The Hong Kong Polytechnic University
Department of English

Postgraduate students' reading of disciplinary academic texts in a second language: An activity theoretical analysis of textual actions and interactions

Svetlana Tchigaeva

A thesis submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy

August 2004

CERTIFICATE OF ORIGINALITY

I hereby declare that this thesis is my own work and that, to the best of my knowledge and belief, it reproduces no material previously published or written, nor material that has been accepted for the award of any other degree or diploma, except where due acknowledgment has been made in the text.

_____(Signed)

Svetlana Tchigaeva _____(Name of student)

Abstract of the thesis entitled:

Postgraduate students' reading of disciplinary academic texts in a second language: An activity theoretical analysis of textual actions and interactions

submitted by Svetlana Tchigaeva

for the degree of Doctor of Philosophy in Applied Linguistics

at the Hong Kong Polytechnic University in August, 2004

Abstract:

Advanced academic literacy has recently attracted a significant amount of attention from second language researchers who, among other issues, have been interested in how postgraduate students, by engaging in text-mediated activities, socialize into and expand their participation with disciplinary communities of practice (Belcher, 1994; Blakeslee, 1997; Casanave, 2002; Johns and Swales, 2002, and others). The interest in advanced academic literacy has been preceded by the growing recognition of the importance of the notion of context within literacy research in general. In L2 reading research, though the importance of context has been acknowledged, few studies have actually defined and/or analyzed context in any systematic ways. Drawing on previous research for its theoretical and methodological principles, this PhD study aims to contribute to two major research areas: to L2 reading research by adapting activity theoretical tools and systematically using them in a study of reading-in-context, and to advanced academic literacy research by analyzing reading within the broader context of postgraduate education.

Taking a naturalistic research approach, the study captured eleven reader's individual reading experiences through qualitative data collection methods, such as observations, in-depth interviews, think-aloud protocols, and collections and examination of texts, read as well as written. The framework used for the analysis of the rich data was developed on the basis of activity theory (Vygotsky, 1978; Leontev, 1978; Engeström,

1999) and led to the analysis of reading at three levels—operations, actions, and activity systems.

The analysis was conducted in three phases: (1) all the cases were analyzed for emerging themes; (2) four cases were selected for in-depth analysis and presentation in the thesis; and (3) the remaining cases were revisited in order to analyze the common themes across them. The analysis of the four case studies revealed that postgraduate reading, when it is studied in contexts of its natural occurrence, is at the same time individual yet deeply social. It extends beyond the interactions between an individual reader and a single text to include multiple texts, semiotic modes, objects of the environment, and people. The cross-case comparison across the eleven cases led to the identification and analysis of three major themes: intertextuality, multimodality, and the situatedness of postgraduate reading in social interactional networks.

Based on the analyses, the study concludes that advanced academic reading involves: (1) an ability to recognize and rely on the intertextual nature of academic texts; (2) an ability to understand and utilize multiple semiotic modes which comprise disciplinary texts; and (3) an ability to see reading as an opportunity to engage in furthering participation with disciplinary and professional communities, as well as to rely on prior experiences with multiple communities in dealing with multiple texts.

Acknowledgements

Many people have contributed to the development of this thesis, whether they realized it or not. First and foremost, I am indebted to my PhD supervisors. Unlike most students, I have been fortunate enough to work with and learn from several of them. I want to thank Prof Liz Hamp-Lyons for taking me as her PhD student when I was still very young and inexperienced. Thank you, Liz, for modeling what a good researcher should be; thank you for helping me realize that there is a fine line between questioning too much and questioning too little. I would like to thank Dr Tom Lumley as well. Tom, thank you for always trusting in me and for showing your support throughout my PhD process. I am indebted to Dr Gail Forey. Thank you, Gail, for seeing me through the last stages of viva and revisions. Thank you also for constantly reminding me that I need to publish my findings and start contributing to the field in earnest. Finally, this PhD would not have been possible without Dr Sima Sengupta. I cannot thank you enough, Sima, for all you have done for me: for being an understanding friend, a caring mother, a critical reader, and simply a wonderful person. Thank you!

I began this research as a complete novice to activity theory. I am therefore grateful to Prof David Russell of Iowa State University (my other alma mater) for helping me to discover the enormous possibilities of this theory and to Prof James Lantolf of Pennsylvania State University for his comments and suggestions on my interpretations as they are presented in this thesis. Thanks are due to all the members of the examining committee as well: Prof David Nunan, Prof James Lantolf, and Dr Yuko Miyazoe-Wong.

This research is based on qualitative case studies of several students' reading. I want to thank all these students for their courage and willingness to participate, as well as for their feedback on my numerous chapter drafts.

I cannot not thank my fellow research students and friends. Some best research ideas were born during our research students' seminars, informal discussions around the cubicles in the research office, and even during dim sum lunches. I especially want to thank Ken and Cissy for stimulating me to work and create. I will definitely miss our research

meetings in Festival Walk. I want to thank all the friends I have made here in Hong Kong, and especially Ahmed and his lovely family for treating me as their sister, Kourosh, Asma, Hugo, Rebecca, Moon, Sabrina, Aishah, Thalea, Phoenix, Emin, Heidi, Tat, Moyin, and many others for being there for me when I needed them most. I would like to thank Aref, Ksenia, Larisa, Mahmoud, Hayati, Heidi, Peter, and other friends who were not in Hong Kong but whose thoughts and care from a far were no less important.

Finally, I am grateful to my family. Without the support, love, and understanding of my mom and my sisters, none of this would have been possible at all. My dad is no longer with us, but my constant prayers and thanks go to him as well.

Table of contents

List of tables

Chapter 10

List of figures

List of vignettes

List of appendices

CHAPTER ONE: Introduction

1.1. Background to the study

The PhD study presented in this thesis is a naturalistic study of eleven postgraduate students' reading. It has grown out of and aims to contribute to two major areas of inquiry: L2 reading and advanced academic literacy research.

1.1.1. Second language (L2) reading research

In the last ten or so years, L1 reading research has undergone some fundamental changes which have become possible due to the increase in the amount of "metadisciplinary inquiry" (Matsuda, Canagarajah, Harklau, Hyland, and Warschauer, 2003, pp. 170-173) in this field. Among other issues, disciplinary L1 reading practitioners have been critically evaluating the nature and historical developments of their research and the methodological and philosophical foundations or paradigms (Kuhn, 1962) informing it. As a result, several currents have developed which characterize the present state of L1 reading research, only some of which are:

1. the growing body of research that views reading and writing as closely interacting and inseparable from context in which both are situated (Nelson and Calfee, 1998; Langer and Filhan, 2000);

2. a noticeable move towards more sociologically-oriented models of reading (Luke and Freebody, 1997; Wallace, 1992); and

3. an ample amount of studies drawing on interdisciplinary research in search of new methodologies and theoretical underpinnings (Editorial, *Journal of Literacy Research*, 1996).

Meanwhile, L2 reading research has been somewhat slow to acknowledge and build on the developments in L1 reading research, and whereas the latter views reading as a socially situated practice, the former still discusses it largely in terms of mechanics of reading (Leki, 2000; Pennycook, 1996). Nonetheless, though few in numbers and lacking in strength, calls have been made in L2 reading research for more situated studies of

reading which would (1) account for the social contextual factors of reading (Grabe, 1997); (2) view readers as socially, politically, and culturally situated actors interacting with others through texts (Penningroth, 1997); and (3) go beyond experimental lab settings to observe reading in naturally occurring contexts (Strømsø and Bråten, 2003).

Several factors may have contributed to the current failure of L2 reading research to engage in the analysis of reading in particular contexts, one of them being the elusiveness of the notion of context itself. Therefore, some L2 reading researchers have additionally called for more concrete conceptualization of "context" and tools for exploring it (Grabe and Stoller, 2002; Grabe, 2003; 2002).

1.1.2. Advanced academic literacy research

The recent attention that literacy researchers have paid to the role of context in students' reading and writing practices has proved to be fruitful to those researchers interested in how postgraduate students, by engaging in text-mediated activities, expand their participation in various disciplinary communities of practice. The emphasis on the social forces surrounding literacy has been accompanied by several definitional complexities in this field, the main one being the subsequent blurring of the boundaries between reading and writing, on the one hand, and between these activities and other text-mediated activities, on the other.

Though the definitions have become problematized, however, it is possible to suggest that most studies have started with writing as their primary focus and point of departure (Berkenkotter, Huckin, and Ackerman, 1991; Blakeslee, 1997; Prior, 1997, etc.). Apart from Benson (1991) and Jiang (2001), little attention has been given to reading; yet, reading is a major backbone of disciplinary knowledge formation and communication (Carson, 2001; Leki, 1993, 2003), and as such, deserves more attention and a more dynamic analysis.

1.2. Research objectives

In light of the gaps identified in L2 reading and advanced academic literacy research, this study aims to accomplish the following:

(1)   to examine postgraduate reading in contexts of its natural occurrence;

(2)   to identify idiosyncrasies as well as common features of postgraduate reading;

(3)   to propose a framework for studying reading in context; and

(4)   to suggest areas of further research to enhance our understanding of postgraduate reading and its role in advanced academic literacy development.

To meet the objectives, the study relies on case study methodology (Yin, 2003, Stake, 2000) for its design and on activity theory (Vygotsky, 1978; Leontev, 1978; Engeström, 1987, 1999) for its analytical framework.

1.3. A brief overview of activity theory and its contribution to the study

Activity theory is a commonly accepted name for a whole line of theorizing and researching which aims to understand "the interpenetration of the individual, other people, and artifacts in everyday activity" (Nardi, 1996, p. 8). To accomplish its aim, activity theory borrows traditional terms such as individual, society, tools, language, activity, and action and reinterprets them as fundamentally complex, dialogically interacting and multifaceted rather than unified, autonomous, and discrete (Prior, 1992).

Originating in the works of the Russian educational psychologists Vygotsky, Luria, and Leontev, activity theory now involves a multivoiced international community no longer limited to psychology. Among other fields, it has gained popularity in literacy research (cf. Bazerman, 1997; Russell, 1997; Freedman, 1995; Prior, 1998; Winsor, 2003; Smagorinsky, 2001), second language acquisition (cf. Lantolf, 2000; Donato, 2000; Ahmed, 1994; Thorne, 2000; van Lier, 1996; Kramsch, 2000), education (cf. Wells, 1996; John-Steiner, 1995), language assessment (cf, Spencer-Brown, 2004), and human-computer interaction (cf. Nardi, 1996; Kuutti, 1996; Bannon, 1997; Kaptelinin, 1996).

Activity theory provides a simple but powerful lens (Russell, 1997) for describing the complexity of reading in context. According to activity theory, context is a complex co-construction of the individual, the social, and the material. It is not a frame that surrounds a focal phenomenon (Goodwin and Duranti, 1992) but the focal phenomenon within which human processes are understood. To understand reading within particular contexts, three levels of analysis discussed in activity theory were adopted in this study: operations, actions, and activity systems.

In this study, the level of **operations** corresponds to the questions of "How does the student read the text? What mediational means does he rely on?" The level of **actions** corresponds to the questions of "What is the student accomplishing by reading? What immediate, defined purposes is the text used to achieve?" The level of **activity systems** corresponds to the questions of "Why is the student reading the text? Why is she doing what she is doing while reading? What broader motives can explain her behaviors?" These concepts are further elaborated on in Chapter 3 of this thesis.

1.4. Outline of the thesis

Following the introductory chapter, **Chapter 2** presents a review of five related bodies of research literature: reading-writing connections, expert vs. novice reading, intertextuality in reading, multimodality, and advanced academic literacy development. The review (1) situates the study within the changes in both L1 and L2 reading research, (2) summarizes some previous findings regarding various aspects of academic reading, and (3) frames the study based on the implications derived from the existing literature.

Chapter 3 details the activity theoretical framework informing this study. The chapter starts with a brief overview of activity theory and its major premises. Then, it explains the three fundamental activity levels and additional concepts important for understanding the analysis employed in this study and its ensuing interpretations. Throughout this chapter, I aim to show that (1) activity theory is consistent with naturalistic approaches to inquiry, (2) provides an appropriate lens for understanding the

current changes and patterning future directions in reading research, and (3) presents a set of principles and tools needed for a rigorous analysis of reading in context.

It is in **Chapter 4** that I document the research methodology employed in the study. First, the naturalistic approach to inquiry using a multiple case study design is presented, followed by a description of the eleven participants and the site of research. Second, the evolving and adaptive data collection process is described and each method of data collection is reviewed. Then the phases and the procedures of data analysis are explained. This chapter concludes with a discussion of generalizability, validity, and reliability as conceptualized in this research.

In **Chapters 5, 6, 7,** and **8**, I present individual focused case studies of four postgraduate students reading four academic texts. In each of the four chapters, I present some background information about disciplinary and literacy experiences of the student, introduce the text the student read, and analyze the reading in light of the activity theoretical framework informing the study. It is through these chapters, that the idiosyncratic nature of postgraduate reading becomes most apparent.

Chapter 9 brings together the observations from all eleven cases used in this study in a discussion of three aspects of postgraduate reading: intertextuality, multimodality, and interactional networks. As in previous chapters, the discussion here relies on activity theoretical concepts and relates the findings to previous findings in reading and advanced academic literacy research.

Finally, the thesis concludes with **Chapter 10**, in which I summarize the study approach and the major findings emerging from it. Based on the findings, I suggest ways in which this research could contribute to L2 reading and advanced academic literacy research. I then engage in a critical evaluation of the limitations identified in this study and suggest future lines of research which could both draw on this study and avoid or minimize its limitations.

CHAPTER TWO: The review of literature

In addition to an overview of L2 reading research, this chapter focuses on five
interrelated research areas. These are previewed in Figure 2.1 below.

Reading is multivocal
and involves making
connections between
texts

Reading is not
bounded and
interacts with
writing and other
activities

Reading involves
relying on multiple
modes of
communication in
addition to language

**2.3.1.
Reading-writing
connections**

**2.3.2.
Multimodality**

**2.3.3.
Intertextuality**

**Expert vs.
novice reading
2.3.4.**

**Advanced
academic
literacy
development
2.3.5.**

Reading is deeply social,
responsive, and constructive
and often involves mental
conversations with authors

Advanced academic
literacy involves more
than reading and writing
effectively

Figure 2.1. Preview of Chapter 2

2.1. Introduction

This chapter presents a brief overview of a major paradigmatic change in reading research and a focused review of five bodies of literature which are particularly relevant to my exploration of postgraduate students' reading processes and practices. Although the literature overlaps in some cases, it generally fits into the following major categories: reading-writing connections, expert vs. novice reading, intertextuality in reading, multimodality, and academic literacy development. The review is provided in an effort (1) to situate the study within the changing "currents" in reading research; (2) to summarize the previous findings regarding various aspects of academic reading; (3) to locate this study within ongoing discussions of reading and academic literacy; and (4) to frame it based on the implications derived from the review. The chapter is structured so that every section reviewing research in a particular area ends with the implications of it for the present study. The literature review concludes with the statement of the purpose and scope of this study, including the specific research questions.

2.2. "Changing currents" in reading research

In 1995, *Journal of Reading* changed its title to become *Journal of Adolescent and Adult Literacy*. In 1996, *Journal of Reading Behavior* became *Journal of Literacy Research*. Most recently, in 2004, the journal *Reading* became *Literacy*. In addition to journals, changes in naming practices have occurred at the level of national organizations (i.e., the United Kingdom Reading Association became the United Kingdom Literacy Association) and at the level of postgraduate programs offered by various institutions (i.e., Kent University's MSEd program in reading education became literacy education; see also Nelson and Calfee, 1998, p. 35).

The changes in the naming preferences are probably not important as such but as indicators of some serious changes and debates which have been taking place across various branches of reading research and of the "metadisciplinary inquiry" (Matsuda et al., 2003, pp. 170-173) which has become important, i.e. inquiry by disciplinary practitioners

into the nature and historical developments of the field and its methodological and philosophical foundations or paradigms (Kuhn, 1962). Some of the "currents" (Matsuda et al., 2003, p. 170) which have affected changes in the naming practices within circles engaged in researching reading are:

1. the growing body of literature which suggests that "the process of reading cannot be usefully treated in isolation from writing or from the talk in which both [reading and writing] are embedded" (The United Kingdom Literacy Association, 2004);

2. "a substantial wave of interest in qualitative studies of classrooms rooted in the social constructionist traditions of cultural anthropology and sociology" (Bean, 2001, p. 2);

3. the expanding role of interdisciplinary research on reading and the increasing range of methodologies employed in studies of reading (Editorial, *Journal of Literacy Research*, 1996); and

4. the move towards more sociologically-oriented models of reading (Luke and Freebody, 1997; Wallace, 1992).

The unifying force behind the "currents" suggested above is the growing acceptance of approaches grounded in discussions of situated literacy, where reading and writing are seen as socially situated and mediated rather than autonomous of each other and of contexts within which they occur.

2.2.1. Situated literacy

Situated literacy perspectives on reading and writing argue that "[a]ll uses of written language can be seen as located in particular times and places" (Barton, Hamilton, and Ivanič, 2000, p. 1). These perspectives have their roots in works of Freire (1970), Scribner and Cole (1981), Street (1984), and others.

Freire (1970) and his followers in critical education have maintained that literacy is a means of transformation and empowerment of the poor and the disadvantaged. Scribner and Cole (1981) as well as others working within the tradition of sociocultural psychology have argued that literacy can be understood only in the context of social practice in which

it is learned and used, and have explained it as a set of culturally organized and shared skills and values learned in specific settings. Similarly, Street (1984) has forcefully argued that literacy is a social practice "in which particular socially constructed technologies are used within particular institutional frameworks for specific social purposes" (p. 97).

More recently, the earlier research of the 70s and 80s has been expanded by the group of New Literacy Studies (see Barton, 1994; Gee, 1996, 2002; Street, 1995) who have conceptualized reading and writing as technologies which have "no effects in and of themselves" and have specific effects when mediating different activities, practices, and identities (Gee, 2002, p. 159). Another group which has contributed further to literacy discussions has been the New London Group (1996), which, concerned with the social changes that have taken place within the last decades in the world, argues that (1) there is a growing multiplicity of modes of communication and (2) an increasing cultural and linguistic diversity in the world. Accordingly, the group suggests that a focus should move to literacies rather than literacy.

All these social theories of literacy do not usher in "the end of language" (Gee, 2002) in literacy research but instead add other dimensions to it. These dimensions can be summarized as: (1) studying reading and writing in particular times and places; (2) involving ethnographically-oriented research methodologies; (3) engaging in the analysis of writing and reading as social practices; and (4) crossing boundaries into other fields for potential frameworks to analyze these social practices.

2.2.2. Paradigm shift in L2 reading research?

As Pennycook (1996) and Leki (1998) point out, L2 literacy research has been slow to acknowledge and build on the developments in L1 literacy research. Whereas the latter views literacy as a social practice, the former is still discussing it in terms of the mechanics of reading and writing. With respect to L2 writing research, Leki (2003) observes that it has become "somewhat undertheorized, not in terms of developing or debating specific aspects of L2 writing but in terms of connecting what we do to broader intellectual strands,

domains, and dimensions of modern thought and contemporary lived experiences" (p. 103).

A similar and even stronger argument may be raised with regards to L2 reading research where it seems that the social turn (Trimbur, 1994) characterizing the intellectual debates across various fields including L1 literacy has somewhat passed by without influencing the area in any noticeable ways.

Meanwhile, L2 writing research, SLA research, L2 academic literacy research have begun exploring the potentials offered by other disciplines and methodologies and have begun interpreting their findings within the broader intellectual debates permeating the social research world of today. A sister discipline, L2 writing research, has engaged in fruitful explorations of written products, processes and writers' identities from sociopolitical and sociocultural perspectives (see the special issue of the *Journal of Second Language Writing* which features Casanave, 2003; Atkinson, 2003; Leki, 2003; Matsuda, 2003; Hyland, 2003 among others).

Calls for more situated studies of reading have been made extensively by many in the field of L2 reading research. Grabe (1997), for example, in his call for more reading research in general suggests that "any effort to account for reading processes needs to consider *social context factors and motivation and affective factors* which influence reading comprehension and the development of reading abilities" (emphasis original, p. 239). Penningroth (1997) strongly argues that studies have so far failed to answer in meaningful ways what she calls "the central question about L2 reading: How do L2 readers make sense and meaning from authentic texts in the target language?" (p. 4). In order to bridge the gap, she calls for an approach which considers the reader as a socially, politically, and ideologically situated actor and accounts for the contextual exigencies that the reader draws upon to interpret texts (p. 8). Most recently, Strømsø and Bråten (2002) have urged L2 reading researchers to turn to methodologies which go beyond experimental lab settings so that to observe naturally occurring reading processes and practices by thus extending our understanding of what it means to read.

It is within these ongoing calls for more socially oriented research in reading employing naturalistic methodologies that this study has been conceptualized and carried out. In the section containing a focused review of some areas of research, I will discuss specific studies to suggest ways in which reading research may benefit from more studies of situated reading.

2.2.3. Struggles with "context"

Several factors may have contributed to the failure of L2 reading research to engage in the analysis of L2 reading as situated in particular contexts, one of them being the elusiveness of the notion of context itself. While it is true that the importance of context has become acknowledged, actual descriptions of what it means when we say "context" are still lacking (Grabe and Stoller, 2002). This is reflective of the broader field of applied linguistics, where as Parks and Maguire (1999, referred to in Leki, 2000, p. 108) suggest, context has been "evoked but not explored" (p. 144).

Grabe and Stoller (2002) in their extensive review of L2 reading research discuss three aspects of context: (1) contexts for L2 reading instruction" (p. 68); (2) "social-context influences on L2 reading" (pp. 68-69); and (3) "learning from context for reading comprehension" (p. 74). Their review highlights that context can be understood at different levels: instructional levels of classrooms, broader social influences, and more immediate surroundings of the text being read and the student's background knowledge of it.

It is probably in advanced academic literacy circles that this multi-levelness of context has been taken into account more and more in recent research. Here, the various levels are not treated as necessarily exclusive of each other but as comprising one whole notion of "context". Leki (2000), for example, defines context as "both immediate contexts of educational settings and personal histories … as well as more distant contexts of social, cultural, economic, political, and ideological environments" (p. 108). I will refer to advanced academic literacy research in order to situate this study with respect to current discussions of context in it.

2.2.4. Implications for this study

By way of summarizing this overview section, the following implications can be drawn with respect to this study:

1.   there is a lack of research, especially in L2 reading, which has studied reading as situated in particular contexts;

2.   more studies are needed which would employ naturalistically-oriented research methodologies; and

3.   the notion of "context" needs clear conceptualizations in specific studies of reading.

Taken together, these implications point to the need for a naturalistic study of L2 reading which would study reading in contexts of its natural occurrence and be based on clearly-defined conceptualizations of context.

2.3. Studies of importance for this research

In this section of the chapter, I will review five areas of research which are particularly relevant to this naturalistic study of postgraduate reading. Although the literature overlaps in some cases, it generally fits into the following major categories: reading-writing connections, expert vs. novice reading, intertextuality in reading, multimodality, and academic literacy development. In reviewing studies in these areas, I will refer to both L1 and L2 research in order to suggest in which ways L2 studies of reading may benefit from parallel studies in L1. While reviewing each group, I will highlight the innovative nature of the research in each area, the limitations of conceptualizations, and relevance to the current study.

2.3.1. Reading-writing connections

Of special interest to this study is research on reading-writing connections which has broadened our understanding of reading and writing as well as the interactions between them. The history of research in this area is fascinating, and recently several insightful accounts have emerged. The interested reader is referred to Matsuda (2001) who traces the

history of reading-writing research and pedagogy by linking it to the history of audiolingualism in language education, Nelson and Calfee (1998) who view reading-writing research within the history of American education over several centuries, Langer and Filhan (2000) who look at reading-writing research from the perspective of developments in L1 literacy education, and finally Grabe (2001, 2003) whose succinct reviews of both L1 and L2 research on reading-writing connections provide numerous suggestions specifically for L2 researchers and educators.

