways students read texts. *Journal of Research in Science Teaching, 25*, 69-84.

Watson, S. (2004). Opening the science doorway. *The Science Teacher*, February, 32-5.

Wesche, M. & Paribakht, T.S. (1996). Assessing second language learner's vocabulary knowledge: Depth versus breadth. *Canadian Modern Language Review, 53*, 12-40.

Westby, C., Dezale, J., Fradd, S., & Lee, O. (1999). Learning to do science: Influences of culture and language. *Communication Disorders Quarterly, 21*, 50-64.

Yore, L.D. (2000). Enhancing science literacy for all students with embedded reading instruction and writing-to-learn activities. *Journal of Deaf Studies and Deaf Education, 5*(1), 105-22.

Yore, L.D. & Anthony, R.J. (2006). *Science literacy: Language as a cognitive technology*. Paper presented at the Pacific Crystal Seminar, University of Victoria, Victoria, BC, Canada.

Yore, L.D. & Denning, (1989). Implementing change in secondary science reading and textbook usage: A desired image, a current profile and a plan for change. *Resources in Education*, ERIC Document Reproduction Service No. ED 305270

Yore, L.D., Bisanz, G.L., & Hand, B.M. (2003). Examining the literacy component of science literacy: 25 years of language arts and science research. *International Journal of Science Education, 25*, 689-725.

Yore, L.D., Craig, M.T., & Maguire, T.O. (1998). Index of reading awareness: An interactive-constructive model, test verification, and grades 4-8 results. *Journal of Research in Science Teaching, 35*, 27-51.

Yore, L.D. & Shymansky, J.A. (1985). Reading, understanding, remembering, and using information in written science materials. *Resources in Education*, ERIC Document Reproduction Service No. ED 258 825

Yore, L.D. & Treagust, D.F. (2006). Current realities and future possibilities: Language and science literacy – empowering research and informing instruction. *International Journal of Science Education, 28*(2-3), 291-314.

Zen, D. (2001). What is wrong with ESL programs in schools? Paper presented at the *Annual Meeting of Mid-America Teachers of English to Speakers of Other Languages*. ERIC Document Reproduction Service No. ED 482 580

Appendix A is not included in this pdf due to copyright restrictions on the material.

Appendix B

The Modifed SORS

Instructions:

After reading each statement, please write which number (1, 2, 3, 4, or 5) best describes your situation when reading science textbooks.

Rating Scale for the Survey of Reading Strategies:

'1' means that "I **never** or **almost never** do this"

'2' means that "I do this **only occasionally**"

'3' means that "I **sometimes** do this" (About **50%** of the time).

'4' means that "I **usually** do this"

'5' means that "I **always** or **almost always** do this"

Remember:

THERE ARE NO RIGHT OR WRONG ANSWERS. THIS IS NOT A TEST!!!! IF YOU ARE NOT SURE ABOUT THE MEANING OF A QUESTION, PLEASE ASK ME!

While I am reading science text my teacher gave me:

1. I have a purpose in mind when I read.
2. I take notes while reading to help me understand what I read.
3. I think about what I know to help me understand what I read.
4. I take an overall view of the text to see what it is about before reading it.
5. When text becomes difficult, I read aloud to help me understand what I read.
6. I think about whether the content of the text fits my reading purpose.
7. I read slowly and carefully to make sure I understand what I am reading.
8. I review the text by noting its characteristics like length and organization.
9. I try to get back on track when I lose concentration.
10. I underline or circle information to help me remember it.
11. I adjust my reading speed according to what I am reading.
12. I decide what to read closely and what to ignore.
13. I use reference materials (e.g., dictionary) to help me understand what I am reading.
14. When text becomes difficult, I pay closer attention to what I am reading.
15. I use tables, figures, and pictures in text to increase my understanding.

16. I stop from time to time and think about what I am reading.

17. I use context clues to help me understand what I am reading.

18. I paraphrase (restate ideas in my own words) to better understand what I read.

19. I try to picture or visualize information to help remember what I read.

20. I use typographical features like **bold face** or *italics* to identify key information.

21. I critically analyze and evaluate the information presented in the text.

22. I go back and forth in the text to find relationships among ideas in it.

23. I check my understanding when I come across new information.

24. I try to guess what the content of the text is about when I read.

25. When text becomes difficult, I re-read it to increase my understanding.

26. I check to see if my guesses about the text are right or wrong.

27. When I read, I guess the meaning of unknown words or phrases.

28. I use tables, figures, and pictures to help me guess the meaning of unknown words or phrases.

29. When reading, I translate from English into my first language.

30. When reading, I think about information in both English and my first language.

Appendix C

The Vocabulary Knowledge Scale: Self Report Categories (Paribakht & Wesche, 1996, in Bengeleil & Paribakht, 2004, p. 248)