Here I will limit the review to some major issues which have interested both L1 and L2 reading-writing researchers and to the major contribution this trend in literacy research has made. The discussion will be structured around (a) L1 research and (b) L2 research. Though this is not a study of first language reading and writing, a brief review of L1 reading-writing connections is important because it has traditionally been at least one step ahead of L2 reading-writing research and the latter has often drawn on it for its own methodologies and research questions (Grabe, 2001; Eisterhold, 1990).

2.3.1.1. Reading-writing connections in L1 research

In L1 research, Nelson and Calfee (1998), drawing on Bakhtin's (1986) notion of centripetal forces, identify several theoretical movements which have been instrumental in bringing attention to studying reading and writing as both interacting and co-influencing each other. Table 2.1 presents these movements and their views on reading-writing connections.

Table 2.1. Centripetal forces in L1 research (based on Nelson and Calfee, 1998)

Theoretical movement	View of reading-writing connections
Comprehension and composition as construction	Both reading and writing involve active construction of meaning
Reader response	Both reading and writing involve individual and subjective responses to texts
The writing process and process writing, including writing across the curriculum	Both reading and writing are recursive, with writers and readers moving back and forth from one sub-process to another
Whole language	Different modalities of language (i.e., reading, writing,

	listening and speaking) develop holistically, in concert with one another
Discourse communities	Reading and writing involve processes and products of meaning making which are tied to groups; reading and writing are part of the social construction of knowledge

Overall, several conceptualizations of reading-writing relationships have emerged over the years of research both within and between the theoretical movements discussed by Nelson and Calfee (1998). If between 1980 and 1990, researchers were primarily interested in writing and reading as (1) having parallel operations in common; (2) having the ability to interact with each other; and (3) influencing and co-constructing each other (see Kucer, 1985; Eisterhold, 1990); these days, reading and writing are conceptualized as (1) interacting not only with each other but also with learning and as (2) being dependent on social contexts (see Langer and Filhan, 2000). It is the latest findings in L1 reading-writing research that will be discussed below.

One major strand of research has evolved around the question of how students utilize multiple texts when producing their own. In their study, Gradwohl-Nash, Schumacher, and Carlson (1993) observed that the students tended to use the first text to establish a reference frame of events and expanded this frame with reading subsequent texts. Stahl and colleagues (1996), in a study of high school students, suggested that the students learned from the first two history texts but not much more from the subsequent texts, and that reading multiple texts helped the students to question the authority of texts. Perfetti, Britt, and Georgi (1995) found that after two revisions of the summaries based on multiple texts, the university students of the study did not add more information to the summaries; however, they did change their positions and stance based on the consequent texts.

Collectively, these and other similar studies have pointed out that task factors have a significant effect on how students read and how they integrate multiple texts into their own texts by thus suggesting the highly situated nature of reading and writing. These studies have also argued that reading multiple texts provides basis for more learning and construction of complex knowledge (Grabe, 2001, 2003) as well as for developing critical

stances towards texts (Stahl et al., 1996). As Grabe (2001) observes, no equivalent studies have been conducted in L2 research, though there have been a few studies which examine transfer of information from reading to writing. For example, studies by Johns and Mayes (1990) and Campbell (1990) show that lower-level students engaged more in copying rather than transforming and synthesizing across textual segments and that L2 students relied more heavily on texts in their summaries than L1 students.

In addition to the growing conceptualization of reading-writing connections as being important for learning, another major development observed by Langer and Filhan (2000) is the growing popularity of studying reading-writing connections as socially situated literacy events (Street, 1984). One interesting strand of research in this area has been concerned with how interactions between readers and others around textual meanings support literacy development. Studies by Pressley and his colleagues (Pressley, 1998; Pressley and Woloshyn, 1995; Pressley et al., 1992), Beck and her colleagues (Beck and McKeown, 2001; Kucan and Beck, 1997; McKeown and Beck, 1998) and Wells (1996, 1999) strongly argue that dialogue and interaction around text comprehension and writing positively affect literacy development. This area may prove to be fruitful for future L2 literacy research, and I will return to it in the section below where I examine studies of expert vs. non-expert reading.

2.3.1.2. Reading-writing connections in L2 research

Though in 1984 Krashen was already suggesting that "It is reading that gives the writer the 'feel' for the look and texture of reader-based prose" (p. 20, quoted in Eisterhold, 1990, p. 88), reading-writing connections as an area of inquiry has not received as much attention in L2 research as yet (Grabe, 2001, 2003; Carson, 2001; Johns, 1993, 1997). Slowly, however, there has been a considerable increase in studies attempting to bridge the gap in this area, and as a comprehensive review by Grabe (2001) shows, there are at least 4 issues which have become of particular interest to L2 researchers (see Table 2.2 below).

Table 2.2. Areas of interest to L2 researchers investigating reading-writing connections (based on Grabe, 2001)

Research area	Some existing research
L1 transfer	Durgunoglu and Verhoeven, 1998; Carrell and Connor, 1991; Carson et al., 1990
L2 language proficiency	Bernhardt and Kamil, 1995; Bossers, 1992; Carrell, 1991; Verhoeven and Aarts, 1998
Extensive reading for writing improvement	Elley, 1991, 1996; Tsang, 1996
Reading and writing demands on L2 students and rethinking of EAP instruction to incorporate both reading and writing together	Leki and Carson, 1994, 1997; Johns, 1993, 1997; Swales, 1990, 1998; Zamel, 1992; Carson, 2000; Silva, Leki, and Carson, 1997

Of significance to this research is the last area specified by Grabe (2001) which links reading-writing connections to EAP concerns. In 1993, Johns argued for the importance of teaching advanced students to synthesize information from multiple texts in EAP contexts. She pointed out needs analyses had to be conducted in authentic academic settings to determine the kinds of tasks that students may need to engage in which would require a combination of reading and writing together. She suggested that EAP practitioners could then use the insights gained from this kind of needs analyses in constructing their own instructional materials and lessons.

In line with Johns' (1993) suggestions, Carson's study (2001) of academic tasks involving reading and writing went beyond the previous research which relied extensively on surveys of faculty and student perceptions (cf. Casanave and Hubbard, 1992; Jenkins, Jordan, and Weiland, 1993) and included multiple sources of data collections involving interviews with students and faculty and analysis of textual products and tasks. She examined academic tasks across levels (undergraduate and postgraduate) and disciplines and pointed out that there were interactions not only between reading and writing but between all the four skills at both undergraduate and postgraduate levels across disciplines of study. An ability to integrate writing and reading was especially important at the postgraduate level.

Another study which answered Johns' (1993) call for more naturalistic research was Jiang's (2001) analysis of three PhD students' writing and reading processes involved in writing a research paper. Since this study provided detailed descriptions of the students' reading processes and since the context of the study resembles the context of this current research, I summarize the three cases presented in Jiang (2001) with a particular focus on the students' reading (see Table 2.3). Together, these cases suggest that though the three students engaged in very similar reading strategies, they differed in terms of how they perceived their roles as readers and writers, the specificity of the goals they had set (or failed to set) for their writing assignments, and the level of engagement with texts.

Table 2.3. Jiang's (2001) PhD students

Sheen	Dah	Yah
• Strategies: gaining the overall meaning of the text; analyzing vocabulary and complex syntactic structures to understand text; scanning titles, topic sentences, keywords; using references for locating future readings • believed that reading formed a basis for the solid preparation for writing the research paper • had her outline of the paper in her mind when engaging in focused reading and monitoring	• Strategies: using references for locating future readings; analyzing grammatical structures to understand text; scanning titles, topic sentences, keywords • could not locate one source and therefore had to abandon one of her hypotheses • did not bother about unknown vocabulary, unless the words were crucial for meaning • grouped texts according to hypotheses • focused on hypotheses, methodological design and discussion • circled key words, underlined important information, put an asterisk next to sections for use in writing and wrote notes on margins	• Similar strategies but • had to read everything to understand the meaning of text • translated many words into Chinese • had to read and reread sections, sometimes aloud to understand them • was concerned with highlighting main points and trying to remember them • did not know what exactly she was looking for and was often concerned with words and remembering things • did not have the plan in her head and had very little idea of what she was going to do with her paper

2.3.1.3. Implications for this study

Though the current research is not about reading-writing relations per se, it is expected that the postgraduate students of this study are very likely to engage in reading within broader writing tasks (Carson, 2001). Therefore, the following implications are derived from the literature reviewed here with regards to this study:

1. reading is not a bounded process as it has often been conceptualized in previous reading research since the research on reading-writing connections has clearly shown that reading and writing co-influence and interact with each other (as well as with other activities);

2. reading across multiple texts so that to construct own texts may be an important aspect of academic education across various levels and may enhance the students' learning and critical awareness of textual authority;

3. dialogue and interaction around reading and writing may positively affect literacy development; and finally

4. there is still a dearth of research in the area of reading-writing relations.

2.3.2. Expert vs. non-expert readers

A major area of research which has also discussed, to some extent, connections between reading and writing is presented by studies of expert and novice reading. These are reviewed separately here because in addition to reading-writing connections, the studies have been interested in investigating numerous other issues. In reviewing the literature, I will focus on two major issues: (a) the role of author in expert and novice reading, (b) reading processes of expert and novice readers, and (c) Pressley and Afflerbach's (1995) theory of expert reading. As before, the section will conclude with some specific implications of this area of research for the current investigation.

2.3.2.1. Reading processes of expert and novice readers

Haas and Flower (1988) were among the first to investigate and compare the reading processes of undergraduate and postgraduate students in considerable detail. In their study, they analyzed L1 students' reading in terms of strategy use and distinguished between the following strategies: (1) content strategies (those dealing with the content or topic of the text), (2) function/feature strategies (those referring to conventional features of discourse), and (3) rhetorical strategies (those aiming at constructing the author's purpose, the context in which the text was written, the possible audience for the text, etc.).

According to their analyses, postgraduate students used rhetorical strategies more frequently than undergraduate students, and the latter read mostly arhetorically. Haswell et al. (1999), in their replication of Haas and Flower (1988), arrived at the same conclusion, but in addition, they noticed that postgraduate students used more personal narratives and more judgments when commenting on the texts they read, while the undergraduates employed mostly noncommittal comments. Hypothesizing that Haas and Flower's (1988) undergraduate participants failed to use rhetorical strategies not because they were not aware of them but because of the lack of content knowledge of the text, Haswell et al. (1999) conducted an additional study in which the students were given a text on a familiar topic. Though the proportion of judgmental comments used by undergraduate students remained low, both undergraduates and postgraduates increased their reliance on rhetorical strategies as well as their use of personal experiences as comments. The authors concluded that it would be premature to suggest that undergraduate students cannot read rhetorically, and argue that even undergraduates can read rhetorically in certain contexts, for example when the topic of the text is familiar to them.

The issues of knowledge and topic familiarity have been more thoroughly investigated in relation to reading processes in such areas as cognitive psychology. Lundeberg (1987), for example, raised the question of "What knowledge and strategies do experts use to understand and analyze a legal case?" She found that knowledge of context and text type was one of the main aspects of experts' reading, and that strategies, or

purposeful behaviors the readers engaged in to understand the meaning of texts, differed between experts and students of law.

Leinhardt and Young (1996) worked with historians, who are "extraordinary, rather than typical, readers", as they admit. The historians in their study had to read a familiar and an unfamiliar, though still familial historical, text. The researchers found that the reading style of the historians differed depending on which text they read: more evaluation and more involvement were found with familiar texts.

Leinhardt and Young (1996) used an elaborate model of document reading in their analysis of historians' reading. They started with the assumption that historians have schemas for identification and interpretation. Identification, according to them, includes identifying the type of the text, corroborating the internal consistency of the text as well as its consistency with other sources, identifying the author of the text, as well as the time and place of its production, and finally placing the text within a family of documents. Interpretation, according to Leinhardt and Young's (1996) framework, could be textual, i.e., "responsive to the actual surface features of the text" (p. 449), as well as historical, i.e., "driven by a historian's unique historical perspective and experience" (p. 449).

These and other studies of expert vs. novice reading highlight the complex processes involved in disciplinary reading. They suggest that knowledge of the textual content may be an important factor in the ability of the reader to engage in such processes as responding to and evaluating texts. As the studies reviewed below, these studies suggest that expert readers may be more attentive to and reflective on the role of the author and their deliberate choices and intentions in writing the text (Haas and Flower, 1988), as well as their hidden meanings (Leinhardt and Young, 1996).

2.3.2.2. The role of author in expert and novice reading

Studies of academic discourse coming from the perspective of dialogicality (Bakhtin, 1986) argue that an academic "text anticipates a reader's response and itself responds to a larger discourse already in progress" (Hyland, 2001, p. 551). According to this view,

successful academic writing involves an awareness of the intended audience (Bazerman, 1988; Hyland, 2001; Swales, 1990; Glanville, Sengupta, and Forey, 1998). Several studies of specific "addressee features" (Hyland, 2001, p. 549) have been conducted to show how writers draw readers into a dialogue (Hyland, 2001; 1998), as well as how they project a certain image of themselves and their stance towards the subject matter (Koutsantoni, 2004).

At the other side of the continuum, studies have emerged on how readers relate to authors and whether they recognize features of the texts which are assumed to be directed at establishing relationships with them. Within this area, some researchers have been interested in the role that authors play in readers' understanding and evaluation of disciplinary texts. Bazerman's (1985) study of physicists reading disciplinary journals to keep up with the developments in their disciplinary fields shows that the scholars often made their decisions on what to read on the basis of what they knew about the author. Some of them knew other authors' work so well that they did not need to read complete texts to know what they were about and limited their reading to scanning through texts or reading the title and the references. How some of the scientists evaluated the texts they read also depended on what they knew about the author.

Like Bazerman (1985), Geisler (1991) also studied expert reading; however, instead of interviews used in Bazerman's study, she asked her 2 experts in philosophy to think aloud while reading several texts on the same topic written by different authors. She observed that the protocols contained numerous mentions and references to the authors as well as comments on the authorship of certain claims. Geisler (1991) discussed the experts' reading in terms of a conversation in which different people (in this case, the reader and the writer) take different positions. She suggested that readers enter into conversations with authors while reading texts and form their responses based on their perceptions of the authors.

Wineburg in a series of studies of historians (1991a, 1991b, 1994) developed the notion of a conversation further. He showed that the historians of his studies, when reading

historical texts, engaged in conversations which were enhanced by their reading of both the literal text as well as its subtext. "Reading" the subtext involved (1) inferring the author's goals behind using certain textual elements, (2) reflecting on how such choices could affect other readers, and (3) inferring the author's biases, theories, intentions, and assumptions.

Both Geisler (1991; and later, Penrose and Geisler, 1994) and Wineburg (1991a, 1991b, 1994) involved experts and novices in their studies. Geisler (1991) and Penrose and Geisler (1994) found that the novices in her study made considerably fewer references to the author. Penrose and Geisler (1994) compared a freshman and a PhD student of philosophy in how they wrote an essay from 8 sources. The PhD students saw the sources as authors with whom he could engage in conversations and saw his essay as construction of knowledge, while the undergraduate student engaged in transferring information and did not perceive herself as a conversation participant.

Wineburg (1991a) found that students related to texts as to sources of facts to be remembered, while experts read texts as rhetorical constructions of specific authors. He explained that both experts and novices displayed a considerable amount of knowledge about the topic of the texts before reading them (as assessed through a background knowledge test), and hence the difference in their responses to texts could not be attributed to the difference in the amount of knowledge they possessed.

Unlike Wineburg (1991a, 1991b), Johnston and Afflerbach (1985) and Afflerbach (1990) suggest that their readers' interactions with the author of the text were dependent on the availability of background knowledge. Anthropology professors and postgraduate students in both anthropology and chemistry were involved in these studies. The authors showed that those with extensive prior knowledge in anthropology engaged in mental conversations with the author, e.g., suggesting the author's implicit purposes and even recommending additional texts by the same author. Those with little background knowledge had to resolve to "a position of blind faith in the author" (p. 96). Lacking knowledge to read critically, they were in "a social contract with the author of the text" (p. 96), believing that the author would not want to mislead them.

Haas (1994) took a methodologically different approach and instead of short studies of several readers, she engaged in a longitudinal naturalistic study involving one biology student. In the first year of her undergraduate program, the student rarely referred to specific authors when discussing her readings with the researcher; instead, she made general comments such as "the book says." The student was required to read research articles from the very beginning of her undergraduate work; however, only 2 years later did she begin reflecting on authors as scientists who have specific motives. By the last year of her undergraduate program, the student developed an elaborate understanding of authors in the discipline, paid attention to authors when reading and even noticed the dates of publications.

As a group, the studies reviewed above suggest that disciplinary reading is often a mental conversation the reader engages in with the author of the text. Awareness of the author emerges as an important aspect of disciplinary reading and is sometimes associated with growing expertise in a disciplinary field (Afflerbach, 1990; Pressley and Afflerbach, 1995). Though the research covered here has resulted in important insights about the interactive nature of disciplinary reading and the role of author in it, most of it has been conducted in controlled settings where the researcher was in control of the texts and reading purposes. To follow the tradition set up by Bazerman (1985) and Haas (1994), more research needs to be conducted in settings where readers engage in reading for their own purposes and as part of their own usual activities.

2.3.2.3. Pressley and Afflerbach's (1995) theory of expert reading

Studies such as the ones reviewed above have served as the basis for Pressley and Afflerbach's (1995) theory of constructively responsive reading. According to their theory, constructively responsive reading is reading performed by experts and is strategic, metacognitive, knowledge-based, and social (p. 115). The importance of Pressley and Afflerbach's theory is in its acknowledgment of, growth upon, and synthesis across the previous theories and models of reading. An additional contribution lies in the fact that

Pressley and Afflerbach synthesize research based on the use of think-aloud data. Through their grounded analysis (Glaser and Strauss, 1967) of 38 primary studies of reading involving think-aloud protocols starting from early 1980s, they suggest that many processes (including social interactions) readers carry out as they read can be reflected by think aloud protocols.

Finally, with regards to social aspects of reading, in particular, Pressley and Afflerbach (1995) say:

> One especially disappointing characteristic of the protocol analysis literature is that social contextual variables were largely ignored in these studies. Even so, the social aspects of reading were present in some of the reports of subjects determining meaning, monitoring, and evaluating, consistent with our perspective that reading is a socially embedded activity. Reading is wedded to social contexts and social uses: A reader may use knowledge gained from reading to engage in a debate or to share with a colleague. A reader working through a difficult task may monitor the construction of meaning with respect to a social criterion, such as whether enough has been learned from the text to use the information in an upcoming discussion. Readers attempting to determine an author's intent, bias, or agenda often consider the social context in which the text was constructed.
>
> (p. 82)

The authors conclude that social aspects of reading may become a fruitful area in future reading research involving the think-aloud as a method of data collection.

2.3.2.4. Implications for this study

The review of the literature in this section appears to suggest the following implications for this study of postgraduate reading:

1. readers with expertise in certain domains such as disciplinary fields may engage in reading processes and interactions which are qualitatively different from those of novices;

2. readers may engage in mental conversations with authors, and the level of engagement may depend on the reader's knowledge of the content discussed by the author;

3. think-aloud protocols may provide a window to the processes and interactions readers engage in when dealing with disciplinary texts; and finally

4.   they have a great potential of contributing to furthering our understanding of social

aspects of reading.

Taken together, these implications point to (1) the need for more research building

on the studies of expert and novice reading and (2) the potential of naturalistic studies of

reading which consider readers' purposes, settings, and needs for reading.

2.3.3. Intertextuality

In section 2.3.1 above, while discussing the most recent research on reading-writing

connections, I have introduced some studies of writing from multiple sources. While

reviewing studies of expert reading, I have additionally pointed out that that experts tend to

evaluate texts they read with respect to other texts they may have read before. Both strands

of research, thus, present moves beyond the "single-text paradigm" (Strømsø and Bråten,

2002, p. 208) in literacy research and explore intertextual aspects of reading and writing.

In this section, I will further develop an argument that reading is not a bounded

process and it is not bounded to one text. The review is structured around the following

points: (a) the notion of intertextuality, and (b) intertextuality in reading research.

2.3.3.1. The notion of intertextuality

The term *intertextuality* was first coined in 1960s by Kristeva (1980) who, drawing

on Bakhtin's (1981) notions of dialogism and heteroglossia, argued that "any text is a

construction of a mosaic of quotations; any text is the absorption and transformation of

another" (p. 66). Intertextuality, in its most general definitions, stands for the complex

interactions between a text and many other texts. According to Kristeva (1986), it implies

"the insertion of history (society) into a text and of this text into history" (p. 39), which, in

turn, could be interpreted in two ways: (1) the text is built on and absorbs texts from the

past; (2) it responds to and reconstructs the texts from the past, and "in doing so helps to

make history and contributes to wider processes of change" (Fairclough, 1992, p. 270).

Various philosophical and theoretical discussions have evolved around the notion of intertextuality since its coinage, and the reader may find good reviews of these in Allen (2000), Hartman (1995), and Plett (1991). In applied linguistics, the notion has proven fruitful in discourse analytical studies. For example, Boje (2001) examines historical and social aspects of intertextual production and interpretation across various types of professional discourse. Tsang (2001) analyzes intertextual aspects of history compositions written by bilingual students in Hong Kong. Scollon, Tsang, Li, Yung, and Jones (1998) examine intertextuality in personal letters of school students. Chapman (1995) investigates mathematical discussions of schoolchildren, while Candlin and Maley (1997) focus on conflict resolution discourse. Most recently, Duff (2004) has examined intertextual references to pop culture in classroom discourse.

In academic literacy research, current interests in intertextuality have been reflected in the analysis of citation practices across various genres of academic communication. This work began with Swales' (1981, 1986, 1990) analysis of citations for pedagogical purposes. Some of most recent studies have heavily relied on the tools afforded by computerized corpora of texts and include those by Pickard (1995) who analyze citation practices of expert writers, Berkenkotter and Huckin (1995) who examine citations of a biologist trying to publish a study, Hyland (1999) who examines citations in research articles across disciplines, and Thompson (2000) who focuses on citation practices of PhD students.

Research findings suggest that an ability to make appropriate references to other texts is an essential feature of academic writing and publishing (Thompson, 2000). Several purposes of using citations in academic publications have been identified some of which are: (1) to provide support and to show novelty of one's work (Hyland, 2000), and (2) to establish a broader disciplinary context for individual claims (Myers, 1990). Hyland (2001), in his discussion of "the rhetorical construction of readers" additionally suggests that "[w]riters construct an audience by drawing on their knowledge of earlier texts and relying on readers' abilities to recognize intertextuality between texts" (p. 551).

In sum, the notion of intertextuality has become an accepted heuristic in studying social aspects of academic writing and highlights the situatedness of texts in webs of other texts and in historical relations to other texts.

2.3.3.2. Intertextuality in reading research

Several approaches to analyzing intertextuality have emerged in reading research as well. Fundamental to all these approaches is the question of what constitutes a text. In this review of literature I will draw on those studies which have conceptualized text as a material entity incorporating "meaning potential…into the fabric of linguistic structure" (Halliday, 1973, p. 42). For an excellent review of studies of intertextual reading which expand their definition of text to include any sign that communicates meaning (i.e., dreams, pictures, sounds), the reader is advised to refer to Egan-Robertson (1998) who views intertextuality through the lens of critical discourse analysis.

Intertextuality in reading research means the practice of referring to other texts while reading the one in hand. One of the earliest researchers of intertextual reading was Hartman (1992, 1995), who conceptualized intertextuality as a cognitive construction in the reader and analyzed it by tracing the links the eight readers of his study made to other texts in their think-aloud protocols. The major question he raised was "What types of connections do readers make while reading multiple passages?" (1995, p. 523). Hartman (1995) identified three kinds of textual resources the students drew on while making intertextual links: (1) primary endogenous (those located within the text the students were reading at the time of the think-aloud), (2) secondary endogenous sources (those located in the remaining four texts provided by the author), and (3) exogenous sources (those located outside of the five texts of the study).

Two major conclusions emerged: (1) that reading involved an orchestrated effort on the students' part to draw upon links between various texts to make sense of the texts with respect to each other, and (2) that the readers revised their previous textual connections as

a result of reading new texts. In short, intertextuality in reading involved not only making new connections between texts but also revising the connections established previously.

In addition to intertextual linking processes, Hartman (1995) observed that the connections the students made were not neutral and that the students assumed certain "discourse stances" towards the texts they read which affected their linking processes. He identified three types of discourse stances: (1) a logocentric stance, meaning that the reader tended to limit the intertextual links to primary endogenous sources and buried himself in one text trying to understand it on the basis of the information available in it; (2) an intertextual stance, meaning that the reader was more open and eager to go beyond one text and construct its meaning with respect to other texts; and (3) a resistant stance, meaning that the reader was interested in constructing his own personal meaning of the text rather than in deconstructing the meaning intended by the author.

Hartman's study (1992, 1995) ushered a new wave of research into the nature of reading, and especially contributed to our understanding of the role of prior knowledge in reading. Proposing intertextuality as an alternative to other theories of background knowledge such as schema theory, Hartman (1995) argued that "prior knowledge is not something that readers merely bring to the passage and unload before they read; rather, it is something that is utilized, constructed, and reconstructed by readers throughout reading" (p. 558).

The first study which applied the notion of intertextuality to the analysis of L2 reading was Chi (1995) in which 10 university students in Taiwan read two stories in English. Unlike Hartman (1995), who relied primarily on think-aloud data, Chi utilized three methods of data collection: (1) the students reported their thoughts verbally during the first readings of the texts; (2) they were asked to make additional comments during the second reading of the text; and (3) after the two readings, the researcher asked the students whether they had thought of any other stories while reading the texts.

Chi (1995) identified four major patterns in the students' use of intertextuality: (1) storying, i.e., using the current text to describe another story, (2) integrating, i.e., applying

the knowledge of the native culture to interpret the text being read and vice versa, (3) evaluating, i.e., generating own views or conclusions by comparing the text being read with previous texts, and (4) associating, i.e., linking the text being read with previous texts without additional explanation. Chi concluded that for the students of her study, intertextuality was "an effective strategy for making meaningful and personal sense of a text" (p. 643).

Like Hartman's (1992, 1995), Chi's (1995) study was quasi-experimental in design; it involved texts selected by the researcher and assumed to be of interest to the students. Various aspects such as social context of the classroom and the students' motivations were not taken into account.

A PhD study conducted by Penningroth (1997) was set in a foreign language classroom but, instead of multiple participants, involved only one student of German as a foreign language. Drawing on Hartman (1995) and Chi (1995) for her intertextual analyses and on situated literacy theorists such as Street (1984) and Gee (1992) as part of her overall theoretical framework, Penningroth included such aspect of context into her analyses as the personal history of the student, his prior experiences with L1 and L2 literacy, and the features of the course from which the text the student was asked to read was taken. With respect to intertextuality, Penningroth found (1) that the student used the text as "a point of reference in interpreting the [other] texts read for class," (2) that "classroom instruction in strategic reading affected his reading of the study texts," and (3) that his exposure to other texts, including other texts in the classroom, "affected the background knowledge he used to interpret the text" (p. 222).

The only study that went beyond classroom settings to analyze intertextuality in reading, to my knowledge, is the naturalistic study by Strømsø and Bråten (2002) of seven undergraduate law students in Oslo reading for their law classes. In addition to previous research on intertextuality, this study drew on Perfetti, Rouet, and Britt's (1999) concept of intertext models according to which at least two kinds of information are attached to individual texts in readers' minds: (1) information about the text per se, such as the author,

type of text, date and place of publication, and (2) relationship of this text to other texts and to viewpoints of different authors. Studies of expert reading reviewed in section 2.3.2 above reveal that experts often note this information about the texts they read (Lunderberg, 1987; Wineberg, 1996), and some students may at least discuss this information when asked about their choice of specific texts for reading (Perfetti et al, 1995).

Strømsø and Bråten (2002) analyzed the changes in the linking processes of several students across a variety of tasks they engaged in as part of their studies. The researchers found that the students changed significantly their linking processes and traced the development of their individual intertext models. An additional finding, which had not been observed in previous studies of intertextuality, was the importance of the students' self-generated notes in their linking practices. The authors noted an interaction between the students' reading of self-generated notes and the reading of study texts. They explained that the students, when using their notes to reconstruct their understanding of previously read texts, often revised their previous understandings and sometimes even rewrote their original notes.

Collectively, the major impact of the studies reviewed above has been in their move beyond single-text reading. The importance of these studies is expressed particularly well by Penningroth (1997) who says,

> the study of intertextuality would not only be desirable, but would seem to be essential, if research is to describe extensively what an advanced reader does…Ultimately, the designation of "advanced" may be no more and no less than a much more elaborated capability on the part of the reader to link diverse textual- and reader-based ways of making meaning.
>
> p. 20

2.3.3.3. Implications for this study

Within the context of this research, the overall importance of the literature reviewed in this section lies in the fact that it has moved beyond the notion of fixed texts and suggested the heteroglossic nature of texts which are connected to and reflect each other. Some specific implications for this study of postgraduate reading are:

1. intertextual reading is an important feature of any reading, and it may be especially crucial as an aspect of postgraduate reading;

2. students reading a text engage in establishing and revising connections between various texts, and the amount of their linking processes may depend on the stance they assume to texts;

3. background knowledge is not a fixed entity; it is highly fluid and gets reconstructed with reading of new texts;

4. readers, while expanding their intertextual links, also develop their mental intertext models which include information about the text and relationship of it to other texts;

5. contextual factors, such as classroom and reading purposes, may affect readers' linking processes; and finally

6. there is a need to learn more about intertextual linking under naturalistic conditions in reading authentic texts for authentic purposes (Strømsø and Bråten, 2002; Hacker, 1998).

2.3.4. Multimodality

If research on intertextuality in reading argues that reading is not bounded to one text, research on multimodality further argues that reading is not bounded to linguistic modes of communication. This section of the chapter presents a review of theory and research on the integration of multiple modes such as language, visuals, and numerical signs in human communication. My aim is twofold: (1) to sketch out what has been done in research on multimodality and (2) to frame the current study based on the implications derived from the review.

2.3.4.1. A multimodal view of texts

Current research dealing with issues of text production and comprehension has increasingly pointed out that texts are multimodal in that they realize meaning through the integration of multiple modes of communication and not only through language (Kress and

van Leeuwen, 1996, 1998; Thomas, 2004; Stenglin and Iedema, 2001). Texts, it is often argued, are becoming increasingly more multimodal as the role of visuals and other modes of communication increases in various domains of public life (Kress and van Leeuwen, 1996, 1998; Raney, 1998; Thomas, 2004) and as the existing technology evolves to incorporate diverse sign systems (see two special issues in *The Reading Matrix*, for 2002 and 2003).

Historical studies of scientific communication by Bazerman (1988), Myers (1990), Atkinson (1999), and Gross, Harmon, and Reidy (2002) have also pointed out an increase in the importance of various modes in scientific argumentation. This increase is especially apparent in Gross et al.'s study (2002) of a large corpus of scientific publications from various journals and in various languages over four centuries (from the 17th to the 20th). Specifically, this study shows a constant increase over the centuries in the amount and significance of numbered tables, figures, and equations in scientific articles and explains it in terms of the increasing mathematization and quantification in science.

Current research in sociology of science also indicates that visual forms of communication play a central role in the creation and communication of scientific knowledge (cf., Lynch and Woolgar, 1990; Law and Lynch, 1990; Myers, 1990, 1992; Shea, 2000; Latour, 1987). Issues which have been explored here include the constructed nature of scientific visuals (Bastide, 1990; Lynch, 1985; Lynch and Woolgar,1990), the role of scientific visuals in the construction of arguments and supporting claims (Miller, 1998; Myers, 1990; Latour, 1987), the transformation of raw data into evidence through construction of visuals (Latour, 1990; Amann and Knorr Cetina, 1990), the development of visuals through scientific periods (see a collection edited by Shea, 2000), and the use of visuals across hard and soft sciences (Smith, Best, Stubbs, Johnston, and Archibald, 2000; Latour, 1990).

In literacy research, numerous calls have been made to take the multimodal nature of texts into account in order to understand better how students learn to make meaning through multiple sign systems. Among these, the New London Group (1996) and Stroupe

(2000), for example, have suggested that multiple modes of meaning making (and not only verbal language) need to be studied and taught, referring to these multiple modes of communication as *multiliteracies* and *a hybrid literacy*, respectively. With regards to TESOL practices, in particular, Kress (2000) has argued that,

> It is now impossible to make sense of texts…without having a clear idea of what these other features might be contributing to the meaning of the text…TESOL professionals continue to act as though language fully represented the meanings they wish to encode and communicate…It is time to unsettle this commonsense notion.
>
> (p. 337, quoted in Petrie, 2003, p. 139)

Kress' and others' calls have been answered by a growing amount of research on multimodality, which itself has become increasingly diverse in terms of approaches and theoretical underpinnings (see van Leeuwen and Jewitt's (2001) *Handbook of visual analysis*). Much of the research, however, has concentrated on the area where visual and language (linguistic) modes intersect (see Rowley-Jolivet, 2002; Johns, 1991, 1998). The analytical focus has yet to extend to other modes of communication such as equations and mathematical language, sounds and movements, though some research does exist in these areas as well, as will be shown below.

In the following sections, I divide the review into three issues which are of particular interest to this study. These are: (a) interactions between linguistic and non-linguistic modes in texts, (b) visuals in meaning making, and (c) social situatedness of construction and interpretation of visuals.

2.3.4.2. Interactions between linguistic and non-linguistic modes in texts

Several researchers have analyzed various genres of written communication to find out how linguistic and non-linguistic modes interact to create meaning within one text. Some studies have shown that visual and linguistic modes appear to be presented autonomous from each other within one text. Thus, Giaschi (2000), in her study of the portrayal of gender in ESL/EFL textbooks, found that certain messages were relayed only though visuals but not through verbal language in the textbooks, and similarly, Astorga

(1999), in her analysis of picture book images, found that some information was communicated only though images, while other information only though verbal language.

Other studies, on the contrary, have shown that linguistic and non-linguistic modes interact to present the same message (see Arizpe and Styles' (2003) analysis of children's picture books). Within these studies, those of Lemke (1998, 2000) are of particular relevance to this research because they involve an analysis of various research genres. Thus, Lemke (1998) observes that while verbal language is powerful when it comes to communicating meaning, it is also limited when it comes to expressing certain scientific meanings such as degree and quantity, relationships between variables, multidimensionality, and others. He explains that other modes in addition to language need to be utilized in scientific communication, and, for example, he reports that graphs are important for presenting experimental results and equations for presenting theoretical underpinnings of studies. Lemke (1998) further suggests that scientific concepts are "not verbal concepts, though they have verbal components" but are "semiotic hybrids" (p. 107), and implicit in this notion of hybrids is the dialogic relationship between the various modes.

According to this view, language and other modes are not necessarily autonomous from each other. Modes, such as visuals, which have often been termed "extra-" or "para-linguistic" (see Kress' (2000) observation on the matter) may be in complex connections with the linguistic mode. Lemke (1998), however, does not suggest that any two semiotic modes, when used together, sum up to one meaning. He argues that they may be reflective of each other but they are not equal to each other and present overlapping yet unique functions. Lemke's views are based on his analyses of visual and linguistic modes in scientific texts and are supported by Stroupe's (2000) analysis of visuals across diverse types of texts, who also points to "dialogically constructed relations between words and images…which can function as a singly intended, if double-voiced, rhetoric" (p 609).

In his discussion of "advanced multimedia literacy," Lemke (2002) further stresses the dialogic nature of the relationship between linguistic and non-linguistic systems when he says that,

> Semiotically, we never in fact make meaning with only the resources of one semiotic system: words conjure images, images are verbally mediated, writing is a visual form, algebra shares much of the syntax and semantics of natural language, geometric diagrams are interpreted verbally and pictorially…all meaning is made in the integration of resources from only analytically separable semiotic resource systems.
>
> (p. 23)

To sum up, the researchers mentioned in this section have been interested in how visuals, language, and other modes interact in the creation of meaning. While some researchers have shown that visuals and verbal modes are often used autonomously in texts, others have argued that there are complex interactions between various modes of communication. Though enlightening, the analyses underlying the studies reviewed above have been limited to the researchers' interpretations of their own meaning making processes. Studies reviewed in the next section have engaged real people in analyzing the importance of visuals in meaning making.

2.3.4.3. Visuals in meaning making

Much attention in recent research has been given to how both L1 and L2 students interact with visuals in the processes of comprehending and producing texts. Many of these studies highlight that that images appear to be integral to meaning making processes of students engaged in creating their own texts. Thus, a study by Bailey, O'Grady-Jones, and McGown (1996) found that images which were made available to the students acted as stimulants for a greater involvement with writing and for taking more risks with grammar, and a study by Canning-Wilson (2001) found that L2 students who were given image-based writing prompts did better with their writing assignment than those who had a prompt without visuals.

Interesting research has recently been published by researchers working on TOEFL. A study, for example, was conducted by Katz, Xi, Kim, and Cheng (2004) on the use of visuals in eliciting speech within the context of The Test of Spoken English (TSE). Drawing on a large body of literature on the comprehension and interpretation of statistical graphs, the study particularly benefited from theories which specify the cognitive processes underlying graph comprehension, these processes being: (1) encoding a visual feature of the graph, (2) interpreting the feature with respect to the graph. Like the earlier studies of graph comprehension (e.g., Carpenter and Shah, 1998), Katz et al. (2004) found that comprehension of graphs often occurred through cyclical processes of encoding and interpretation. They also found that that the more information was presented in a visual, the longer it took to comprehend it. The researchers concluded that graphs with fewer visual elements were easier to describe and led to better communicative quality of test takers' spoken descriptions.

Ginther (2001), in another study of TOEFL but within the context of listening tasks, found that test-takers preferred audio stimuli which were accompanied with visuals, though the effect of the visuals on the overall performance was not significant. She concluded that visuals accompanying audio stimuli made the audio texts easier to comprehend, more concrete and more memorable.

These studies echo the earlier findings of Mayer and colleagues (Mayer, 1984, 1989, 1993; Mayer, Bove, Bryman, Mars, and Tapangco, 1996; Mayer, Steinhoff, Bower, and Mars, 1995 and others) who, through a series of experiments, consistently found that (1) the information presented in language and visual sources must be complementary in order for facilitative effects of the visuals to occur, and (2) facilitative effects of visuals tended to reduce when the visuals appeared on pages separate from the verbal language. These studies also echo much earlier research which showed that illustrations had positive effects on children's comprehension of oral prose (Pressley and Miller, 1987), on learners' cognitive and affective responses to illustrated texts (Peeck, 1987), and on science students' comprehension of arguments relying on visual modes (Winn, 1987).

The studies reviewed above suggest that visuals may have a facilitating effect on the comprehension of verbal messages in texts. Some researchers, however, have also warned that illustrations and visuals may actually obstruct meaning making (Samuels, 1970; Levin, Anglin, and Carney, 1987), a warning which seems to have been strengthened with more recent studies of teachers' perceptions of the role of visuals in literacy development (Petrie, 2003; Burniske and Monke, 2001; Dexter, Anderson, and Becker, 1999).

Though the studies presented in this section have led to significant contributions in our understanding of the role of visuals in meaning making processes, most of them have involved experimental or quasi-experimental designs. I am aware of only few ethnographically-oriented studies in this area. Tang's (1991) study of two classrooms showed that students tended to pay only nominal attention to graphics and found it difficult to use the information presented in visuals effectively. Her later study (Tang, 1992) additionally showed that explicit instruction in the use of graphics was effective for students' comprehension and recall of information.

Johns (1993) presented the views shared by her engineering informants of the central role that visual information and related language play in grant writing where visuals serve the purpose of argumentation. She presents the grant proposal writers' discoveries about their evaluators and shows that these discoveries are not limited to linguistics presentation and argumentation. One of her informants suggested that inserting formulae into proposals made them "look more scientific" (p. 83); another informant explained that visuals have to be "interesting, yet not appear too commercial or glossy" (p. 83).

Students of her earlier study (Johns, 1991) also highlighted the importance of visuals and accompanying linguistic texts in biology. Her later study of economics students (Johns, 1998) showed that the case study student, Margaret, preferred the visual to the textual and used visuals to complete assignments for her joined writing/reading and microeconomics classes. Visuals played a primary role in her construction of arguments for the papers, with the prose being constructed after the visual to fit the visual. Finally, Rowley-Jolivet (2002) analyzed the role of visuals in scientific conference papers and identified various functions

visuals play in structuring presentation discourse. She found that some nonnative speakers of English who confessed they may not understand English at conferences, relied on math and visuals instead.

What all these studies collectively suggest is that there is a need for more research involving naturalistic methodologies into the importance of visuals (and other semiotic modes) in meaning making processes of students engaged in writing, reading, speaking and listening to texts. Most of the studies reviewed here (apart from the ethnographic studies by Johns (1991, 1993), Tang (1991, 1992), and Rowley-Jolivet (2002)) are situated within psychological paradigms of research, where little attention has been given to social aspects of multimodal meaning making. This aspect has attracted the attention of various other researchers whose work is reviewed in the section below.

2.3.4.4. Social situatedness of construction and interpretation of visuals

Situated literacy researchers have argued that visual images are socially and culturally situated and that their construction and interpretation depend on specific conventions (Kress and van Leeuwen, 1996, 1998; Stroupe, 2000). Based on this argument, critical discourse analysts further argue that visuals point to different forms of social interaction and construct meanings which are not necessarily transparent and universally understood (Thomas, 2004; Kress and van Leeuwen, 1996, 1998).

Much research has been stimulated by the work of Kress and van Leeuwen's (1996, 1998) who have been called "pioneers in analysis of the visual dimension of printed texts" (Garrett and Bell, 1998, p. 14). The underlying theory of their work is that of social semiotics according to which meaning is produced by social actors in social contexts. In their 1996 book, *Reading images: The grammar of visual* design, they present a framework for the analysis of visuals which includes three elements: (1) information value, i.e., the way in which the placement of various elements "endows them with the specific informational values attached to various 'zones' of the images: left and right, top and bottom, center and margin" (p. 183); (2) the visual weight of the elements of the text or

salience, i.e., "the hierarchy of importance among the elements, selecting some as more important, more worthy of attention than others" (p. 212); and (3) framing, i.e., the way in which "the elements of groups of elements are either disconnected, marked off from each other, or connected, joined together" (p. 214). They suggest that these elements of multimodal texts may set up particular reading paths, i.e. reading progressions, for readers to follow, some of which are more plausible than others.

In one of their publications, Kress and van Leeuwen (1998) present an analysis of front pages of four newspapers applying the framework described above. Through their analysis, they argue that newspapers position visuals and text, provide them with different degrees of salience and framing so that to encourage certain evaluations by readers of the reported events. Others have since appropriated Kress and van Leewuen's framework and have extended it to include more complex analyses of reader or viewer positioning (see Jewitt and Oyama, 2001). Some others have also applied this framework, especially in critical discourse analysis, and Thomas (2004), for example, traces "a preferred reading path" and "a hierarchy of meanings" through a newspaper advertisement (p. 53). She argues that the hierarchy implied by the authors of the advertisement reinforces the preferred interpretations and may influence the readers' stance to the text.

In addition to critical discourse linguists, cultural and media study researchers have also been concerned with the situated nature of visuals. Unlike others, studies in this area have been interested in the role of visuals in contemporary and emergent practices of different social groups studied within their formative historical contexts (see Lister and Wells, 2001). Consequently, they add such aspects to their analyses as (1) context of viewing, i.e., location of the visual and purpose of viewing it and (2) context of production, i.e., intentions and motives of image producers and distributors. However, like the previous group, researchers in this group also limit their analyses to their own interpretations of visuals and do not appear to involve real people (other than the researchers) making meaning of visuals in real situations and for real purposes.

2.3.4.5. Implications for this study

In concluding this section on the multimodal nature of texts and meaning making processes, the specific implications that are important for this study are:

1. views of texts have changed over the last decades from defining them exclusively as linguistic objects to arguing for the muldimodal nature of texts;

2. it is suggested that scientific communication depends on a combination of modes, where different modes interact together (and not autonomously) to convey meaning;

3. current studies show both in L1 and L2 that visuals may play a facilitating role in students' comprehension of spoken and written texts as well as in students' production of their own texts, spoken and written. These studies, however, have been largely experimental, and only few ethnographically-oriented studies have examined visuals and their use in naturally occurring contexts.

4. As Johns (1998) suggests, there is a need for a further exploration of "visual/textual interactivity" which she defines as "the ways in which language and visual representation interact within specific environments" (p. 186).

5. finally, it has been argued that visuals are socially situated in that their interpretation and construction are social context dependent. Studies in this area, however, have focused on researchers' interpretations of visuals rather than analyses of other people's processes of interacting with visuals.

Taken together, these implications point (a) to the need to be aware of the multimodal nature of texts in an investigation of postgraduate academic reading and (b) to the need to examine how postgraduate students make use of multiple modes of meaning making or semiosis in their reading of academic texts.

2.3.5. Advanced academic literacy research

Recent research in applied linguistics and related fields has been interested in disciplinary enculturation processes through which postgraduate students acquire advanced academic literacy needed for their successful completion of graduate programs and

socialization into disciplinary communities. *Advanced academic literacy* has been acknowledged to entail a set of complex skills and knowledge structures which involve more than the ability to read and write effectively, but also the knowledge of one's discipline, with its prevailing conversations (Bazerman, 1988), discourse conventions, and paradigms (Myers, 1990), research skills and ability to adapt to academic and social cultures of universities (cf., Braine, 2002; Hyland and Hamp-Lyons, 2002; Sengupta, 2004; Colombi and Schleppegrell, 2002; Angelova and Riazantseva, 1999).

Disciplinary enculturation has been shown to be a highly complex process involving more than learning certain knowledge structures and development of discourse processing skills, but also constant negotiation and interaction between postgraduate students and others, often, though not always, ridden with problems and tensions, power and identity conflicts, and sometimes resulting in failure (cf., Prior, 1998; Casanave, 2002; Angelova and Riazantseva, 1999; Blakelsee, 1997).

2.3.5.1. Reading in studies of advanced academic literacy

Research into advanced academic literacy has been characterized by various definitional complexities, one of which is the blurring of the boundaries between reading and writing, on the one hand, and between these activities and other text-mediated activities, on the other. Though the definitions have become problematized, however, it is possible to suggest that most studies have used writing as their primary focus and point of departure (Berkenkotter, Huckin, and Ackerman, 1991; Blakeslee, 1997; Prior, 1992, 1998, etc.).

Meanwhile, studies have been conducted which show that reading presents a major part of postgraduate education and a major backbone of disciplinary knowledge formation (e.g., Carson, 2001). However, apart from Benson (1991), who examined the reading of one postgraduate student interacting with various texts of one course, and Jiang (2001), who studied the processes of readers engaged in preparing for writing their class

assignments (as reviewed in section 2.3.1 above), few other studies have analyzed postgraduate students' reading in any systematic way.