Vocabulary Knowledge Scale (VKS)

FIGURE 1
VKS Elicitation Scale: Self-Report Categories

Self-report categories	
I	I don't remember having seen this word before.
II	I have seen this word before, but I don't know what it means.
III	I have seen this word before, and I think it means _____. (synonym or translation)
IV	I know this word. It means _____. (synonym or translation)
V	I can use this word in a sentence: ____. (Write a sentence.) *(If you do this section, please also do Section IV.)*

Appendix D

Modified Vocabulary Knowledge Scale and List of Target Words

Instructions:

After reading each word, please write which number (1, 2, 3, or 4) best describes your understanding of that word. Follow the instructions in brackets.

Rating Scale for the Vocabulary Knowledge Scale:

'1' means "I don't remember having seen this word before".

'2' means "I have seen this word before but I don't know what it means"

'3' means "I have seen this word before, and I think it means

_____

(synonym or translation)".

'4' means "I know this word. It means _____ (synonym or translation),
and I can use it in a sentence (make a sentence with this word)".

Vocabulary Wordlist

1. varies
2. devastating
3. faint
4. vibrations
5. jarring
6. massive
7. seismograph
8. tremor
9. amplitude
10. stationary
11. principle
12. cylindrical
13. relative
14. inertia
15. tended
16. anchored

Appendix E

Possible questions to guide the open-ended interviews

(1) Background Information

How long have you been in Canada?

How long have you been learning English?

What grade are you in right now?

What grade did you finish before coming to Canada?

Do you like science?

What job would you like to have when you are older?

Are there Canadian students in your science class?

(2) RE: Science text

How many times per week do you have a science class?

How much time do you spend reading your science textbook each week?

Are you good at reading in science? What makes science easy or difficult to understand?

What problems do you have when you read your science textbook?

What strategies do you use to solve those problems? (what other strategies…./most common strategy?)

Do you think visual inscriptions help you to read your science textbook? How?

What would make your textbook easier to read?

Do you think you understood the text you just read? (Scale)

What made it difficult to understand?

Have you studied the topic of earthquakes before?

If you could tell people who make science textbooks how to make them easier to read, what would you tell them?

Appendix F

The Reading Passage

13.2 MEASURING EARTHQUAKES

The strength of earthquakes **varies** greatly. Although some are **devastating**, others may go unnoticed. It is important to be able to measure and compare the size of different quakes.

About 2000 years ago, the Chinese invented an instrument sensitive enough to detect even very **faint** ground motions. It consisted of an intricate arrangement of levers and wheels that released a ball in response to any kind of **jarring** movement (Figure 13.7). Although it was more sensitive than human senses, this device could not distinguish between large and small **vibrations**.

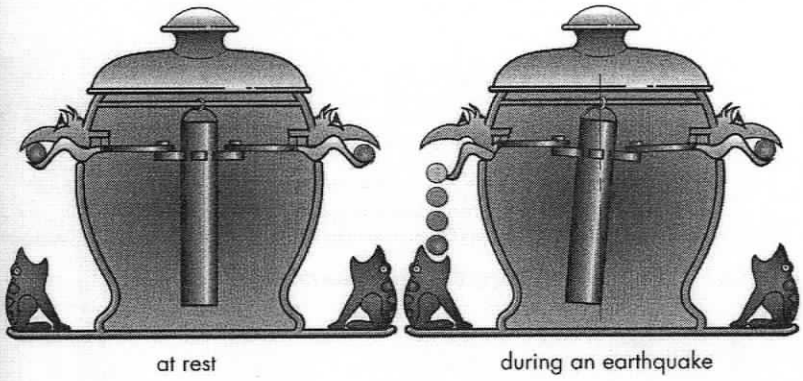


FIGURE 13.7 ▲
Chinese earthquake detector. Levers were attached to a pendulum suspended inside a bronze jar. When an earthquake shook the jar, the pendulum moved the levers, causing a ball to drop out of the mouth of the dragon into the mouth of the frog below. This device indicated the first ground motion from an earthquake.

THE SEISMOGRAPH

An instrument that is used to measure the ground motion resulting from earthquakes is known as a **seismograph**.