2.3.5.2. Social aspects of postgraduate enculturation

The existing studies of advanced academic literacy, even if they are not directly concerned with reading, have contributed greatly to this research by illuminating the complex social aspects of postgraduate education. Among many issues, these studies, as reviewed below, have highlighted that (1) advanced academic literacy involves an ability on the part of students to adjust to the various social, disciplinary, and cultural demands of their universities and departments; (2) the nature of supervisor-supervisee relationships may impact students' disciplinary development; and (3) students' disciplinary enculturation often takes place at the nexus of multiple communities.

Interest in the social aspects of postgraduate enculturation processes has been apparent from some of the earlier studies in the area. Berkenkotter, Huckin, and Ackerman, (1991), for example, analyzed the textual products of one student, Nate, and explained the changes in his writing with respect to his growing awareness of the linguistic conventions governing disciplinary communication and of the concerns and issues central to the interests of established disciplinary practitioners. Gosden (1995, 1996) through a series of text analytical studies, traced the development of several drafts produced by a group of Japanese students and analyzed the revisions they undertook as a result of interacting with the reviewers of their drafts. In addition to linguistic changes, Gosden was able to identify a growing awareness on the part of the students of the audiences for whom their writing was intended. Finally, a study by Schneider and Fujishima (1995) explored a case of an unsuccessful L2 postgraduate student and explained his failure by suggesting that, in addition to linguistic demands, the student had to, but was not able to, adjust to cultural and social aspects of postgraduate education at an American university.

One aspect that has received substantial attention in the more recent advanced academic literature has been the issue of supervisor-supervisee relationships (Blakeslee,

1997; Dong, 1998; Angelova and Riazantseva, 1999; Cadman, 2000; Dysthe, 2002). Belcher's (1994) analysis of three supervisor-supervisee relationships was among the first to target this area of research. Through a collection and analysis of texts, observation of supervisory meetings, and discussions with both the supervisors and the students, Belcher showed three relationships which differed across such dimensions as the allocation of power and status, nature of supervisory feedback, and shared understanding of objectives. Later studies of supervision have further focused on such issues of postgraduate enculturation as power and status relationships, interactional tensions and conflicts, and the need for a more explicit articulation of needs and expectations by both supervisors and students.

A major study in supervisor-supervisee relationships has been Dysthe's (2002) investigation of supervisors' and master's degree students understanding and perception of supervisory practices across 3 departments at a Norwegian university. Dysthe (2002) identifies three supervision models: (1) teaching, which she describes as "a traditional teacher-student relationship defined by an emphasis on asymmetry, status difference, and dependency. Feedback is seen as correction, and students rarely hand in exploratory texts" (p. 518); (2) partnership defined as "more symmetrical: the student's thesis is seen as a joint project. The contractual nature of cooperation is emphasized. Feedback is presented in dialogue, and exploratory texts form a basis for discussion" (p. 519); and (3) apprenticeship, "characterized by the student's learning by observing and performing tasks in the company of the supervisor. The student and the supervisor may be involved in a joint project, but there is no doubt about who is the master" (p. 519).

Two other major discussants of advanced academic literacy and disciplinary enculturation have been Prior (1992, 1994, 1997, 1998) and Casanave (1992, 2002). In addition to highlighting the socially situated and often problematic nature of disciplinary enculturation, both of them have suggested that postgraduate students are situated at the intersection of multiple communities. For example, in her study of five MA students in TESOL, Casanave (2002) shows that the students were interacting with at least two

communities: (1) the academic community of the program and the institution and (2) the professional community of disciplinary practitioners.

Similarly, Prior (1997), with respect to PhD dissertation writers, argues that "For dissertation writers, the different systems of graduate schools, the department advisors and committees, graduate student employment, and the job market are [ ] not separate, autonomous systems, but are continually intersecting and overlapping each other" (p. 277). He further develops the idea of laminated or layered activity systems to emphasize that participants may assume multiple stances as different social formations become more or less foregrounded.

2.3.5.3. Context in studies of advanced academic literacy

Fundamental to the studies of postgraduate enculturation reviewed above is the importance of contextual factors in the development of advanced academic literacy. In these studies, context tends to appear at different levels: the local, immediate, and interactive influences on students' writing and enculturation processes and broader, less immediate factors, such as norms for writing and communicating in various communities (Johns and Swales, 2002; Hyland and Ham-Lyons, 2002). Central to conceptualizations of context is some form of a community or "collectivity" (Johns and Swales, 2002, p. 17).

2.3.5.4. Implications for this study

Several implications arise from the brief review of advanced academic literacy research with respect to this study of reading:

1. There is a need for studies of advanced academic literacy development which, without ignoring aspects of writing and other activities, would provide systematic analyses of what postgraduate students do when they read disciplinary texts.

2. Context has been conceptualized at different levels, and some notion of a community is often used as fundamental for analyses. Communities have been discussed as

heterogeneous rather than homogeneous and interactive rather than autonomous

from each other.

3. Finally, supervisory relationships have been shown to be a major aspect of the

    context which impacts on the development of advanced academic literacy.

2.4. Statement of research goals

Reflecting the review of literature presented in this chapter, the overall goal of this

study is to extend the existing research base by seeking to:

1. examine postgraduate reading in contexts of its natural occurrence;

2. identify unique features of postgraduate reading within cases and to locate

    commonalities across cases;

3. propose a framework for studying reading in context; and

4. suggest areas of further research to enhance our understanding of postgraduate

    reading and its role in advanced academic literacy development.

Two major research questions guiding this study are:

RQ1: **What is the nature of postgraduate reading when it is studied in contexts
of its natural occurrence?** Within this question, a key sub-question is: **What social
forces are involved in postgraduate reading and how do these forces interact with and
shape reading?**

RQ2: **What common themes will emerge across cases?** Within this question, a key
sub-question is: **In what ways will these themes be similar and different across the
cases?**

2.5. Conclusion

In this chapter, I mapped out the areas of research which have contributed to the

conceptualization of this study. Central to these areas of research is the notion of context

which has become influential yet has often been left ill-defined. In the next chapter,

Chapter 3, I will explicate the activity theoretical framework (based on Vygotsky, 1978; Leontev, 1978; Engeström, 1987, and others) which has been used in this study to understand and analyze the complex notion of context. I will highlight the multilayered nature of context and the unity of the social, the individual, and the material in it.

CHAPTER THREE: Activity theoretical framework

Chapter 3 will detail the framework which has formed the basis of the current PhD study, and Figure 3.1 below previews the main aspects of the framework which will be presented throughout the chapter.

Principles:
3.3. Context as the unit of analysis
3.4. Social vs. individual
3.5. Mediated agency

Explanatory concepts:

3.7. Affordance

3.8. Contradictions and psychological double binds

3.9. Zone of proximal development

3.10. Expanding involvement

3.6.1.3   Tools

3.6.3. Operations

3.6.1.1 *Subject*

3.6.2. Actions

3.6.1.2 *Object*

3.6.1.Activity systems

3.6.1.5. Rules

3.6.1.4. Community

3.6.1.6. Division of labor

Figure 3.1. Preview of Chapter 3

3.1. Introduction

This dissertation opened with an argument for undertaking a study of academic reading within a naturalistic mode of inquiry. It further situated the study within the arguments of social constructivist studies of academic discourse and postgraduate enculturation. Chapter 2, Literature Review, uncovered a set of conceptual changes which have accompanied the developments in research on postgraduate students' literacy needs and enculturation processes, changes which can be summarized here under the following categories:

- texts: from monologic to multivocal texts

- postgraduate readers and writers: from individuals to group members

- disciplinary communities: from autonomous and homogenous communities to heterogeneous and interacting communities

- reading: from abstract reading to reading intertextually, interactively, constructively and responsively

- enculturation and literacy: from textual to social processes and practices

The central aim of this chapter is to explicate in what ways activity theory has contributed to this study and what conceptual tools it has provided. The chapter starts with a brief presentation of the theory and its major premises; then it details the three fundamental activity levels the analytical part of the study is based on; and finally it explains some additional activity theoretical concepts which will be essential in the interpretation of the data. Throughout its sections, the chapter will illustrate that activity theory is consistent with naturalistic approaches to inquiry, and that it provides an appropriate lens for understanding the current changes and for patterning future directions in advanced literacy research. It will further highlight that the theory can provide us with a set of suitable principles and tools needed for rigorous and insightful understandings of disciplinary enculturation processes involving advanced literacy development.

3.2. Activity theory: Introduction

Activity theory is a commonly accepted name for a whole line of theorizing and researching which aims to understand "the interpenetration of the individual, other people, and artifacts in everyday activity" (Nardi, 1996, p. 8). To accomplish its aim, activity theory borrows traditional terms such as individual, society, tools, language, activity, and action and reinterprets them as fundamentally complex, dialogically interacting and multifaceted rather than unified, autonomous, and discrete (Prior, 1992).

Originating in the works of the Russian educational psychologists Vygotsky, Luria, and Leontev (Выготский, Лурия, Леонтьев), activity theory now involves a multivoiced international community appropriating and applying the core original ideas of the Russian theorists and developing them further in different ways through critically reflective research and conscious search for correspondence and compatibility with other research traditions (see, for example, Miettinen, 2001, and Hickman, 1990, for in-depth treatments of correspondence between activity theory and Dewey's pragmatism and Prior, 1998, and Freedman, 1995, for comparisons with Bakhtin's dialogism).

No longer limited to psychology, activity theory has gained popularity in literacy research (cf. Bazerman, 1997; Russell, 1997; Freedman, 1995; Prior, 1998; Winsor, 2003 for writing and Smagorinsky, 2001; Bazerman, 1985 for reading), second language acquisition (cf. Lantolf, 2000; Donato, 2000; Ahmed, 1994; Thorne, 2000; van Lier, 1996; Kramsch, 2000), education (cf. Wells, 1996; John-Steiner, 1995), language assessment (cf, Spence-Brown, 2004), and human-computer interaction (cf. Nardi, 1996; Kuutti, 1996; Bannon, 1997; Kaptelinin, 1996), among other fields. For detailed treatments of activity theory and its application, the reader is advised to refer to Lantolf (2000), Lantolf and Appel (1994), Engeström (1987, 1993, 1999, 2001), and Nardi (1996).

Contrary to some expectations, activity theory does not present "a fixed body of accurately defined statements" (Kuutti, 1996, p. 25), but instead offers a set of perspectives on human activity and a set of tools for describing and analyzing it. This somewhat amorphous nature of activity theory and its concepts has been its greatest strength (as its

application across various branches of inquiry may suggest) as well as its strongest criticism. Thus, for example, it has been observed that "while AT does provide a general conceptual framework for understanding and analyzing human activity, it does not provide any clear methodology as to how such activities are to be recognized, delineated, and scrutinized" (Bannon, 1997, p. 3). Engeström (1999) explains this criticism by suggesting that "the ensuing openness and 'incompleteness' of the conceptual systems may be aggravating for a researcher who would like to simply apply in practice a well-defined theoretical frame" (p. 28).

In this study, activity theory concepts have been used as guidelines to understanding the data rather than ready-made techniques and fixed conceptual determinants of meaning. Their openness to interpretation and application has been considered a positive rather than a negative aspect for one major reason: as activity theory argues, concepts are not tools unless they are put into use by an individual (or a group) and are re-conceptualized or, in Engeström's (1993) terms, "concretized according to the specific nature of the object under scrutiny" (p. 97). The process I went through in appropriating and concretizing the loosely-defined concepts of activity theory as my research analytical tools has helped me to stay focused on the object of this research and consequently, has mediated my understanding of its complex nature.

The main benefit of adopting this framework for the analysis of reading lies in the simple but powerful lens it provides for describing the complexity of reading in context, the complexity which on the surface may resemble the discussions of strategies and motivation in reading research, but in fact goes beyond these in essential ways by describing the dynamic interactions between the levels of context rather than assuming static and unchanging strategies and motivations. It has additionally provided me with empirically systematic and valid ways to acknowledge the idiosyncratic nature of reading processes and, at the same time, to find some common features of advanced academic reading.

The purpose of the coming sections is to explain the concepts which have formed the basis of the framework adopted for this study. The purpose is not to imply the agreed-upon treatment of these concepts across various activity theorists. Good sources describing and explaining the various debates regarding specific activity theoretical notions and concepts would be Engeström (1999), a volume edited by Lektorsky (1991), issues of *Mind, Culture, and Activity*, or the web-based discussion forum *CHAT*.

3.3. Context as part of the unit of analysis

The primary reason behind my adoption of activity theory for an analytical framework in this study was the fact that, as argued by Dias (2000), it corresponds well to naturalistic approaches to inquiry that explore how actual human processes and practices are accomplished in concrete contexts. Activity theory offers empirical rigor and systematicity for our understanding of the notion of "context" and the tools for analyzing it (Russell and Yaňez, 2003; Nardi, 1996). The uniqueness of the activity theoretical take on *context* is that, unlike many other theoretical approaches, it sees context as part of the unit of analysis.

To use Goodwin and Duranti's (1992) analogy, when the term context is used in studies of reading, its significance is often justified by the assumption that a focal phenomenon (i.e., some aspect of reading) cannot be understood, analyzed, interpreted or described without the researcher extending the lens beyond the phenomenon to include other phenomena within which the focal one is embedded. Thus, context is often seen as a frame that surrounds the focal phenomenon and provides the means for understanding it.

Instead of assuming a clear dichotomy between the focal phenomenon and the frame used to explain it, instead of treating the frame as merely surrounding the focal phenomenon, activity theory approaches **context** as a complex co-construction of the individual, the social, and the material, thus making context the focal phenomenon within which human processes are understood. Context, seen this way, becomes both internal to individuals because it involves specific motivations and goals, and at the same time, it is

external to individuals because it involves tools, other people, and sociohistorical and temporal-physical settings. When treated this way, context becomes an integral part of the unit of analysis and highlights the multiplicity of its levels. In order to understand how context can be analyzed at different levels, I will first turn to the discussion of the social and the individual and then to the discussion of the mediated agency in the sections immediately below.

3.4. The social vs. the individual

Traditional studies of reading are predicated on an assumed dichotomy between the individual and the social, and hence reading, when analyzed as comprehension and information processing, is often assumed to reside in the individual reader's head, and the processes of using reading and texts for social purposes are assumed to reside in some social context (and are often in fact ignored). In Chapter 2, when reviewing some of the debates revolving around the question of which aspects are most important in reading—individual or social (see Urquhart and Weir, 1998), I pointed out that these debates are based on the premise that the social and the individual are clear dichotomies. Born as a response to the dichotomies set up by behaviorism and introspection in the early 20th century, activity theory rejects the duality of the social and the individual. Instead, it emphasizes the interpenetration of the two and assumes that "[psychological] processes are the reconstruction in the mind of the individual of the mediated social interactions that this individual has experienced on the social plane" (Kramsch, 2000, p. 133).

As a way of illustrating this complex principle, let us consider an example. When reading a research article assigned by his supervisor, Jim, one of the participants in the study, engaged in the individual action of preparing for revising his draft which itself was accomplished through such individual operations as analyzing the author's style, noting the headings used through highlights, and including the same headings into his own draft. Though the student was totally on his own while engaging in the reading operations and, stimulated by the text, engaged in extensive inner conversations with himself, he was not

52

in complete social isolation. The fact that the text was assigned by the supervisor already suggests the influence of a significant social other. In addition, Jim consciously interpreted the style of writing in the article as his supervisor's preferred style and remembered the supervisor's suggestion that he think of his revisions in terms of the possible questions he may face from the future examiners. Thus, the goal for reading itself came from the social motive of meeting the requirements of the supervisor and the future examiners. The text was further interpreted with the thoughts of the future examiners in his mind.

As this brief example suggests, the focus on the human as an individual subject does not assume his "discrete individuality" (Prior, 1992), while the focus on the social does not strip the individual of his or her agency. The focus on both the social and the individual is achieved through the complementary layers of activity assumed in the theory—operation, action, and activity system. These layers will be discussed later in the chapter because they form an essential part of the framework and have enabled me to find systematic contextual commonalities in the apparently individual phenomenon such as reading. The notion of mediated agency will be discussed first to further explain the interpenetration of the social and the individual in an activity theoretical analysis.

3.5. Mediated agency

A key principle in activity theory, the principle of mediation, helps to break down "the Cartesian walls that isolate the individual mind from the culture and the society" (Engeström, 1999, p. 29). According to the principle of *mediation*, humans do not act upon the outer world directly but through certain tools and signs, of which language is the most powerful (Vygotsky, 1981). These tools and signs carry with them the rudiments of prior uses (Prior, 1998), and therefore their use in concrete actions is always situated in sociocultural contexts.

Thus, human action, through mediation, is inherently tied to the sociocultural milieu in which it occurs. The relationship, however, between the action and the society is that of dialectical interaction rather than unidirectional causality (Haneda, 2000). On the one hand,

by appropriating mediational means in the process of collective activities (see section on activity systems below), human mental functioning is shaped in socioculturally specific ways. On the other hand, these mediational means also reflect and are involved in fundamental ways in maintaining and re-creating the sociocultural contexts.

If we consider the case of John (Chapter 8), we see how his reading of a research article was accompanied by conscious attempts at analyzing and appropriating the ways of thinking and argumentation in the disciplinary community of mechanical engineers. Looked at from this perspective, the text he read would hopefully mediate the development of John's thinking in disciplinary specific ways. However, his actions of learning to think and argue like a mechanical engineer were also involved in maintaining and recreating the disciplinary contexts, in legitimate even if still peripheral ways (Lave and Wenger, 1991).

Mediated action is then a major focus for activity theory, and for some, such as Wertsch, it is the main unit of analysis. Wertsch (1994) pinpoints the essence of mediated action in the following excerpt:

> The essence of mediated action is that it involves a kind of tension between the mediational means as provided by the sociocultural setting, and the unique contextualized use of these means in carrying out particular, concrete actions. In this view, any attempt to reduce this basic unit of analysis to the mediational means or to the individual in isolation is misguided.
>
> (Wertsch, 1994, p. 205)

An essential feature of mediated action is that it points to the importance of the reconceptualization of the notion of agency to mean not an individual in isolation but to extend "beyond the skin" (Bateson, 1972, referred to in Smagorinsky, 2001; Wertsch, 1994; Cole, 1996; and many others). In addition to mediating the relationships with the outer world, signs and tools have the potential of providing the individual with what Vygotsky (1978) called "external stimuli" to "control their behavior from the outside" (p. 40). The idea is that humans can control their own behavior using and creating artifacts.

As we will see in Chapter 9, one major tool Jim used to enhance his revisions of a research proposal was a model research proposal written by his supervisor. The supervisor gave this text to Jim because he believed the proposal written by the student did not meet

the genre expectations of research proposals in mechanical engineering. This model thus served as a stimulus that affected Jim's revisions of his proposal from the outside by presenting the kind of discourse accepted and expected by the wider community.

The principle of mediation adds another important dimension into the notion of context—that of material and semiotic tools, in addition to the dimensions of the individual and the social. It provides a lens for looking at postgraduate reading by suggesting that readers are agents actively and often strategically appropriating sociocultural tools in social milieus. The current findings in advanced academic literacy research, according to which literacy development and use are socially distributed, situated, and mediated (see Prior, 1998 and many others), supports the need for a framework which would be able to account for these forces. The framework developed for this study involves three levels of analysis, as explained in the section below.

3.6. Levels of analysis

The three levels of analysis were adopted for this study from two major sources: Leontev's three-level model of activity (activities, actions, and operations) and Engeström's elaboration of it into activity systems. I will start the discussion with activity systems.

3.6.1. Activity systems

As Kramsch (2000) warns us, the term 'activity' must be used with caution in Western contexts. Basing her explanations on Kozulin (1986), Galperin (1969) and Davydov and Radzikhovskii (1985), she points out that activity should not be contrasted with mental processes and thought, but rather it includes mental processes and stands for the "sociocultural interpretation that the participants construct of the events in their context of occurrence" (p. 136). She stresses that when an individual is said to be engaged in an *activity*, what is meant is that he or she is functioning in certain sociocultural contexts.

The notion of activity is inseparable from the concept of motive. As Leontev (1978) argues, "Activity does not exist without a motive […] 'nonmotivated' activity is not activity without a motive, but activity with a subjectively and objectively hidden motive" (pp. 62-63). Uncovering motives driving the students' reading thus comprised a major aspect of this level of analysis. Since the level of activity corresponds to the question of why something is done (Lantolf and Appel, 1994), the questions that guided the analysis of the students' reading in terms of activities were: "Why is the student reading the text? Why is he doing what he is doing when reading? What broader motives can explain his behaviors?"

Prior (1998), referring to Goffman (1981), argues that any situation is essentially *laminated*, meaning that there are multiple activities present at the same time, some of them being foregrounded and others backgrounded. In a similar vein, Davydov (1988) talks about leading activities, as opposed to non-leading activities. With respect to reading, I would argue that the same text can be read by the same student almost at the same time as part of multiple activities, some of them more foregrounded than the others (see the case of Dewey as described in Chapter 7).

In addition to being motive-oriented and either backgrounded or foregrounded, activities have another major characteristic—they are always socially distributed. Engeström (1987) uses the notion of activity systems to stress the socially distributed nature of activities (see Figure 4.2 below for Engestrom's famous triangle representing an activity system). ***Activity systems*** are dynamic formations which can be defined as any "ongoing, object-directed, historically conditioned, dialectically structured, tool-mediated human interaction" (Russell, 1997, p. 510). This broad definition of activity systems implies that examples of it could be as diverse as a family, a discipline, a university course, a university itself, etc.

Engeström (2001) particularly stresses the open nature of activity systems, which means that one activity system can be related to other activity systems in multiple ways. For example, when applied to postgraduate education, an individual university course can

be an activity system in and of itself, as well as being part of a larger activity system of a university. The acknowledgment of the open nature of activity systems has been particularly important for this study because it allowed me to superimpose students' activity systems and find networks of social interactions within which their reading was situated.

Figure 3.2 provides a graphic representation of the activity system of PhD, while Figure 3.3 provides a graphic depiction of many other possible activity systems that could be related in some ways to the activity system of PhD. These figures are presented here to illustrate the constituent elements of activity systems and their interrelations with other systems.

Tools: courses,
meetings, texts

Subject:
Pg student

Object:
PhD degree

Outcome: expanded and more central participation in disciplinary activity systems

Rules:

Engage in research, learn disciplinary conventions and conversations

Community:

Supervisor/s University, department, disciplinary community

Division of labor:

Student works independently under the guidance of the Supervisor

Supervisors are assigned more power than students

Figure 3.2. PhD as an activity system in and of itself
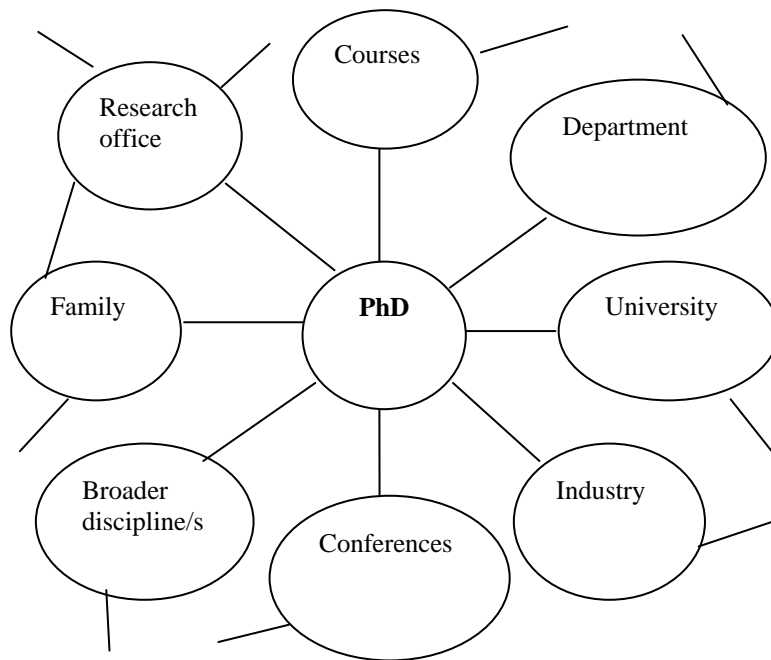
Figure 3.3. PhD as an open activity system (adapted from Harms, 2003)

Note: Only some of the possible activity systems which could be related to the activity system of PhD are presented in this figure. Each of these activity systems (shown above as circles) could also be individually presented with Engeström's expanded activity triangles. Note that each activity system is open, i.e., it may in turn be related to many other activity systems.

3.6.1.1. Subject

The *subject* of the activity system is "the individual or subgroup whose agency is chosen as the point of view in the analysis" (Engeström, 1993, p. 67). By participating in activity systems, subjects "not only use instruments, they also continuously renew and develop them, whether consciously or not. They not only obey (and challenge or disobey) rules, they also mold and reformulate them—and so on" (p. 67). In this study, postgraduate students are treated as subjects through whose eyes we look at several activity systems which emerge as important for understanding their reading.

Postgraduate students, as individuals, are members of many different activity systems at once, with varying levels of involvement, legitimacy, and participation. This aspect is reflected in the phrases which could be often used to refer to the same student: research student, PhD candidate, departmental assistant, husband, father, son, doctor, and

even Assistant Professor. Activity theorists assume that each participant in an activity theory would have his own interpretation or representation of the activity system to which he belongs. Since activity systems are by default communal endeavors, they further argue that though "individuals are active agents in their own development, [they] do not act in settings entirely of their own choosing" (Cole, 1996, p. 104). With respect to reading, this may suggest that though individual readers read and learn actively and strategically, they do so in environments involving others which may both constrain and afford their textual actions.

3.6.1.2. Object

Objects are the driving forces of activity systems in that they refer to the "'problem space' at which the activity is directed and which is molded or transformed into outcomes with the help of physical and symbolic, external and internal tools" (Engeström, 1993, p. 67). PhD programs, for example, would not exist if there were no social and professional roles for which the students engaged in postgraduate education would need a PhD degree. In Raithel and Velichkovsky's (1996) description, objects are like "the bull's eye of the archer's target" (p. 219). The PhD degree is thus a kind of bull's eye that channels and directs the postgraduate student's attention as he may engage in such actions as preparing for courses and writing chapters of the thesis. The attainment of a PhD degree might be something that is always "held in the line of sight" (p. 219) while the student engages in various actions comprising the activity system of PhD.

Objects do not have to stay at the same level without changing. Engeström's work (1999, 2001), in particular, has highlighted that an object itself may undergo changes in the process of activity. However, objects do not change quickly and on a moment-to-moment basis, and there is a certain stability about them.

3.6.1.3. Tools

Originally developed by Vygotsky (1978), the concept of tools is fundamental for most of activity theoretical research and has already been discussed somewhat in the section on mediated agency above. Its significance in the theory, as mentioned above, implies the significance of the notion of mediation according to which participants engage with activity systems not directly but by using various tools. ***Tools*** can be both symbolic and material. Among symbolic tools important for this study are academic texts. Other symbolic tools include drawings, disciplinary jargon, genres, and both human and computer languages. Material tools can be computers and software, pens, desks, libraries, etc. Often, tools are both material and symbolic, and thus in discussing a text as a tool, we can talk about the material pages on which a text is presented and the symbolic meanings which a text conveys.

Russell (1997), who has extensively applied activity theory to the analysis of written genres, reminds us that newcomers and old-timers in an activity system would probably use tools in different ways and with differing levels of awareness. While for old-timers the use of tools often becomes unconscious and routine, for newcomers, the use of the same tool might require specific purposeful actions. The same tool can be used to mediate the accomplishment of various goals, as has emerged throughout the cases in this study.

3.6.1.4. Community

As I have already stressed, in activity theoretical conceptualizations an individual does not function in social isolation. Engeström's work was fundamental in extending Vygotsky's (1978) notion of mediation to include the social elements, one of which is community. A ***community*** can be conceptualized as multiple other individuals who are engaged in attaining the same general object. For example, in the case of a PhD activity system, the community is comprised of the supervisor or multiple supervisors, other experts in the discipline, fellow postgraduate students and research staff, departmental committees, university, etc.

The community within which the postgraduate student works does not have to be limited to representatives of various levels of the academia. For several students in this research, the community included non-academic representatives such as patients, students, teachers, software developers, etc. It is often these various members of the community representing various activity systems that act as a link between the student's academic and professional activity systems.

3.6.1.5. Rules

Rules in activity systems correspond to the values held by its participants. They can be both explicit and implicit. For example, in an activity system of PhD, a rule for the activity system participants (the student, the supervisor, the research participants if applicable) could be to produce as many publications as possible. This rule would represent one of the values—number of publications. For insiders, rules can become habitual and routinized so that their awareness of them may diminish. Some novices may not be aware of rules and become conscious of them only after breaking certain rules and suffering consequences as a result (Harms, 2003).

Rules can be tacit or explicit. An example of a tacit rule of doing a PhD, as emerged from the data provided by some students, was the belief that they were expected to write and publish as many research articles as possible, while an example of an explicit rule would be the need to demonstrate an ability to present academic research in writing. Different members of the activity system may hold different expectations and perceive rules differently. This, in turn, can lead to contradictions within activity systems, a point I will return to later.

3.6.1.6. Division of labor

Division of labor in activity theory corresponds to two levels: (1) along the so-called horizontal level, it refers to the ways in which tasks and responsibilities are divided across the various participants in the activity system and (2) along the vertical level to how power

and status are distributed across the various members. In our example of a PhD activity system, the responsibility of the student would be to engage in independent research, while the responsibility of the supervisor would be to guide the student through the myriad of options which could otherwise confuse him. Additionally, the supervisor would usually be the one with more power and higher status as a result of his or her experience and contributions to disciplinary and administrative communities (i.e., university, department).

Table 3.1 summarizes the elements of an activity system and provides a brief example for each one of them.

Table 3.1. A summary table for activity system

Element of activity system	Definition	Example for the activity system of PhD research
Subject	The individual from whose viewpoint an activity system is analyzed	An individual postgraduate student/reader
Object	The socially stipulated driving force which channels and directs individual actions	PhD as a degree
Tools	Material and symbolic objects which mediate the subject's engagement with the activity system	Academic texts, computers, programming and human languages, etc.
Community	Multiple individuals who share the same general object	The student, the supervisor/s, fellow students and colleagues, the department, the university, etc.
Rules	Implicit and explicit values and expectations	Student should be able to display ability to write academic papers
Division of labor	1. division of tasks and responsibilities across participants 2. distribution of power and status across participants	1. student engages in independent research under the guidance of supervisor 2. student is assigned lower status and less power than supervisor

3.6.2. Actions

Activity systems are realized as individual or group actions, and thus actions comprise the second level of analysis in this study. An ***action*** is defined in activity theory as the process which "is subordinated to the representation of the result that must be attained, that [which is] subordinated to a conscious purpose" (Leontev, 1978, p. 63). Corresponding to the question of what is being done (Lantolf and Appel, 1994), actions are basically linear and finite (Engeström, 1999). They are conscious because the subject is assumed to have a goal in his or her mind, and different actions may lead to the accomplishment of the same goal.

In activity theoretical explanations, goals do not coincide with objects (see the section on activity systems immediately above). While goals are "finite aims of individual actions," an object is "an enduring, constantly reproduced purpose of a collective activity system that motivates and defines the horizon of possible goals and actions" (Engeström, 1993, p. 150). Thus, the goal may be to prepare for a class, but the object which defines it may be the attainment of a PhD degree. As Leontev (1978) explains, that which energizes a person's activity and that to which his action is directed do not coincide. The distinction that activity theory makes between objects and goals has enabled me to observe empirical rigor in analyzing motivation behind the students' reading.

Kramsch (2000) additionally reminds us to be careful not to conflate the notion of a goal with a stable external target of which the individual is conscious ahead of the action and which she attempts to accomplish "by traveling along a time or space line". She suggests that better translations for the word 'goal' would be 'orientation' or 'directionality' because they stress the open and developing nature of goals and leave space for changes an individual may go through in his definitions and settings of goals in the course of accomplishing them.

The questions that correspond to this level of analysis are "What is the student accomplishing by reading a text? What immediate, defined purposes is the text used to achieve?"

3.6.3. Operations

Actions are said to have operational aspects (Nardi, 1996; Lantolf, 2000). *Operations* are the ways in which actions are actually carried out. In concrete analyses, this level is usually operationalized as the level of spatio-temporal conditions and the subject's use of mediational means (Lantolf, 2000), an example of which in this study was the use of computers. There is a fine line between operations and actions in terms of routineness and the amount of consciousness given. Something which may have been an action at one point can become an operation with practice by becoming unconscious and routinized.

One operation observed with the students was writing notes when reading. At one point, this could have been an action consciously engaged in by the students: for example, when learning to take notes, they may have had to think consciously of what information to include in them and of how to write notes most efficiently. However, in the cases I observed, note-taking seemed to be a routine rather than a conscious process. Since operations depend on the conditions under which the subject carries out the action, how and what notes were left by the students when reading texts likely depended on such conditions as the text, the reader's familiarity with the text, time, physical settings, etc.

The questions that correspond to this level of analysis are "How does the student read? What mediational means does he use?"

3.6.4. Summary

By way of summary, Table 3.2 provides a definition, a corresponding research focus and a brief example for each level. The table is presented in such a way as to stress that activity systems subsume actions but are not limited to the sum of actions in the same way as actions subsume operations but are not limited to sums of operations.

Table 3.2. A summative table of three levels of analysis

Level of analysis	Definition		Research focus		Example
Activity system	"on-going, object-directed, historically conditioned, dialectically structured, tool-mediated human interaction" (Russell, 1997, p. 510).		social formation of goals, social others, interactions		PhD activity system which may be related to disciplinary, university, departmental and other activity systems See Fig x above
Actions	Processes subordinated to conscious goals and situated in activity systems		goals guiding reading and achievement of these goals	Reading a textbook to prepare for the course	
Operations	Conditions in which actions are realized		spatio-temporal conditions and the use of mediational means	Taking notes while reading, highlighting, checking words in a dictionary, etc.	

In addition to the three levels of analysis detailed immediately above and the principles mentioned in the beginning of the chapter, this study has additionally relied on several other activity theoretical concepts—affordance, zone of proximal development, contradictions and psychological double binds, and expanding involvement. These have proved to be necessary for linking the different levels of analysis and for interpreting the findings. Each of these concepts will be discussed in the sections which follow.

3.7. Affordance

Some researchers employing activity theory as part of their analytical frameworks have also been increasingly drawing on the notion of affordances originally developed by the psychologist Gibson (1979). Van Lier in second language acquisition (1996, 2000, 2002; van Lier and Matsuo, 2000) and Prior (1995, 1997, 1998) in literacy research, for example, have both incorporated the concept into their complex analyses.

In simple terms, an **affordance** consists of the opportunities for interaction that objects of the environment and cultural phenomena present for a person relative to his

motivations, histories, and capacities. An affordance affords actions and operations (but, as van Lier (2000) points out, does not trigger or cause them). What becomes an affordance depends on the subject's activities and capacities, and therefore affordances are "fundamentally relational and, thus, complex, fluid, and multiple" (Prior, 1998, p. 183). The same feature of the environment or cultural phenomena may offer different affordances to different subjects or to the same subjects at different moments.

For example, the same text being read by different students may offer very different affordances to them: it can offer a site of learning new words for one student, information about disciplinary developments for another, a range of grammatical structures to be imitated in her own writing for yet another student, and so on. In all cases, the text is essentially the same: its properties (as the text is presented in a material form) do not change. What happens is that different properties of the text are singled out and acted upon by different students.

The construct of affordance is relevant to the study of postgraduate reading in terms of the contribution it may make to our understanding of advanced academic literacy development of postgraduate students. As the example above illustrates, a text may provide opportunities for various actions to the active reader. It is of utmost interest to advanced literacy researchers to understand whether and how students come to see and act upon certain aspects of texts as affordances, in order for us to understand the role of reading in disciplinary socialization.

3.8. Zone of proximal development

First described by Vygotsky (1978), the zone of proximal development (ZPD) has recently been applied to analyze various issues, including those pertaining to second language acquisition (see the collection edited by Lantolf, 2000). As developed by Vygotsky, it was commonly used as a metaphor to refer to the distance between what an individual can do on his own and what he can do with the assistance of others and/or cultural artifacts. Some socioculturally oriented researchers may assume that the ZPD will

have to involve interactions between an expert and a novice, where the expert would provide some form of assistance to the novice. Recent research, however, including research in second language acquisition (see Lantolf, 2000) has pointed out the narrowness of the expert-novice conceptualization of ZDP.

In activity theory, **ZPD** is now used to describe the collaborative construction of conditions or opportunities (affordances, as described above) which foster and scaffold the individual's development of mental abilities and expanding involvement with activity systems. While these collaborative constructions include expert-novice (apprentice-master) interactions, they are not limited to them.

An example of collaborative co-construction of affordances (also known as "scaffolding" in Vygotskian-based literacy research) for learning from texts, as observed in this study, involved collaboration of students with their supervisors (the expert-novice interactions described above). Thus, Jim collaborated with his supervisors partly through regular meetings of which discussion of readings were an important part. These discussions were, metaphorically speaking, the zone of proximal development for the student because through collaborative discussions with the supervisor and by closely observing the supervisor's textual practices, he reflected on the texts he read and learned to see ways in which the texts could enhance his development of his own research paper.

Engagement with various kinds of social others led to the creation of zones of proximal development for some of the students in this study, and these will be discussed in detail later on in the thesis. The zone of proximal development is a useful concept for this study because it helps to analyze the students' interactions with others (around the texts being read) in terms of collaborative opportunities they provide for accomplishment of goals and appropriation of tools.

3.9. Contradictions and psychological double binds

A major activity theoretical concept used in the interpretation of the data was that of contradictions. In activity theoretical terms, contradictions may arise both within and

between activity systems. Contrary to common sense, **contradictions** should not be analyzed as mere conflicts but rather as "historically accumulating structural tensions within and between activity systems" (Engeström, 2001, p. 137). Likewise, contradictions do not have to be only negative. In activity theory, contradictions are viewed as potential sources of change and development, a point I will discuss later when dealing with expansive learning.

One kind of contradiction which became apparent in at least two students' cases (Amy and Sam) is that between (1) the rules of the academic activity systems they were engaged in (a course and a supervisory meeting, respectively) which led them to believe that they were to understand everything of the texts they read and (2) the tools of the disciplinary activity systems they were initiating into (the research articles in remote sensing and geo-positioning, respectively). Both of the student felt that the texts were "incomplete" because they contained references to previous work which, they felt, were needed in order to understand the text completely. The contradiction caused the students to experience what activity theory calls double binds. Harms (2003) uses a very explicit metaphor for the notion of **psychological double binds**—the feeling of being pulled in completely different directions. These students felt exactly what Harms (2003) describes—they felt they were torn between moving on with their work and ignoring these "incomplete texts", on the one hand, and the pressure to focus on these texts and locate the references they needed to understand them completely, on the other.

Though often accompanied with negative feelings, contradictions do not have to result in negative outcomes. Thus, eventually, Amy found a way of locating the other texts and by doing so engaged in expanding her involvement and knowledge of the disciplinary activity system.

The notions of contradictions and double binds are important for this study of advanced reading because they can be used to explain what has been termed "comprehension problems" in reading research. In addition to referring to comprehension,

68

though, these notions may explain why reading-related problems arise, how they are solved, and how their presence and solution affect accomplishment of reading goals.

3.10. Expanding involvement

In spite of double binds and contradictions, humans manage to extend their participation with activity systems by engaging in mediating interactions and making use of affordances. Engeström (1987, 2001) has theorized extensively on how subjects extend their participation and involvement with activity systems by discussing the notions of learning by expanding (1987) and expansive learning (2001). Instead of the linear accumulation of knowledge and skills, **expanding involvement** implies a circular, loop-like model of learning. Instead of assuming that learning is an acquisition of transferable skills, activity theorists see learning as mediated by the subject's expanding involvement with an activity system (Russell, 1998). Learning, seen this way, emerges as active and includes appropriation of new tools, which by itself is also an active process.

All the students in the study engaged in some form of learning by expanding involvement through reading various texts. One peculiar example was of June, who consciously looked for and read texts within the area of gene research, a disciplinary activity system which was relatively new to her. By reading these texts, she hoped to learn about the kinds of issues discussed and the kinds of methodologies employed in gene research today so as to eventually engage with the activity system later on in her research career.

The notion of expanding involvement, as applied in this study, is valuable because it draws attention to the social interactive and developmental aspects of advanced reading. It begs the questions of whether and how reading mediates students expanding involvement with various activity systems. It further explains that students' expanding involvement with disciplinary activity systems does not have to be a smooth process and may involve loops back and forward.

3.11. Conclusion

Figure 3.4 presents a summative overview of the framework and the main concepts used for the analysis of reading in this study. Activity theory has served as a tool of inquiry or a "thinking device" (Gee, 1999) to accomplish two major goals:

- to understand reading at the levels of immediately observable behaviors, individual agency and social interactions, and

- to find empirically systematic and valid ways in order (1) to acknowledge the idiosyncratic nature of each student's interactions with texts and, at the same time, (2) to find some common features of advanced academic reading.

This research, by adopting an activity theoretical framework, aims to add to the existing inquiry into reading by extending the object of research and applying powerful explanatory concepts to the interpretation of the data. I believe in doing so, I have followed the recent calls in advanced literacy research for contextualizing studies of literacy processes and practices (Smagorinsky, 2001; New London Group, 1996; Strømsø and Bråten, 2002; Haas, 1994; Grabe, 1997, and many others) and have found a way of defining and analyzing these processes in concrete sociohistorical and temporal-physical settings.

I have presented this framework in this chapter with the aim of explicating some important aspects of it and under the expense of oversimplifying its theoretical underpinnings and developments. This oversimplification was felt necessary for the sake of the reader trained in non-activity theoretical frameworks. In reality, activity theory is extraordinarily complex and my understanding of it has evolved and changed throughout the whole PhD process. In the chapters that follow, which present the actual analyses of the data, I hope the complexity of the activity theoretical framework employed in this thesis will become more apparent and appreciated.

1. Three levels of analyzing reading in context:
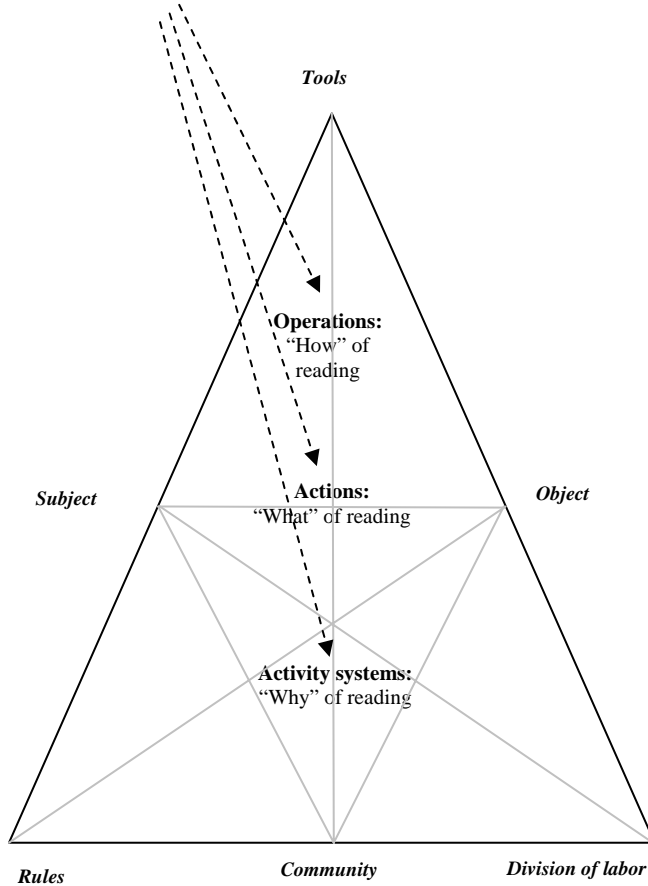
2. Concepts used to interpret the interactions between the levels and their elements:

Tools

Operations:
"How" of reading

Actions:
"What" of reading

Subject

Object

Activity systems:
"Why" of reading

Rules

Community

Division of labor

Affordances: opportunities for interaction presented to the reader by texts relative to his activities and capacities

Contradictions and psychological double binds: contradictions between elements of activity system/s which lead to feelings of frustration for the reader

Zone of proximal development: a collaborative construction of conditions for expansive learning through reading

Expanding involvement: expanding involvement with activity systems through reading

Figure 3. 4. A summative look at the activity theoretical framework

CHAPTER FOUR: Research design and methodology

Chapter 4 will explicate the research design and methodology which were utilized in this study of postgraduate reading, and Figure 4.1 below previews the main sections of the chapter.

4.2. Qualitative research based on naturalistic inquiry
4.3. Multiple case study design
4.4. Research site

4.5. Research participants
→ 4.5.1. Purposive sampling
→ 4.5.2. Interactions with participants and ethical considerations

4.6. Data collection
→ 4.6.1. Interviews
  → 4.6.1.1. Introductory interviews
  → 4.6.1.2. Text-based interviews
  → 4.6.1.3. Interpretative interviews
→ 4.6.2. Think aloud method
  → 4.6.2.1. Theoretical considerations
  → 4.6.2.2. Think aloud in this study
    → 4.6.2.2.1. Think aloud sessions
    → 4.6.2.2.2. Explanatory interviews
    → 4.6.2.2.3. Observations
→ 4.6.3. Collection of texts
4.6.4. Reading logs

4.7. Preparing data for analysis
→ 4.7.1. Transcribing the data
→ 4.7.2. Managing and organizing the data

4.8. Data analysis
→ 4.8.1. Phase one: Initial thematizing
→ 4.8.2. Phase two: In-depth case studies
  → 4.8.2.1. Verbal data
  → 4.8.2.2. Textual data
  → 4.8.2.3. Observational data
  → 4.8.2.4. Assembling the cases
→ 4.8.3. Phase three: cross-case analysis

4.9. Generalizability in this research
4.10. Trustworthiness: Validity and reliability in this research

Figure 4.1. Preview of Chapter 4

4.1. Introduction

Two basic assumptions, as reflected in Chapters 2 and 3, underlie this study:

(1)   that there is a need for a qualitative study which would examine reading in contexts of its natural occurrence (Chapter 2), and

(2)   that context itself should be conceptualized as laminated, multi-layered and involving other humans and material surroundings (see Chapter 3).

My choice of the methodological tools has been made on the basis of their applicability to these two assumptions rather than their fit with the research methodologies prevailing in second language reading research today. Consequently, this research is situated within the qualitative research paradigm (Denzin and Lincoln, 2003; Kvale, 1995; Wolcott, 1994; Huberman and Miles, 2002), is based on naturalistic inquiry (Owens, 1982; Lincoln and Guba, 1985), and employs a multiple case study design (Yin, 2003; Stake, 2000) with adaptive and evolving procedures for data collection (Denzin and Lincoln, 1998) and reiterative methods of data analysis (Miles and Huberman, 1994; Richards, 2003).

Chapter 4 documents the research methodology employed in this study. First, the approach to inquiry and the overall research design are presented, followed by a description of the research site and participants. Second, in separate sections, each method of data collection and the procedures involved are described. Then, the phases and the procedures of data analysis are presented. The chapter ends with a discussion of generalizability, validity, and reliability as conceptualized in this study, followed with a section on limitations.