Trying to measure the distance the ground moves during a **tremor** presents a challenging problem. Imagine you are an ant hanging onto a rope (Figure 13.8). You would certainly know you were moving from side to side, but would be unable to measure the **amplitude** of that motion. (Amplitude is the height of waves).To do that, you would need a **stationary** reference point, such as a point on the floor, to measure your motion using

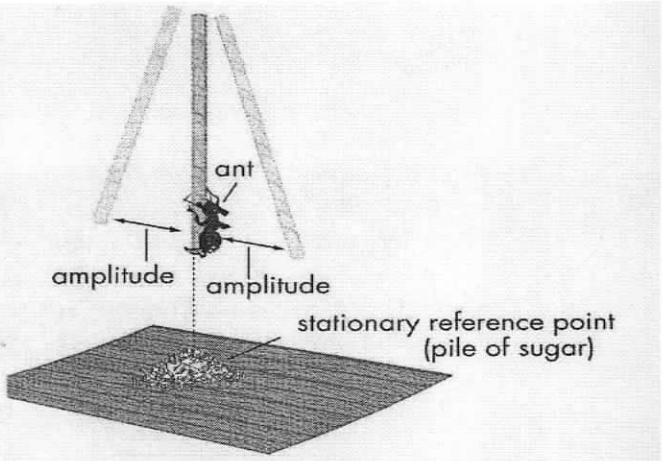


FIGURE 13.8 ▲
An ant on a rope needs a reference point to measure its motion.

an instrument that is fastened to the ground. To measure ground motion, there needs to be a reference point that remains stationary even when the ground is shaking.

You can demonstrate a **principle** that solves this problem in the following way. Place a smooth, **cylindrical** object (like a pencil or a piece of chalk) on top of a sheet of paper on your desktop. Holding the opposite edges of the paper, quickly shake it back and forth perpendicular to the pencil while keeping the paper flat against the desktop. How does the pencil move **relative** to the paper? How does the pencil move relative to a fixed point (such as the desktop)?

You have just demonstrated a principle known as **inertia,** defined as the tendency of a mass to stay at rest or continue moving unless the state of rest or motion is changed by external force. In this case, a stationary object (the pencil) **tended** to stay stationary even when another body (the surface it rests on) suddenly moves. We say that the pencil is showing inertia. The greater the mass, the greater is its inertia. You can experiment with this concept yourself using more **massive** objects, such as cylinders of metal of varying weight.

A seismograph contains a large mass of metal that is suspended so that it can move independently of it supports (Figure 13.9).

The rest of the instrument is **anchored** to a strong concrete foundation. During a tremor, the suspended mass tends to stay in one place as the ground vibrates under it. Because of its inertia, the mass become the stationary reference point. Sensors measure the difference in movement between the ground and the stationary mass. The amplitude of motion is electronically magnified up to 100 000 times and recorded by the vibrations of a pen over a roll of paper.

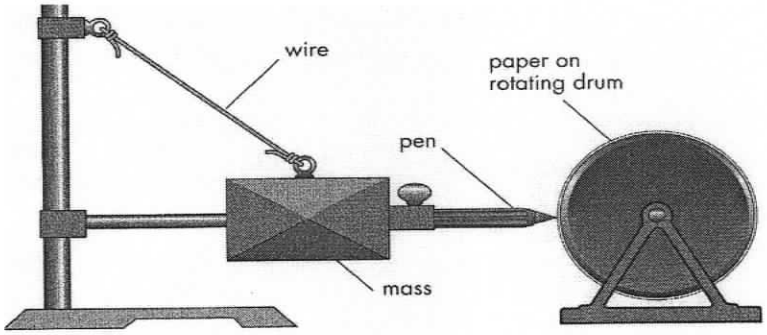


FIGURE 13.9 ◀
A simple seismograph.

Appendix G

Letter to School Principal

Dear Mr. XXXXXX,

Re: UVIC Graduate Student Research Project

I am a UVIC graduate student in the Faculty of Education, Department of Curriculum and Instruction. The main focus of my thesis will be the reading comprehension skills and strategies of ESL students as they encounter science content.

I am hoping to find a middle-school, teachers, and approximately 6 ESL students who would be interested in volunteering their time to assist me in the completion of this project. For teachers, volunteering would entail delivering a letter of interest to potential student participants. For student volunteers, the following table summarizes the tasks and approximate amounts of time they would be asked to commit. From the school, permission to use a room (after school hours) to conduct tasks [b] through [f] would be requested. If granted, the number of times required for use would coincide with the number of student participants, and the maximum time for each meeting would be 1 hour.

Task	**Time**
(a) Explain project and Consent Form	5-10 minutes
(b) Survey of Reading Strategies	5-8 minutes
(c) Vocabulary Knowledge Scale	5-10 minutes
(d) Open-Ended Interview	10-15 minutes
(e) Think-Aloud practice	8-10 minutes
(f) Think-Aloud exercise	10-15 minutes

I hope to speak with an interested school, students, and teachers very soon. If you have any questions or concerns, please feel free to contact my supervisor or I directly (Dr. Robert Anthony: ranthony@uvic.ca or 721-7780 // Ryan Deschambault: anisseyo@uvic.ca or 381-0007).