4.2. Qualitative research based on naturalistic inquiry

The naturalistic inquiry to this PhD study is reflected primarily in its aim which is to understand postgraduate reading in the contexts of its natural occurrence. Specifically, the aim is to understand the reading of 11 postgraduate students of the Hong Kong Polytechnic University by interpreting what the students did when they engaged in academic reading at

their own convenience and at their own pace, for the purposes of their own studies. This aim reflects my belief that human phenomena, including reading, are context dependent, and that in order to understand them, it is important to study them in natural contexts in which they occur (Owens, 1982; Lincoln and Guba, 1985).

The need for naturalistic studies of reading has been highlighted by some previous research. Hacker (1998), for example, with regards to self-regulated reading comprehension research, notes that much of what experimental studies show may not reflect "the kinds of reading typically encountered in educational settings" (p. 175). With respect to research on reading to learn, Goldman (1997) concludes that though variables identified in laboratory-based experimental studies are important for understanding reading to learn, they seem to be "swamped by more macrovariables operating in the context" (p. 381). Finally, Strømsø and Bråten (2002) argue that reading in higher education involves processes and practices which are considerably different from those detailed in experimental research.

As a naturalistic study of postgraduate reading, then, this PhD research grew out of and follows the tradition laid out by previous studies of reading which have initiated the tradition of researching reading in multiple contexts of its natural occurrence (e.g., Smagorinsky, 2001; Penningroth, 1997; Strømsø and Bråten, 2002; Heap, 1991) and out of naturalistic studies of academic literacy described in Chapter 2 (e.g., Haas, 1994; Prior, 1998; Berkenkotter, Huckin, and Ackerman, 1991; Casanave, 2002; Spack, 1997).

My assumptions about the importance of context situate this study within the broader qualitative research paradigm (Creswell, 2003; Lincoln and Guba, 1985, 2000, 2003). As a qualitative study of reading, this study seeks to understand "*how* social experience is created and given meaning" (Denzin and Lincoln, 2003, p. 13). It does so by relying on "a set of interpretive, material practices that make the world visible" (Denzin and Lincoln, 2000, p. 3) to collect data which are not easily quantifiable and are analyzed through cyclical and highly reiterative processes of reduction, display, and verification (Miles and Huberman, 1994).

Ontologically, the following beliefs usually associated with social constructivism or interpretivism (Cresswell, 2003; Lincoln and Guba, 2003) underlie this qualitative study of postgraduate reading in naturally occurring contexts:

- there is no one single reality,

- reality is context-dependent,

- it is not independent of the inquirer who seeks to understand it,

- it is co-constructed by multiple participants.

In light of this ontological stance, this thesis which presents the study should itself be seen (1) as a representation of realities lived through and interpreted by the participants of the study and (2) as a representation of realities filtered through the eyes of the researcher. This ontological stance further corresponds to the following beliefs about knowledge:

- our knowledge about advanced academic reading will depend on particular historical and cultural settings,

- it will be subjective and will be a result of interpretation, both of the participants and the researcher,

- it will be constrained as well as afforded by the specific methods which are used to collect, analyze, and present the data.

This epistemological stance dictates that, as a researcher, I detail the particulars about the settings in which this research was carried out, the methods I employed to collect rich data and the methods I used to analyze and make sense of the lived experiences of the participants in the study. It also necessitates a discussion of validity, generalizability, and reliability as they were understood in this research. In the sections that follow, I detail all these aspects, and I start by describing the study as involving a multiple case study design.

4.3. Multiple case study design

Due to the focus of this research on (1) the contexts in which postgraduate reading is undertaken and (2) the participants' interpretations of their reading experiences, it was

carried out as multiple (eleven) case studies (Stake, 1995; Cohen, Manion, and Morrison, 2000; Yin, 2003). Stake (1988) defines a case as "the unity or totality of a system with some kind of outlines or boundaries" (p. 255). In this study, a case is defined by the unit of "a postgraduate student reading academic texts in English". Every case, in turn, contains several reading episodes, which are defined as an instance of a student reading a particular text in particular physical-temporal settings.

As will be presented in the subsequent sections of this chapter, various data collection methods were utilized and various data types were sought after to ensure a deeper understanding of each case and each reading episode within the case. The data were further compiled into case records and analyzed with two major purposes in mind: (1) to understand the uniqueness of each case, and (2) to locate commonalities across the cases. Subsequently, this research designed as multiple case studies will result in a detailed presentation of three reading episodes from three case studies (Chapters 5-8) and a discussion of the common themes which have emerged on the basis of all eleven cases (Chapter 9). More information on the analysis and presentation will be provided in section 4.8 below.

Qualitative case studies have been valued particularly for their ability to shed light on the complexity and idiosyncrasy of human phenomena (Yin, 2003; Cohen et al., 2000). Accordingly, they have established themselves in various disciplines interested in human learning, socialization, cognition and communication (Nunan, 1999; Duff, 2002; Braine, 2002; see also Chapter 2, section 2.3.5, in which I reviewed major case studies of disciplinary socialization). Case studies, however, have also been criticized on the basis of their ability to lead to generalizable knowledge (which is assumed by some to be incompatible with the focus on idiosyncrasies in human phenomena; see Cohen et al., 2000). Building on Stake (2000), Lincoln and Guba (2000), and Donmoyer (2000), I believe that case studies may provide a "natural" basis for generalization, and in section 4.9 of this chapter, I will revisit the question of generalizability by discussing it specifically with respect to this study.

4.4. Research site

The research was conducted at the Hong Kong Polytechnic University (PolyU), one of the seven tertiary level institutions in Hong Kong. Education at this university, including postgraduate education, is interpreted in terms of practical needs of the industry, the economy, and the society of Hong Kong (see Ko, 1997; Wu, 1997, and others). Hence departments of various applied sciences are the homes to the 11 participants of the study.

At PolyU, the length of the normal postgraduate study period depends on the program the student is registered for and, for PhD programs, on the availability of a Master's degree. Table 4.1 below contains more details regarding the length of the normal study period across various types of postgraduate programs.

Table 4.1. Normal periods of study across program types in PolyU

Degree	Availability of Master's degree	Length of the normal study period	Notation within thesis
PhD	Yes	3 years	3yr PhD
PhD	No	4 years	4yr PhD
MPhil	No	2 years	MPhil

Within the normal period of study, students are expected to take a certain amount of taught and independent study courses, to complete a research study and to present it in a thesis. According to the Research students' handbook for 2003-2004, in their theses, postgraduate students are expected to show that they are able to:

- Fully understand and critically evaluate the literature related to their chosen area of study
- Identify problems of relevance and significance worthy of examination
- Formulate the problems into testable pieces amenable to rigorous investigation
- Apply appropriate research methodology to conduct the investigation
- Perform careful and thorough analysis from which valid conclusions are drawn
- Present the findings in a clear, lucid and cogent manner

(2003, p.1)

A system of examinations is used to ensure the progress of postgraduate students and the quality of their research output. Every student has to pass two major exams: a confirmation and an oral defense, both of which include a written and an oral presentation components.

4.5. Research participants

4.5.1. Purposive sampling

Purposive sampling, which is defined as a strategy by which participants are chosen on the basis of the researcher's judgment of their ability to contribute meaningfully (Creswell, 2003), was employed in the study. Three criteria for choosing the participants were established at the very beginning, and these criteria were piloted and were found viable. The three criteria were: the participants were to be non-native speakers of English, enrolled for a full-time MPhil or PhD program at PolyU, and willing to spend a considerable amount of time participating in this research. Being interested in understanding reading in diverse contexts, I hoped to get a maximum variation within the participants.

Potential participants were attracted through advertisements in the student hall as well as through personal contacts. All the applicants met the specified criteria when selected for participation. Initially, data were collected from twelve students; one of them, however, was not included into the analysis. The student had agreed to participate in this study when he was in the very beginning of his PhD and his study load was relatively undemanding. However, with time, his PhD became too overwhelming for him to spare any time, and thus there was insufficient amount of data at the end, in comparison with the other cases. The eleven remaining participants are introduced in Table 4.2 which includes information on their program (MPhil/PhD), year into the program, hosting department, native language, and gender.

Table 4.2. Study participants

	Program	**Year at PolyU**	**Dept**	**Native language**	**Gender**
Joanna	MPhil	Beginning of 1st	ENG	Cantonese Chinese	F
Jim	4yr PhD	Beginning of 2nd	BSE	Mandarin Chinese	M
Hugo	4yr PhD	Beginning of 2nd	LSGI	Canadian French	M
Amy	3yr PhD	Beginning of 1st	LSGI	Nigerian	F
Sam	3 yr PhD	Beginning of 1st	LSGI	Mandarin Chinese	M
Lora	3yr PhD	Beginning of 1st	ISE	Mandarin Chinese	F

Mike	3yr PhD	Beginning of 1st	ME	German	M
Dewey	3yr PhD	Beginning of 1st	RS	Mandarin Chinese	M
June	3yr PhD	Beginning of 1st	ABCT	Mandarin Chinese	F
John	3yr PhD	End of 3rd	CSE	Mandarin Chinese	M
Fred	2 yr PhD	Beginning of 1st	CSE	Mandarin Chinese	M

Notes:
(1). ENG=Dept of English; BSE=Dept of Building Services Engineering; LSGI=Dept of Land Surveying and Geo-Informatics; ISE=Dept of Industrial and Systems Engineering; ME= Dept of Mechanical Engineering; RS= Dept of Rehabilitation Sciences; ABCT= Dept of Applied Biology and Chemical Technology; CSE=Dept of Civil and Structural Engineering.
(2). Fred was a unique case who had to finish his PhD within 2 years of study (2yr PhD).

4.5.2. Interactions with participants and ethical considerations

It has become almost a truism within qualitative research to suggest that the primary tool for data collection and analysis is the researcher herself (Denzin and Lincoln, 2003). If, as the researcher, I am to be considered a major research tool, it is of utmost importance to account for the interactions I engaged in with my study participants. Before the study commenced, I knew 4 out of the 11 students of this study. As an international postgraduate student, I came to know Hugo, Amy, and Mike through various social functions and meetings organized for the international students of the university. As a student of the English department, I knew Joanna through research seminars and gatherings.

Over the progress of data collection and analysis, casual and diverse interactions with all the eleven participants developed, which was an asset to the naturalistic inquiry characterizing this study. We communicated through e-mail on a frequent basis and met on social functions held in the university student hall. I attended various presentations by the students at the students' approval and looked through their writing if they asked me to. On the one hand, I was a postgraduate student who shared experiences with my study participants and was similar to them in many respects. On the other hand, I was a researcher who was in charge of the study and an English tutor who could be of help to the students. The students themselves were enthusiastic to participate in the study because they were interested in the object of the research. Being postgraduate students, many of them

felt reading was a very important aspect of postgraduate education and were eager to learn more about it along with me. Some students additionally saw this study as a chance to practice and improve their English which contributed to the enthusiasm with which they engaged in it.

Regarding ethical considerations, I followed the following precautions. First, consent forms detailing the study and the responsibilities of the participant and the researcher were prepared and distributed to the students (Appendix 4.1). All the students agreed to participate based on the conditions and the description of the study. Additionally, consent was obtained from some of them for video-taping and from all of them for audio-taping.

Second, following a common practice in qualitative research writing, the participants' names were changed for pseudonyms in the final write-ups of the thesis to ensure the participants' privacy. Third, the participants of the detailed case studies presented in Chapters 4-8 of this thesis were asked to read through several drafts of corresponding chapters and comment on my analysis and interpretations of their reading (see section 4.6.1.3 for more details). Finally, issues related to presenting the participants in this thesis had to be considered (Atkinson, 1992). I decided to present excerpts from various transcripts without modifying them for grammatical and syntactical features and explain my decision in section 4.7.1 below which details the process of data transcription.

4.6. Data collection

As characteristic of naturalistic research, this study employed flexible data collection procedures (Goetz and LeCompte, 1984), which, when put to practice, meant two things: (1) the students were given a choice of whether to participate in certain methods of data collection or not, and (2) the amount of data collected and the number of reading episodes comprising the cases depended on the amount of reading each student undertook and the amount of time they could spare to this study. On average, each student engaged in text-based interviews for the period of 3 months during which some of the students additionally participated in think aloud sessions which were accompanied with observations.

Introductory, interpretative and explanatory interviews were further employed to gather

information about the students' literacy practices and PhD studies and to ensure the

credibility of data analysis and interpretation. Texts were collected from all the students,

and one student was additionally able to keep reading logs. Figure 4.2 below displays the

methods of data collection and thematic foci for each one of them.
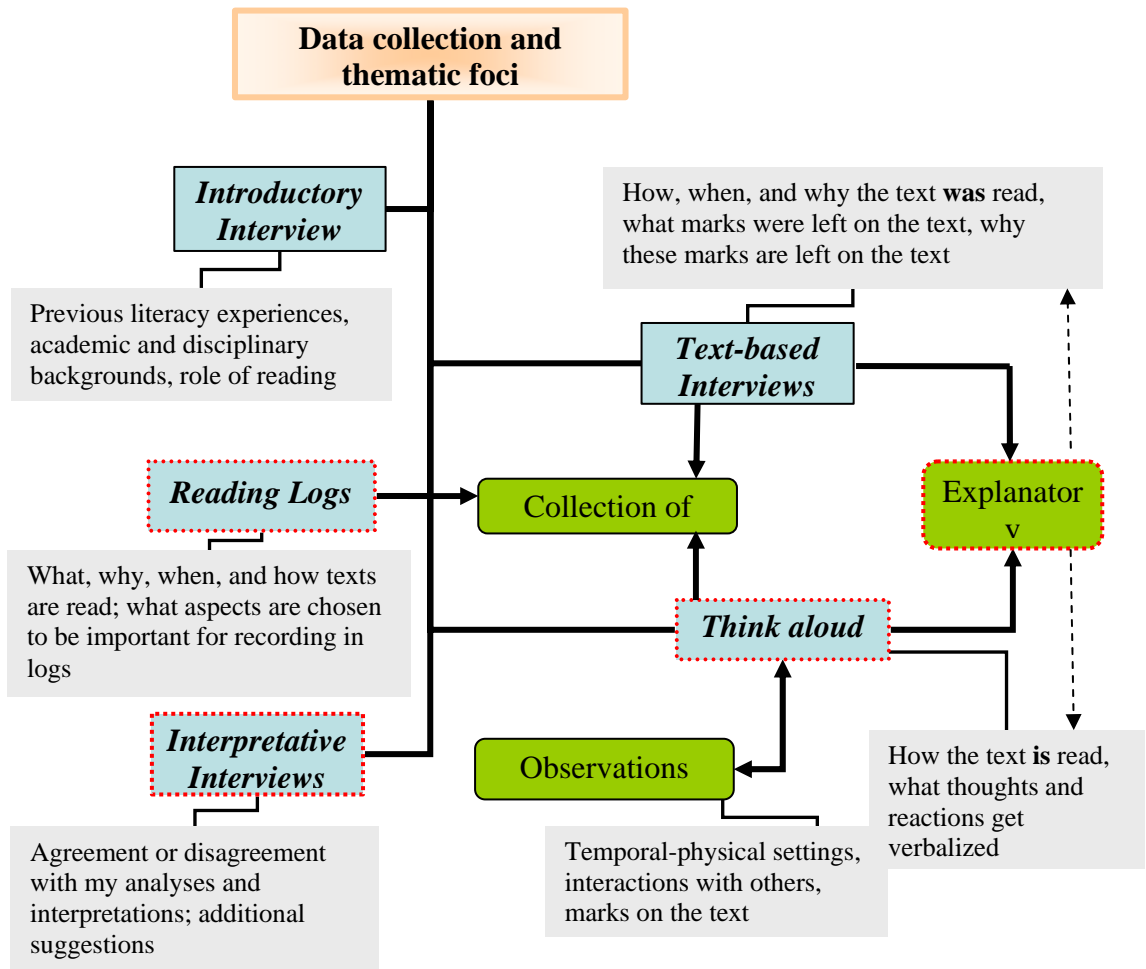
Figure 4.2. Methods of data collection used in the study

Note: methods which were employed only with some students are enclosed in red dotted
lines.

As the figure shows, several methods of data collection were used so that to target

similar areas of interest, and thus, for example, text-based interviews, think-aloud sessions,

and collections of reading logs were planned in order to understand how academic texts

were read. In addition to method triangulation, the study also relied on data triangulation

(Denzin, 1978), and thus textual (resulting from collections of texts), verbal report

(resulting from interviews and think-aloud sessions), and observational data (also resulting

from think-aloud sessions) were collected. Table 4.3 below further displays the distribution

of data across the 11 cases.

Table 4.3. Data sources across cases

	IntroI	**TBI**	**TA**	**Exp lanI**	**InterI**	**RL**	**N of texts**	**Period of data collection**
Joanna	√	3			√		11	28/01/03-03/04/03
Jim	√	2	1	√			7	23/01/03-11/03/03
Hugo	√	2	1	√	√	√	25	24/07/02-31/03/03
Amy	√	3			√		6	16/02/03-07/04/03
Sam	√	2		√			8	22/02/03-05/04/03
Lora	√	3			√		7	14/02/03-09/04/03
Mike	√	1	1	√	√		7	11/02/03-10/03/03
Dewey	√	2	2	√			9	20/01/03-11/04/03
June	√	2	1	√	√		7	28/01/03-15/03/03
John	√	3	1	√	√		4	23/07/02-07/11/03
Fred	√	2					2	17/01/03-01/03/03

Note: IntroI=Introductory interview; TBI=Text-based interview; TA=think aloud session; ExplanI=explanatory interviews; InterI=interpretive interview; RL=reading logs

Though the methods presented in Figure 4.2 and Table 4.3 provided the study with

the major data, as the research proceeded, I collected bits and pieces of more information

from additional sources, such as student presentations, MSN discussions, and e-mails.

Over time it became clear "that finding what one can, where one can, is part of the

condition for qualitative research" (Holliday, 2002, p. 84; emphasis original). Out of these

additional data sources, Power Point presentations prepared and used by some of the

students for their own study-related purposes were particularly useful, and accordingly, all

the four case studies presented in detail in Chapters 5-8 relied on information from these

presentations.

4.6.1. Interviews

Although I did not rely on interviews to the exclusion of other methods of data collection, they contributed most to the overall volume of the data collected. There are at least two reasons to account for the importance of this method: on the one hand, interviews, as Oppenheim (1992) explains, are often "concerned with trying to understand how ordinary people think and feel about the topics of concern to the research" (p. 67); on the other, as Prior (2004) emphasizes, in-depth interviews reveal the participant's goals, processes, contexts and feelings (p. 179). Since the goals of this research are to understand reading from the perspective of the readers and to understand reading as a contextualized phenomenon, I felt that interviews were best suited as the primary method of data collection for this study.

Different types of interviews were conducted with the participants on an individual basis and could be described as guided purposeful in-depth "conversations" (Minichiello, et al., 1990). Though I went to all interviews with a list of questions I felt I needed to ask, I also allowed the interviews to develop naturally, with time left for clarification, follow-up questions, and personal exchanges. In accord with the existing suggestions on how to conduct qualitative interviews, I attempted to make the interviews friendly, casual, conversational, yet also somewhat scholarly and formal (Haas, 1994).

All the interviews, with the exception of a few introductory interviews, were tape-recorded and transcribed. I contemplated taking additional notes during interviews; however, I decided against them for two major reasons: I did not want to distract the student by taking notes, and I felt the tapes would provide me with sufficient information. Additionally, I recorded reflective notes right after each interview session which included such information as impressions from the interview, main topics covered, and a preliminary plan for the next interview. Table 4.4 previews the types of the interviews employed in this study. The sections that follow this table will additionally outline the procedures involved in each interview type.

Table 4.4. Interview types

Type	When conducted	Purpose
Introductory interviews (IntroI)	Beginning of data collection	1. to introduce the study 2. to get consent 3. to elicit information about participant's literacy, educational, and disciplinary backgrounds
Text-based interviews (TBI)	After the introductory interview, throughout the rest of data collection	1. to elicit student's reports on reading particular texts 2. to gain insight into goals, processes, and social forces in reading
Explanatory interviews (ExplanI)	After think-aloud sessions and/or after any stage of data analysis which revealed a gap in understanding the data and the need for more explanation from the student	1. to ask the student to explain a certain segment of the data 2. to gain a richer insight into the reading processes and elements of activity (will be discussed in section 4.6.2.2.2 as part of the think-aloud method)
Interpretative interviews (InterI)	After initial analyses of data	to validate my analysis and interpretations through "member checks"

4.6.1.1. Introductory interviews

Introductory interviews were used as funneling (Minichiello, et al., 1990) to help the participants start thinking about issues related to their reading processes and practices. There were 3 specific purposes which guided these interviews: to introduce the study, to get the students' official consent (see Appendix 4.1), and to elicit information about each participant's literacy, educational, and disciplinary backgrounds. This information was important for the study because of several reasons: (1) it provided me with an initial understanding about the students' activity systems and the role, amount, and kind of reading they engaged in, and (2) it provided me with information necessary for preparing think-aloud training materials (see section 4.6.2 below).

4.6.1.2. Text-based interviews

Text-based interviews (also known as "discourse-based interviews"; see Odell, Goswami, and Herrington, 1983) have been gaining in popularity among literacy researchers (Prior, 1992, 2004; Haas, 1994). In short, these are interviews in which the

discussion between the interviewer and the participant is stimulated by specific texts. In this study, text-based interviews were individual interviews which evolved around the texts of academic nature the student had read during one or two weeks preceding the interview and as part of their PhD studies.

In the beginning of the interviews, I took a few seconds to look through the students' texts in order to see how much had been done to them in terms of note-taking and highlighting. Then, the student and I discussed each individual text. To begin with, I asked the student to tell me what the text was about and this general question often led to detailed accounts of purposes for and relevance of reading it. Then, the student and I went through specific notes and highlights left on the pages of the text, with the student explaining the content and the reasons of these textual marks. This part of the interview revealed significant information about the student's textual actions, his interactions around the text, and the overall progression of reading.

Following Haas' (1994) procedure, I tried to avoid asking direct questions about the authors of the text, their intentions, affiliations or any other social elements which may have been involved in the student's reading. What I learned about these aspects of reading arose in the natural course of the student telling me about the text he read and the marks left on the pages of it. However, when there was a reference to social others in our discussion of a specific text, I attempted to elicit as much information as possible by prompting the student to continue with comments such as "Oh, really?" and "Can you tell me more about it?"

As I did with other interviews, I audio-taped and transcribed all text-based interviews. When transcribing, I asked myself whether I had enough information to understand the student's reading and its contexts; I began marking those segments which needed further explanation from the student and followed up either at the next interview or via e-mail.

By utilizing the students' notes and highlights as stimulants for data elicitation, I saw myself as a bricoleur (Denzin and Lincoln, 2003) piecing together the seemingly "banal"

and "everyday" slices of life (Miles and Huberman, 1994) into complex wholes in order to make "vivid what has been obscure" (Eisner, 2001, p. 136). The notes and highlights students leave on their texts were those seemingly banal pieces of information which were so easily available and eventually contributed to wonderful insights into the reading processes of the students.

4.6.1.3. Interpretive interviews

Interpretive interviews were used as a strategy to invite students to actively engage in critiquing my interpretations of their reading and to suggest their own. They usually took place after enough data were collected to inform initial analyses of the student's reading processes and practices. Most interviews were stimulated by written-up drafts of my analyses and interpretations which the students had a chance to read through before the interview. Following Sarangi and Candlin's (2003) advice, I avoided presenting my interpretations as the final and unquestionable understandings of the student's reading. With this in mind, I attempted to construct these interviews as "an occasion for inventing and concretizing opinions, not merely presenting already fully formulated ones" (Sarangi and Candlin, 2003, p. 279).