Thank you in advance for your time and I look forward to hearing from you.

Respectfully,

Ryan Deschambault
MA Student
Dept. of Curriculum & Instruction

Appendix H

Participant Consent Form

You are invited to be a participant in a project called ***Middle school ESL students' science content reading moves: Inferencing, comprehension, and visual inscriptions.***

My name is Ryan Deschambault, and I am a Graduate Student in the Department of Curriculum and Instruction at the University of Victoria. If you have any questions about this project, you can contact me at anisseyo@uvic.ca or 381-0007.

As a Graduate Student, I have to do research to complete my Master's degree in Language and Literacy. My supervisor for this project is Dr. Robert Anthony. He can be contacted at ranthony@uvic.ca or 721-7780.

Why am I doing this project?

I am doing this project to learn about how ESL students understand the things they read in their science textbooks. For example, when you are reading and can't understand what the author is trying to say, how do you guess about the meaning? I would also like to know how the pictures in your science textbook help you to understand these difficult ideas.

Why is this project important?

I think this project is important because learning how students solve problems when they read will help teachers understand their students. Then teachers will be able to help their students become better readers. The project is also important because it might help us to design textbooks that are easier for students to read.

Why were you asked to help with my project?

I have asked you to participate in this study because you are middle-school students, and because reading usually starts to get more difficult in middle school. I have also asked you to help me because the first language you learned to speak was not English.

What will you need to do if you participate?

If you agree to help me, you would be asked to complete the following tasks.

Task	**Time**
(a) Explain project and Consent Form	5-10 minutes
(b) Survey of Reading Strategies	5-8 minutes
(c) Vocabulary Knowledge Scale	5-10 minutes
(d) Open-Ended Interview	10-15 minutes
(e) Think-Aloud practice	8-10 minutes
(f) Think-Aloud exercise	10-15 minutes

Inconvenience

If you decide to participate, you will be asked to volunteer your time after school, and to choose a place where you can complete the tasks. Also, you will have to concentrate and use a lot of energy during this time.

What can you learn if you help me?

If you decide to participate, I think you can learn about: (1) your own reading habits and strategies, (2) good habits and strategies for reading, and (3) the research process at a university.

How will I thank you for helping me?

If you decide to participate, I will sign for two hours of ***Participation in an English Activity***.

How can you stop participating in the project?

You can choose to stop participating at any time. If you choose to stop participating:

(1) There won't be any consequences.
(2) I will ask you if I can use your data. If you sign the form, that means I can use your data. If you do not sign the form, I cannot use your data.

Also, if you stop participating after you have finished the first task, you can still ask that I sign for 2 hours of English participation.

Why will you need to sign your name at our meeting?

If you decide to participate, we will need to meet one time – after school hours. At this meeting, you will be asked to sign your name on a piece of paper after each task. Signing your name means that you still want to participate.

Will people know you are participating in this study?

When I write my report I will change your name, the name of your school, and the name of the city. I will do this so that people who read my report will not know which students helped me with my project.

Will your teacher or people from your school know what happens at our meeting?

No. None of the things you *write* during our meeting will be shown to your teacher or anyone from your school. Also, nothing you *say* during our meeting will be reported to your teacher or anyone from your school.

Who will see your data?

Your data will be protected by passwords on my computer, and will be locked in my desk drawer at home so that nobody but me can see it. I must do these things so that people who read my final report will not know your actual identity.

What will I do with the report?

When my report is finished, I will present the information in this report in different ways: as my MA thesis at UVIC, in meetings with other researchers and professors, and maybe in books, articles in journals, or in magazines.

What happens to the data when I am finished?

When my report is finished, the computer files will be erased, computer disks will be smashed, and paper will be shredded or burned. The data will be destroyed so nobody else can see, use, or copy it.

If you or your parents want to be sure that the University has given me permission to do this study, please call the Associate Vice-President of Research at UVIC. His telephone number is (250) 472-4545. He works with the Human Research Ethics Board – they are the group of University people who approved my research project.

By signing this form, you are showing that you understand the tasks and conditions of the study, and that I have answered any questions you had about it.

_____ _____

Name of Participant *Signature* *Date*

[NOTE: One copy of this Consent Form will be given to the you (the student), and I (the researcher) will keep one copy.]

Appendix I

Think-aloud Instructions

Think-Aloud Instructions:

1) Read the text.

2) When you come to a highlighted word, please try to give a synonym or translation of that word.

3) If you don't know the meaning of the highlighted word, please try to guess about the meaning of that word.

4) As you are guessing the meaning of the word, please talk out loud about how you are guessing the meaning of that word (e.g., using the sentence, using a picture, using your first language)

***I might ask you questions about how you are guessing as well.