Consequently, the language of my interpretations involved a lot of hedging and I constantly asked the student "Do you think this is reflective of what you do or how you read? Do you think there is something important that I am missing here?" Similar to the other kinds of interviews, there were certain questions I had planned depending on a particular case; there were also other questions which arose from the student's particular responses and suggestions.

This type of interviews was particularly useful for detailed case studies where the participants were consulted several times and were asked to read several drafts of my writing. In addition to ensuring ethical considerations, this strategy afforded a form of "member checks" which allowed me to see how well I understood the students' contexts and their reading and thus establish credibility of my descriptions and interpretations

(Denzin and Lincoln, 1998). It also allowed me to maintain a dialectical relationship between the *emic*, or insider, and *etic*, or outsider, perspectives on the research object and the data (Geertz, 1983) so as to arrive at analyses which were richly theoretical and researcher-oriented yet not void of student perspectives and interpretations.

4.6.2. Think aloud method

4.6.2.1. Theoretical considerations

Think aloud as a method of data collection has been applied extensively in various branches of inquiry interested in the thought processes of humans engaged in certain tasks (Ericsson and Simon, 1984; Gaas ands Mackey, 2000; Nunan, 1999). In reading research, the think aloud method has been applied extensively in studies of comprehension processes, information processing, and strategy use (cf. Pressley and Afflerbach, 1995; Cohen, 1998; Grotjahn, 1987; Cavalcanti, 1987).

The most known theory underlying and justifying the use of the think aloud method has been the information processing theory as advocated by Ericsson and Simon (1984, 1993, and 1998). However, since this study is based on naturalistic inquiry, Ericsson and Simon's (19984, 1993) cognitivist conceptualization of the think aloud method somewhat contradicted its purposes; therefore, in my preparation for the think aloud sessions I benefited most from Smagorinsky's (1998) and Boren and Ramey's (2000) sociocultural views of the think aloud method which are based on Bakhtin's (1986) notions of dialogicality and addressivity and Vygotsky's (1978) notions of egocentric speech, mediation, and zone of proximal development (see Chapter 3).

The two perspectives differ along various dimensions, the major disagreement being in how they regard the issue of reactivity in research involving the think aloud method. In brief, the question is: "Do subjects' verbalizations of thoughts during a task actually alter the cognitive processes required to carry out the task—in ways that either enhance or obstruct the cognitive processes subjects would use when not under the TA condition?"

(Stratman and Hamp-Lyons, 1994, p. 89). Table 4.5 juxtaposes the views of Ericsson and Simon (1984, 1993, and 1998) and Smagorinsky (1998) with regards to reactivity.

Table 4.5. Two views on reactivity in think aloud research

Ericsson and Simon (1984, 1993, and 1998)	Smagorinsky (1998)
• "under *some* circumstances, thinking can be verbalized without altering its course" (Ericsson and Simon, 1998, p. 180). • The goal is to minimize the effects of the researcher and the method on the participant's thinking	• "[i]t is possible to change but not to minimize the social role of speech in protocol-based research" (p. 167). • The goal is not "so much to neutralize the effects [of the researcher and the method of data collection] but to assume they exist and then to identify and account for them in the data collection and analysis" (p. 169).
Procedures that need to be ensured: (1) the reader should report his thoughts rather than engage in interpreting them; (2) the researcher should enhance his or her invisibility; (3) the reminders to the reader should be neutral and timed; and finally (4) the participants should "focus on the completion of the presented task" (Ericsson and Simon, 1998, p. 181).	**Factors that need to be taken into account:** (1) "the intersubjectivity between the researcher and participant" (p. 169); (2) "the dynamic, unfolding natures of thinking and speech and their dialectic relation" (p. 173); and (3) "the *activity setting* in addition to the *protocol*" (p. 174).

4.6.2.2. Think aloud in this study

Fully mindful of the limitations attached with the use of the think aloud method, I chose to use it in this study because its ability to reveal some of what is hidden in the human mind and is inaccessible otherwise outweighs its limitations (Pressley and Afflerbach, 1995). Like Smagorinsky (1998), I was interested in using the method to open up "windows that allow researchers to peer into workings of the mind" (p. 171). Realizing the difficulties which accompany thinking aloud for some students as a result of the pilot study, I explained what thinking aloud was to the students and let them choose whether they wanted to participate in the method. As a result, think-aloud sessions were conducted

with 6 participants who agreed and were able to verbalize their thoughts while reading: Jim, Hugo, Mike, Zach, and June.

4.6.2.2.1. Conducting think aloud sessions

Following Ericsson and Simon's (1984) suggestion, a careful preparation went into the planning of the think aloud sessions, a major part of which constituted think aloud training sessions (see Appendix 4.2). Following Smagorinsky's (1998) advice, I also considered these sessions as a critical point in the process of data collection and as a source of potentially useful information, as will become apparent in the case studies presented in Chapters 5-8.

Consistent with the principles of naturalistic enquiry, I attempted to collect think-aloud protocols in settings of the students' usual reading. Hence, the think aloud sessions were conducted in students' offices, dorm rooms, and even a coffee shop. Consistent with sociocultural approaches to the think aloud method, I engaged in the sessions as a conversant rather than a silent invisible researcher. However, I did not talk extensively to the students and minimized my comments to those of "think aloud" or questions when the student was silent for an extended period of time (more than 5 minutes). In Bishop's (1999) words, my role in the think-aloud sessions was somewhere in the "the middle road", where I was "moving into the scene, where it seem[ed] natural and polite, and moving back to observe more carefully when that also seem[ed] functional" (p. 75).

Because the expert scientists in Bazerman's (1985) study previewed, skimmed, and skipped parts of the texts they read and because the current literature on expert-novice reading suggests that natural reading is seldom linear (Pressley and Afflerbach, 1995), I asked the students to read as they wished and that they were free to skim through, preview, or even skip sections of the texts they brought to the think-aloud sessions. Some students, however, had already previewed their papers before coming to the think-aloud sessions, and hence, they engaged in seemingly more linear reading.

After the student finished reading the text (or several texts, in some cases), I asked him to explain why he read the text and where he found it. This information was important in order to gain a more complete sense of the student's motivations. Additionally, I asked questions about the specifics of the text, and these questions were prepared while I observed and listened to the think-aloud session. The think aloud sessions resulted in transcripts of the protocols and my notes. In some cases, where the students allowed it, videotaping was used and the video tapes were later utilized as a tool for further data elicitation as described in the next section.

4.6.2.2.2. Explanatory interviews

Encouraged by the potential of the method described as "grounded ethnography" (Frankel and Beckman, 1982; Douglas, 2000), I decided to use the videos resulting from the think aloud sessions as a means of eliciting the participants' accounts of and their reactions to their thinking aloud. Essentially, these were meant as explanatory interviews where I encouraged the students to explain what they were doing and what they were saying in the think aloud session. Procedurally, this interview involved the three major stages diagrammed in Figure 4.3 below.
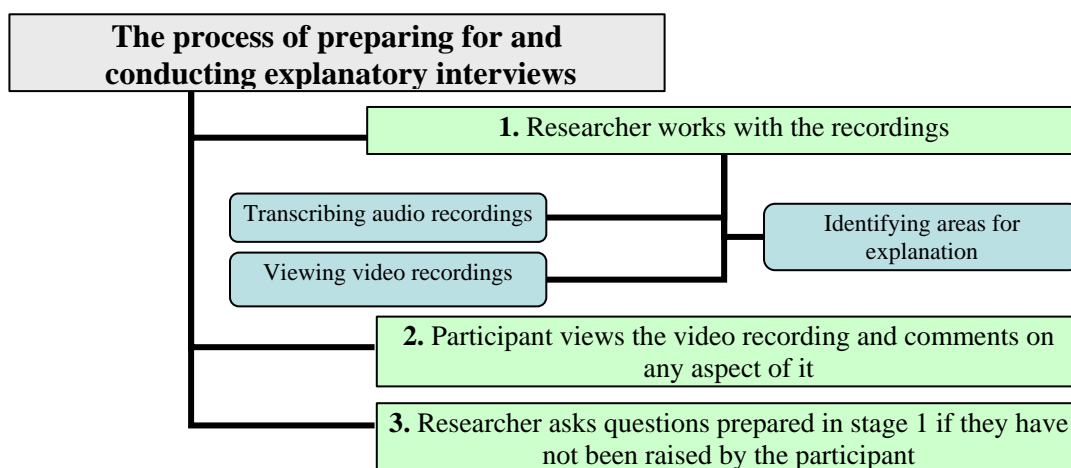
Figure 4.3. Stages of preparing for and conducting explanatory interviews

These interviews were audio-taped and their transcripts were incorporated into the original transcripts of the think-aloud sessions. Such incorporation allowed me to triangulate the data and see the various sources of information in one transcript (see section 4.7 for more information on transcribing and organizing the data).

4.6.2.2.3. Observations

Since think aloud protocols were collected in naturalistic settings and since I was present during the think-aloud sessions, they provided me with an opportunity to engage in observations, a data gathering method considered to be basic to naturalistic research (Marshall and Rossman, 1989). Based on my research focus, the observations resulted in two sets of hand-written notes about: (1) the reading environment including the physical-temporal setting and (2) the reading behaviors including comments on what the student did to the text. The notes were later retyped and enhanced upon viewing the videos.

4.6.3. Collections of texts

All the texts the students read during the period of engagement with this study were collected from the students and became part of each student's case records. In compiling each student's collection of texts, I engaged in the following:

1. collecting the texts after each interview or think-aloud session;

2. making a copy of each text;

3. re-highlighting the text based on the original copy of the student's marks;

4. checking whether all the original notes got copied and, if necessary, adding the missing notes; and

5. writing an accompanying contextual record (Prior, 1992; 2004) for all texts which included such information as the source, the date and the place of their collection, and my initial analyses of the highlights and notes.

4.6.4. Reading logs

In addition to the methods described above, I hoped to gain more insight into the students' reading by asking them to keep reading logs. However, similar to Prior's (1992) students, most students in this study were not able to keep reading logs because of individual time constraints or dislike of writing. Only one student, Hugo, agreed to provide me with reading logs, and his agreement can be explained by the fact that he had already kept notes about his readings in EndNote, the software he was using for keeping track of his readings. These reading logs provided the study with deeply interesting data which was a major consideration in my decision to include Hugo as a detailed case study in this thesis (see Chapter 6 and Appendix 6.2 for an example of a reading log).

Additionally, some students, such as Dewey and Joanna, kept brief logs about the texts they read. The logs contained such information as the basic details of the text and the day when the text was read. This information proved to be useful in keeping track of the students' reading and the amount of reading in their studies.

4.6.5. Summary

In this section, I have described the methods of data collection employed in the study. I have tired to convey the sense that the process of collecting the data was adaptive to the students' purposes, activities, natural settings, and suggestions. I have additionally tried to draw attention to how these data sources acted together in providing complex data of the students' reading. In the section that follows, I move to the question of how I analyzed the rich and complex data I collected and how I made sense out of it.

4.7. Preparing the data for analysis

The first stage of transforming the data involved transcribing and organizing it. I treat these two processes as initial and important stages of analysis because they allowed me to get closer to the data and affected what I saw when analyzing the data further.

Transcription, especially, became "a central method of inquiry" (Prior, 1992, p. 141) and is detailed in the next section.

4.7.1. Transcribing the data

A common practice in qualitative research has been to transform interview data into interview logs which contain excerpts from the interviews deemed to be important by the researcher (Glesne, 1999; Harms, 2003). Such practice is said to save the time the researcher needs to spend preparing the data for analysis. In this study, I deemed it important to transcribe the data resulting from the interviews and think-aloud sessions for two major reasons: (1) because I listened to the tapes for several times when transcribing, the process allowed me to get closer into the data and to get a sense of the students and their reading processes and contexts, and (2) though the transcripts did not substitute the tapes, they became the primary representations of the verbal data used in the subsequent analyses.

Interviews and think-aloud sessions were transcribed within 2 weeks of data collection. While transcribing the data, I had to make several important decisions. First of all, I had to choose how to present the individual speech patterns of my participants. Since I wanted my readers to remember that the participants are all non-native speakers of English, I decided to preserve the lexical choices, syntactic sequences as well as morphological constructions of the students. This led to the ethical question of whether the students would be comfortable with presentations of their speech which contained obvious linguistic inaccuracies. To avoid ethical complications, I asked the students whose words are presented in the thesis verbatim to read the sections of transcripts and comment on whether they thought I presented them accurately. For transcript conventions, please refer to Appendix 4.3 of the thesis.

4.7.2. Managing and organizing the data

The multiple data collection methods described above led to a vast amount of data, which had to be managed and organized in ways that would assist in data analysis and write-ups. Various techniques were used to manage the data. First of all, the transcripts of all the interviews and the observation notes were stored in one computer folder, with each student being assigned a sub-folder. Paper-based folders were also used for a back-up copy of the electronic folder and allowed for a quick access and marking as the analysis proceeded.

Second, copies of the texts discussed during text-based interviews or read during think-aloud sessions were collected from the students and stored in paper files. Finally, for those reading episodes which drew on multiple kinds of data, it was important to juxtapose the data next to each other. Therefore, textual, verbal and observational data were combined into data matrices as the ones presented in Appendices 5, 6, 7, and 8. For example, I recorded the student's verbal comment, the textual segment which triggered the comment, and the physical behavior of the student which accompanied the comment. Such organization of the data aided in both gaining an overall picture of the reading episodes and specific themes emerging within and across the data sources (see Prior's (1992) discussion of integrative analysis).

4.8. Data analysis

Morrison (2003) argues that a most distinguishing feature of qualitative research is that it depends on "a loop-like pattern of multiple rounds of revisiting the data as additional questions emerge, new connections are unearthed, and more complex formulations develop along with a deepening understanding of the material" (Fretchling and Sharp, 1997, p. 1; quoted in Morrison, 2003, p. 85). This aspect of doing qualitative research has proved to be both enlightening and most challenging in this study, and in the coming sections I will discuss the procedures I employed to engage in these "rounds of revisiting the data."

In general, I followed what Miles and Huberman (1994) call an "analytic progression" which took me from describing what happened when students read texts to locating key themes and identifying important indexes and establishing relationships between them. The data analysis involved such processes as description, analysis, and interpretation (Wolcott, 1994) and was complemented with the use of charts, diagrams, and tables which helped me to sort through, cluster, and relate the data (Miles and Huberman, 1994). Three major phases can be distinguished in the overall analysis of the data, which are previewed in Table 4.6 below.

Table 4.6. Three stages of data analysis in this study

description		Focus	Data	Kind of analysis	Resulting product	Location in thesis
	Phase 1	Each student's reading of each text	Think aloud and/or interview data	Description and initial analysis of individual cases Synthesis across cases	1. a short narrative about each student 2. diagrams of each student's reading (for each text) 3. a map of common themes	**Appendix 4.4** **Appendix 4.5** **Appendix 4.6**
		Qs: How did each student read each text? Are there common features across cases?				
	Phase 2	In-depth case studies	Think aloud or text-based interview data + texts, introductory and interpretative interviews	Analysis and interpretation of individual cases	1. case studies 2. a focused question for the next stage of analysis	**Chapters 5-8** **Appendices 5-8**
		RQ1: What is the nature of postgraduate reading when it is studied in contexts of its natural occurrence?				
	Phase 3	Cross-case analysis	Same as above (stage 2)	Refined analysis and interpretation of common themes	a discussion of intertextuality, multimodality, and interactional networks in reading	**Chapter 9**
		RQ2: What common themes will emerge across cases? In what ways will these themes be similar and different across the cases?				

description ⟷ interpretation

4.8.1. Phase one: Initial thematizing

The first phase of data analysis commenced when the data collection was still in progress. At this stage, I was concerned with understanding each reading episode as it emerged from the data and examined the data with the focus on the processes and interactions the students engaged in when reading each text. To accomplish the goal, I read through transcripts of interview and think aloud sessions for several times, concurrently indexing them for the main themes which were emerging from the data (Stewart, 1998). Additionally, I was closely examining the data for missing pieces, the strategy described by Goetz and LeCompte (1984) as "scanning," so that to prepare for the coming interview sessions or ask the students for specific information via e-mail.

Eventually, the themes were summarized into two kinds of diagrams:

1. diagrams for each case, which contained such elements as processes I was able to identify in each reading episode, reading purposes, broader PhD motivations and social others which emerged to be important in the student's reading (see Appendix 4.5), and

2. a summative diagram, which was built as a result of overlaying the previous diagrams and which included those themes which emerged across more than one case. These common themes were: reading-experimenting connections, reading-writing connections, reading for a course, reading mathematics, reading visuals, reading references, reading across multiple texts, reading websites, role of supervisors in reading, role of others in reading, recognizing authors, and contacting authors (see Appendix 4.6).

In addition to the two types of diagrams, as a result of recursive readings and indexing, I wrote out page or two page descriptions of the students and their academic reading profiles which included such information as the amount and kinds of reading, usual settings for reading, motivations to do PhD, the object of the student's PhD, etc (see Appendix 4.4 with a sample profile). Both the diagrams and the descriptive narratives of reading profiles proved to be useful in the next phases of data analysis as discussed below.

4.8.2. Phase two: In-depth case studies

The second phase of data analysis involved a very fine-grained analysis of individual reading episodes for four students who were selected based on my judgment of the quality, quantity, and theoretical interest of their data. The theoretical interest was envisioned to be in the line of progression represented by these students who were at different stages of their PhD studies. Additionally, their availability and willingness to extend engagement with the study and comment on the ensuing drafts of relevant chapters was an important consideration.

If in the first phase, I analyzed primarily verbal data, at this stage, I additionally engaged in the analysis of textual and observational data (see sections below). The purpose of this analytical phase was to understand the specifics of single reading episodes so that to get a better understanding of interactions between the various elements I had identified in the previous phase. This was important in order to understand the nature of reading in particular contexts of postgraduate education. At this stage of analysis, I relied extensively on the activity theoretical framework which, as described in Chapter 3, provided me with appropriate tools for understanding reading in context.

Through the analysis at this stage, I attempted to answer the following questions in detail:

What is the nature of reading in context?
- How does the participant read?
- What actions does he accomplish while reading?
- Why does he read?

What are the social forces involved in reading, and how do these forces interact with and shape reading?
- What kinds of social others emerge through the data?
- What rules and distributions of power and responsibilities characterize the student's interactions with these others?
- In what ways do these relationships with others interact with the student's reading?

4.8.2.1. Verbal data

The verbal data for the four cases were revisited and re-indexed for the following themes presented in Figure 4.4 below. As the figure shows, an additional category, not previously identified in phase 1, emerged and is called "researcher influence". I found this category important in analyzing and understanding the influence of my own presence and behavior on the kind of verbal data elicited from the students.

Progression of reading
(i.e., skipping, scanning, previewing)
Tools used
(i.e., visuals, other texts, material objects)
* Verbalizations
(i.e., comment, direct reading, reflection, explanation of behavior)

Initial goal/s
(i.e., the initial purpose for reading)
Further goals
(i.e., changes in reading goals, development of new ones)
Significance of goals
(i.e., in broader activities)

References to the author
(i.e., mentions of the author's affiliations, status, writing and other abilities)
References to others
(i.e., colleagues, instructors, classmates, supervisors),
Positioning assumed with respect to others
(i.e., status, power, division of responsibilities)
Rules implied or stated
(i.e., doing PhD, contributing to disciplinary community, etc.)
Researcher influence
(i.e., suggestive remark, direct question, restatement, prompt)

Figure 4.4. Categories used in indexing the verbal data

The think-aloud data were somewhat more difficult for indexing than the data resulting from the text-based interviews. The difficulties were triggered by the fact that think-aloud data have been traditionally analyzed for cognitive processes and, considering that my aim was not limited to cognitive processes, I could not adopt the previous analytical schemes without adaptations or major changes. Hence, the following was decided:

1.   Building on the work of Hartman (1995), the transcribed protocols were divided into verbalization units which were defined as "those words spoken aloud by a student that were preceded and followed by some period of silence" (p. 529).

2.   Similar to the categories previously identified in cognitive studies of reading, I identified the category of "verbalizations" with such subcategories as guessing, evaluative, and comparative comments, among others (see Pressley and Afflerbach, 1995). The same verbalization unit could contain several cognitive processes and hence could be assigned different indices (Stewart, 1998).

3.   In addition to the cognitive operations identified this way, I was interested in the student's explanations of their behavior. Since there were numerous instances of explanations in the think-aloud data, an additional subcategory called "explanation of behavior" emerged and included statements of explanations of what the student did and what goals he aimed to accomplished.

4.   The verbalization units were further analyzed for the presence of social others and the student's stance with respect to these others. Such subcategories as "author", "other authors", "supervisor", "disciplinary community", etc. emerged as a result of this process of analysis.

5.   There were cases when students vocalized extended segments of the text, as cautioned by Ericsson and Simon (1984, 1998). Unlike information processing theorists, I did not disqualify these data because I assumed that only those sections which were important to the reader for some reason were verbalized. These verbalization units were assigned the descriptive category of "direct reading" and in many cases were accompanied with the sub-category of "explanation of behavior".

     Overall, data indexing was accompanied and often enhanced with the analysis of the texts, as described below.

4.8.2.2. Textual data

The texts did not lend themselves to the same kinds of indexing as the text-based interview and think-aloud data. The texts were used as a secondary source of data and hence their analysis was subordinated to the kinds of findings which were emerging from the interview or think-aloud data. 5 major aspects were usually analyzed across the cases. I started by reading the text with the aim of understanding the overall content and the basic organization of the text. Considering that I was far from being an expert in most of the disciplines presented in this study, this stage of textual analysis was considerably difficult. However, with the aid of the student's accounts, outside sources, and advanced organizers used in texts, I managed to get a general idea of what the text was about.

After that, I looked for more information about the author(s) of the text. This was usually available through the internet, from the student accounts, and other disciplinary texts (i.e., historical accounts of disciplinary developments). Here, I was interested in the author's affiliations, status in the disciplinary community and/or the status of the text within disciplinary communication. This information was useful for the further analysis of the student's stance towards the text and to answer the questions of whether the author of the text was an important social other for the student (Haas and Flower, 1988; Haswell, et al., 1999).

Next, I analyzed the texts for the amount of manifest intertextuality (Fairclough, 1992), or for "the traces of other texts" (Bazerman, 2004, p. 91). I analyzed the amount and context of references and citations. Along with the number of other texts, I counted the number of visuals and traced the relations between the visuals and the verbal text. For some cases, additional analyses were necessary, triggered by the findings emerging from the analysis of interview and think aloud data. For Joanna, for example, I analyzed the amount and content of definitional lists, and for John, equations (see Chapters 5 and 7).

The marks the students left on the surface of the texts they read were analyzed for all the cases. Based on the previous studies of note-taking (Slotte and Lonka, 1999), I started the analysis of the notes by categorizing them as cognitive responses (i.e., definition,

comparison, evaluation, etc.). Along with identifying these categories, I additionally analyzed what textual content received responses from the student and whether there were mentions of social others in these notes. My assumption throughout this important stage of analysis was that by analyzing note-taking, I could get insights into how the reader read, what he aimed to accomplish, what he accomplished by reading, and what interactions he engaged in while reading. In addition to the notes on the text, I had to analyze notes off the text when those were available. This, for example, was done for John whose case is presented in Chapter 8 below.

Many texts had traces of highlighting which often accompanied hand-written notes. Highlights, hence, were used as an additional layer of context within which the notes were analyzed. Overall, the highlights were analyzed for the content of the highlighted textual segment and for the amount of highlighting. I assumed that the amount of highlighting could be an indicator of the student's involvement with the text and that the textual segments which got highlighted could signify the issues of interest to the student. The latter was additionally important for understanding the students' goals and motivations. Figure 4.5 below summarizes the aspects of the texts which were deemed important for analysis in this study.
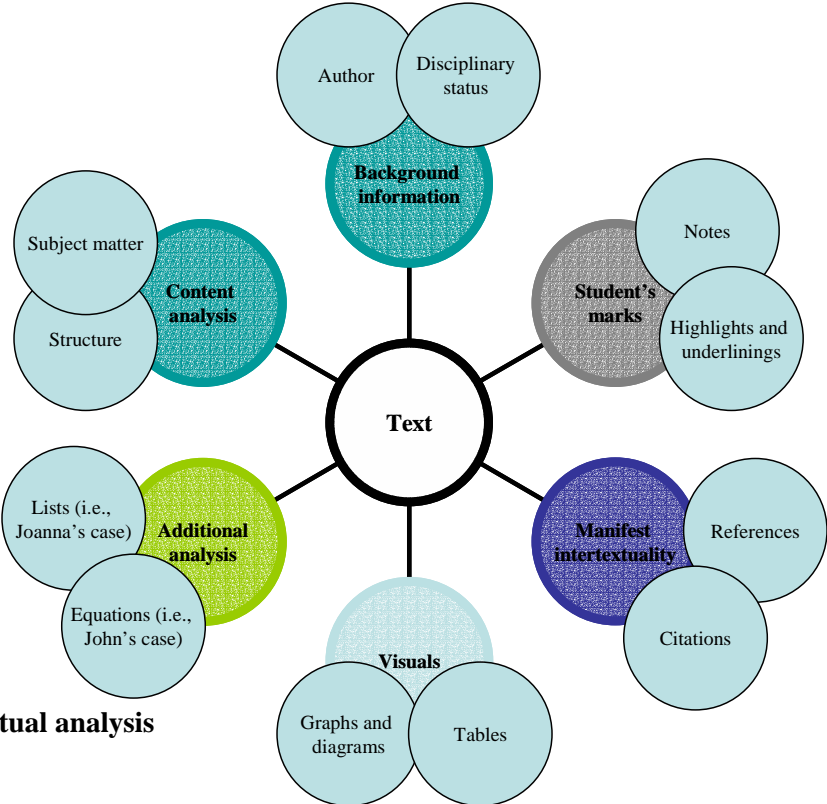

Figure 4.5. Aspects of textual analysis

4.8.2.3. Observational data

The observational data which resulted from the think-aloud sessions provided information about the settings in which reading took place and the observable behaviors of the student. These data were incorporated into the transcripts of the think-aloud sessions and analyzed along with the verbal protocols, as described above.

4.8.2.4. Assembling the cases

The analysis of the individual reading episodes was written up as four case studies which are presented in Chapters 5-8 of this thesis. Each case study is arranged as a presentation of the processes of one student reading one text. It focuses on the operations, actions, and activities of the students, as I was able to reconstruct them from the various kinds of data. I have included information about the students' background, both educational and literacy development in an effort to provide the reader with a richer picture of the student's processes. The four case study chapters are structured in similar ways in order to facilitate comparisons across the cases; yet every case is also unique in its own right and could be read separately from the others.

The 6 sections of each chapter are organized in the following manner:

1. Introduction

2. Participant:
   English literacy experiences; activity system of PhD; other activity systems and their role with regards to the activity system of PhD

3. Reading episode:
   data sources, physical and temporal settings, text, reasons for reading the text

4. The nature of reading in context: From reading operations to textual actions and social others

5. Conclusion

4.8.3. Phase three: Cross-case analysis

At the third phase of analysis, I went back to all the eleven cases comprising this study in an attempt to understand how some of the themes I had identified in the first and

second phases were similar and different across the cases. The overall technique I used at this stage could be called "constant comparison" advocated by Glaser and Strauss (1967) and other grounded theorists, by which I would compare the themes across cases for similarities and differences. Comparison of incidents within each category facilitated the generation of specific properties for each particular category and the deepening of understanding about the themes.

At this level of analysis, interpretation became particularly important in that I engaged in "[transcending] factual data and cautious analysis and [probing] into what is to be made of them" (Wolcott, 1994, p. 36). Here, I was thinking of the data and the categories which emerged from the analyses in terms of the larger issues which I previously identified as being potentially interesting to academic literacy and reading researchers (see Chapter 2, Literature Review). Three broad issues I felt the data could eliminate were intertextuality, multimodality, and the social nature of reading.

In order to interpret the data so that to relate them to the issues at point, I used most of what activity theory could offer to this study and in my interpretations appropriated such concepts as the zone of proximal development, tool mediation, affordances, contradictions and double binds, and expanding involvement (see Chapter 3, Activity theoretical framework). A major issue I considered to be particularly important at this stage was interpreting data in various plausible ways (Denzin and Lincoln, 1998) and looking for plausible explanations. Thus, for example, in interpreting Amy's problems in understanding the research article she was reading, I first considered that she was overly concerned about her PhD progress which inhibited her comprehension. However, further collection and analysis of data somewhat contradicted this preliminary interpretation and revealed a more complex explanation for Amy's difficulties.

Chapter 9 presents this phase of analysis and answers the following main research question: **What common themes emerge across cases and in what ways are these themes similar and different?**

4.8.4. Summary

In this section, I have described the phases comprising the data analysis in this study. Though I have undertaken a somewhat linear approach to presenting this section, I have tried to convey the sense that data analysis was recursive, reiterative, and multi-dimensional. In the concluding sections of this chapter, I will discuss how issues of generalizability, reliability, and validity apply to this research in general and to its cyclical analyses and interpretations described here.

4.9. Generalizability in this research

There is an ongoing debate across various paradigms regarding the generalizability of the case study methodology. While adherents of quantitative research have often pointed out generalizability as the major limitation of case studies, qualitative researchers have often argued that case studies should not be evaluated on the basis of generalizability, especially if it is conceptualized in the same manner as in the positivistic paradigm.

Stake (2000), a major case study analyst, says that "case studies will often be preferred method of research because they may be epistemologically in harmony with the reader's experience and thus to that person a natural basis for generalization" (p. 19). He does not reject generalizability per se, but that type of it which he calls "law-like generalizations" (p. 23). As a viable alternative, he suggests case study researchers should aim at achieving naturalistic generalization by capturing the particularities of human phenomena and "recognizing it in new and foreign contexts" (p. 22).

The idea of recognizing particularities in various contexts has been further developed by Lincoln and Guba (2000) who shift the terminology to suggest a new term, transferability. Basing on Cronbach's (1975) idea of working hypothesis, they argue that

> the degree of *transferability* is a direct function of the *similarity* between the two contexts, what we shall call '*fittingness*'. Fittingness is defined as the degree of congruence between sending and receiving contexts. If Context A and Context B are 'sufficiently' congruent, then working hypotheses from the sending originating context *may* be applicable in the receiving context...The person who wishes to make

a judgment of transferability needs information about *both* contexts to make that judgment well.

<div align="right">(p. 40)</div>

According to Lincoln and Guba (2000), it is not reasonable to expect the researcher to think of all possible contexts in which their research findings may be applicable, and hence, like Stake (2000), they also highlight the active role of the reader in judging the degree of transferability of a research study. The researcher, on the other hand, is expected to provide thick descriptions of their own research contexts. Donmoyer (2000) has since criticized Lincoln and Guba's (2000) conception of transferability for assuming that one can use knowledge from one case to understand another only when the cases are similar. He argues that differences between cases can be equally important in leading to knowledge. Thus, he argues that the reader should take into account not only the similarities but also the differences between the reader's and the researcher's contexts.

On the basis of the arguments put forward by these major discussants of case study research, generalizability is conceptualized in this study as below:

1. as a qualitative study based on naturalistic inquiry and designed as multiple case studies, this research does not need to and cannot result in law-like generalizations;

2. the case studies conducted in particular contexts of this research may illuminate other similar and/or different contexts;

3. the reader is free to engage in transferring the findings to her contexts; however, as a researcher, I will attempt to facilitate these attempts by presenting the case studies with sufficient details in Chapters 4-8 of this thesis;

4. additionally, in the final analysis chapter (Chapter 9), I will discuss the major themes so that to show both *similarities* and *differences* between the readings of individual students and between their contexts. This will hopefully also assist the readers in their decision of how generalizable the findings are of this study to their particular contexts.

4.10. Trustworthiness: Validity and reliability in this research

While some qualitative researchers still question "the validity of the validity question" (as described by Kvale, 1995) or the need for reliability in qualitative research (Stenbacka, 2001), others strongly argue for the need of qualitative researchers to take validity and reliability into account (Mason, 2002). Some consensus, however, seems to exist and it has become accepted that the two criteria "have not lost their relevance" (Morrison, 2003, p. 88) but have been extensively re-conceptualized in order to reflect the philosophical underpinnings of qualitative research.

In positivistic terms, validity of this study of postgraduate reading would be seen as a measure of the degree to which the study would correctly attribute effects to a particular explanatory variable (internal validity) and the degree to which a study of similar students would result in similar findings (external validity). Guba and Lincoln (1989) redefine validity in naturalistic terms as "trustworthiness" and "authenticity" and argue that a question in evaluating qualitative research is in how trustworthy its findings and interpretations are. This study follows Guba and Lincoln's (1989) conceptualization of validity in qualitative research and assumes that the study is valid if it could establish that it is trustworthy.

Trustworthiness, as conceptualized in qualitative research, is not the end product of a study, but rather a quality of the whole process of research. Validation or establishing trustworthiness, hence, is an integral part of the research process from the very beginning to its very end; it is not just a mere stage at any point of it (Kvale, 1995). As has been detailed throughout the sections of this chapter, I have made a conscious effort throughout the stages of this PhD research to ensure the trustworthiness of the study. Table 4.7 presents a summary of the major strategies I relied on.

Table 4.7. Strategies used to enhance the trustworthiness of the study (based on Guba and Lincoln, 2003)

Strategy	Brief description
Extended fieldwork	The data for each case were collected over extended periods of time

Researcher-as-bricoleur (Guba and Lincoln, 2003)	The main instrument of the study was the researcher attempting to collect as many pieces of information as possible
Data triangulation	Multiple data types, such as verbal, textual and observational, were collected to understand the object of inquiry
Methodological triangulation	Multiple methods of data collection, such as think alouds, observations, and interviews were used
Explication	This chapter presented in considerable detail the methods of data collection and analysis and suggested potential biases and limitations
Participant feedback	The researcher's interpretations were discussed with the participants for verification and further insight
Low-inference descriptors	Direct quotations were often used in the presentations of the case studies
Reflexivity	The researcher attempted to remain aware of her own beliefs and changes in perspectives throughout the study by using research notes
Peer review	The researcher's progress and interpretations were discussed with other people, including disinterested peers and various conference attendees. The researcher's supervisors, in particular, played the role of "the devil's advocate".

Reliability, in positivistic terms of quantitative research, is usually defined as "the extent to which findings can be replicated, or reproduced by another enquirer" (Denzin and Lincoln, 1994, p. 100; quoted in Morrison, 2003, p. 89). As Morrison explains, redefined in naturalistic terms, reliability can be seen as a fit (Glaser, 1978, p. 4) between the object of a study and the explanation resulting from it. According to Lincoln and Guba (1985), consistency of the research findings is of central importance. In order to account for the consistency of the research findings resulting from this study, several precautious were made with regards to the procedures of data collection and analysis (Richards, 2003).

To account for the consistency of the transcripts, I listened to the same segment of an interview or think aloud session for at least two times and used the same transcribing conventions with all the verbal data. To ensure the correctness of my observations of physical-temporal and material settings in which students read, I viewed videos while consulting my observations notes. Additionally, I used the same basic interview plan for

interviews with all the participants, and kept research notes (or "audit trail") of the investigation (Owens, 1982; Kvale, 1995).

4.11. Conclusion

This chapter described the methodology utilized in this naturalistic research involving multiple case studies of postgraduate students. Stemming from the main objective of this research which is to examine how postgraduate students read academic texts in English and what the role of advanced academic literacy is in enculturation processes, the research questions were designed to explore both the individual and the social aspects of postgraduate reading. Various methods of data collection were utilized and several kinds of data were gathered. The ensuing analyses were highly complex and involved the overlapping stages of description, analysis, and interpretation which were additionally conducted in three phases.

The account I have provided here of how the study was conducted and how my decisions were shaped by various factors is unavoidably partial (Prior, 1992). However, it has been presented here with the hope that it will help the reader to understand the chapters that follow and with the hope that it will be useful for future researchers of advanced academic reading. The next five chapters of the thesis will present the four individual case studies and the major themes which emerged as important across the eleven cases.

CHAPTER FIVE: Joanna

At the heart of the case study presented in Chapter 5 is one student's reading of one chapter from an introductory textbook as part of a course. Figure 5.1 previews the main aspects which will be discussed in the chapter.
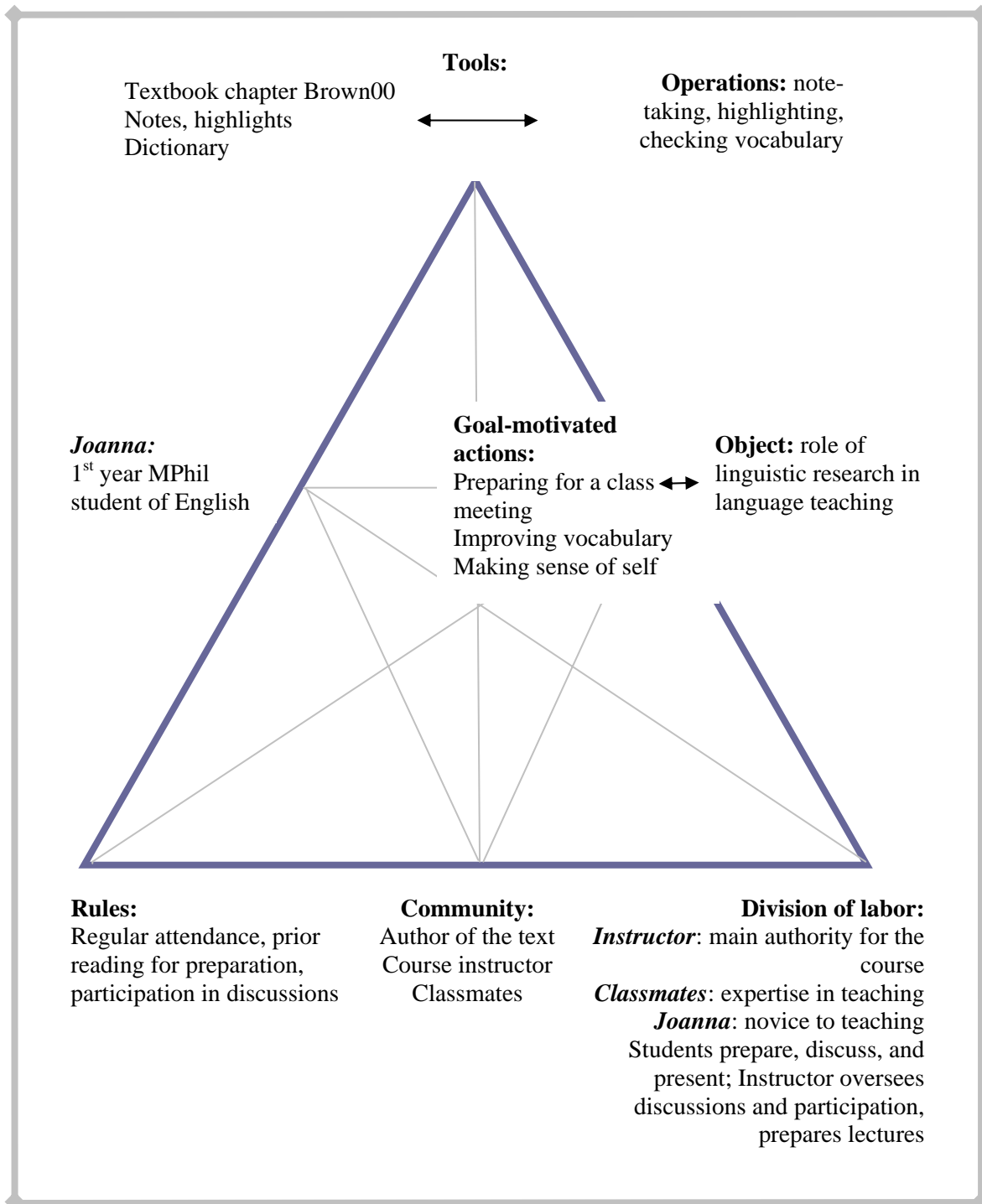
Tools:
Textbook chapter Brown00
Notes, highlights
Dictionary

Operations: note-taking, highlighting, checking vocabulary

Joanna:
1st year MPhil student of English

Goal-motivated actions:
Preparing for a class meeting
Improving vocabulary
Making sense of self

Object: role of linguistic research in language teaching

Rules:
Regular attendance, prior reading for preparation, participation in discussions

Community:
Author of the text
Course instructor
Classmates

Division of labor:
Instructor: main authority for the course
Classmates: expertise in teaching
Joanna: novice to teaching
Students prepare, discuss, and present; Instructor oversees discussions and participation, prepares lectures

Figure 5.1. Preview of Chapter 5: The case of Joanna

5.1. Introduction

In the two previous chapters, I presented the activity theoretical framework guiding this research and the methodology through which the study was realized. This is the first in the series of four chapters covering in detail four case studies, and the spotlight here is on Joanna, a second-semester MPhil student of Applied Linguistics. By analyzing Joanna's reading of a chapter from an introductory textbook, I will start piecing together the various bits which make a mosaic of postgraduate reading. I will show how, from the analysis of her textual operations, I was able to see an individual student interacting with an individual text to achieve such goals as preparing for a class discussion and learning new words. I will also show how, on the basis of the text-based interviews, I was able to isolate another goal governing Joanna's interactions with the text—that of understanding her own practices.

Through the analysis of Joanna's goal-directed actions, I will begin to situate her individual interactions with the text at the nexus of social rules, expectations, and divisions of tasks and responsibilities. Here, I will analyze Joanna's perceptions of these social forces and will situate her reading within the web of her interactions with classmates and the instructor of the course.

5.2. Participant: Joanna

A 23-year-old Cantonese speaker of Chinese, Joanna, at the time of our study, was registered as an MPhil student with the Department of English, PolyU. A year later, she successfully passed her confirmation exam and was upgraded into the PhD program. Below, I will provide a brief sketch of her English literacy experiences and then present her MPhil activity system.

5.2.1. Joanna's English literacy experiences

A native speaker of Cantonese, Joanna received her undergraduate degree from the Department of Chinese and Bilingual Studies of PolyU. Unsurprisingly, she is highly

proficient in both Mandarin Chinese and English, in addition to her native Cantonese. In terms of English, Joanna is one of the most articulate students involved in this study. She possesses a wide range of vocabulary, both of academic and general registers; her accent is very comprehensible; and her ability to sustain a conversation is remarkable.

Joanna's first formal exposures to English began when she was in kindergarten. She continued studying English throughout her years at an English-medium school and into the university. Though extensive, her history of using English has been limited to educational settings. The language she uses with her relatives and most friends is Cantonese, English being delegated the role of her "study language". In spite of the fact that her command of English is comparatively outstanding, Joanna is not confident about her English and is deeply concerned about improving it further. The following excerpt from one of our earlier interviews highlights her anxieties and suggests the sources of her concerns:

> **Joanna:** *At the same time I am doing my studies, I really want to improve my English. Because I mean, if I study in an Engineering department, I don't have that stress. But I am here. And whenever your relatives ask you what you study, I used to tell them oh I study English, rather than I study tense and aspect in second language acquisition. And they assume you that your English should be improved and should have good English proficiency.*
>
> <div align="right">TBI, 12/02/2003</div>

As this excerpt suggests, and as the word "stress" (which Joanna uses to describe her state) confirms, Joanna is anxious to improve her English. This concern stems from her perception that others (in this case, her relatives) expect her to speak good English since she is a student of an English department. Just like Joanna, John and Dewey, two other participants of this study, were very keen to improve their English; however, neither of them was as concerned about it and both of them were at levels much lower than Joanna's.

Reading academic texts in English constituted a major part of Joanna's MPhil activity system around the time of our interviews. She had a simple, if somewhat ambitious, plan according to which she had to read every day from 9 am to 5 pm. Her readings, she divided into two categories: those for her classes and those for her MPhil study. Joanna's reflections on her reading of particular texts often involved such sentiments as her wish to

finish the text in a shorter period of time and her inability to finish it within the time frame she had set for herself. She often mentioned difficulties with concentrating on the texts due to boredom and desire to do something else.

5.2.2. Joanna's MPhil activity system

Joanna first came to PolyU in 1998 as an undergraduate student of Language and Communication of the Department of Chinese and Bilingual Studies. After completing her studies, she worked as a research assistant with the Department of English of the same university. Joanna's decision to apply for MPhil studies was influenced by Dr. Chiang, a staff member of the Department of English under whose supervision she worked as a Research Assistant. She said, "*I won't say I have a strong need to get a PhD or MPhil. It just happened. My supervisor asked me if I was interested and I think this topic is interesting. And I think maybe I can spend 2 or 3 years*" (InterI, 03/04/2003). Joanna was admitted for a two-year MPhil program, and Dr. Chiang became her postgraduate supervisor. It is Joanna's extended period of affiliation with PolyU and her close and also extended interactions with her current supervisor that were so instrumental in affecting her choices for a postgraduate program, and indeed her decision to undertake postgraduate studies.

Through her MPhil study, Joanna aimed to investigate the broad issue of "semantics and L1 influence in the acquisition of English verb tense and aspect in the Hong Kong secondary school learners" (CR, 2003). At the time of our interviews and with respect to her study, she was concerned with (1) learning about the hypotheses proposed by second language acquisition researchers with respect to the acquisition of tense and aspect by L2 learners and (2) trying to identify whether there could be additional factors affecting the acquisition of tense and aspect.

During this period of time, she did not meet her supervisor on a frequent basis. She said, "*I don't meet my supervisor quite often because she thinks it's good for me to study and to really put some time into reading and after that she ask me to formulate the*

research question and methodology by the end of this semester" (TBI, 28/01/2003). Joanna was given a considerable amount of space by her supervisor to read and think about her research independently. Nothing in the interviews indicated that Joanna was unhappy about the amount of meetings with her supervisor, and indeed she seemed to appreciate the freedom she was allowed at this stage of her postgraduate studies.

According to PolyU regulations, all MPhil students are required to take a certain number of taught courses in order to fulfill their degree requirements. This semester Joanna was taking three linguistics courses: two of them offered by the Department of English of PolyU, and one of them—by the Department of Modern Languages and Intercultural Studies of another local university. Her engagement with these courses is significant because it means that Joanna's activities were divided according to at least two objects: the object of her particular research and the object of expanding knowledge of linguistics in general. When we discussed her work that semester, Joanna said, her goals were primarily "*First for my research, really related to my topic, tense and aspect and hypotheses...Second purpose is to learn about linguistics in general; something I didn't learn in BA*" (TBI, 21/02/2003).

Figure 5.2 below is a summative representation of Joanna's MPhil activity system, and as expected, it includes various interrelated elements. Thus, the Subject of this activity system is Joanna, a native speaker of Cantonese Chinese who holds a BA degree in Language and Communication. Joanna's activities this semester are guided by two broad goals (Objects in the diagram): on the one hand, her activities are aimed at enhancing her understanding of issues related to the acquisition of English verb tense and aspect by ESL learners; on the other hand, her activities are geared towards a much broader object of general linguistics. As a primary outcome, Joanna sees the formulation of research hypotheses and the design of research methodology for her own study. These activities are mediated by various means (Tools in the diagram) such as texts, lecture notes, the library, and of course the English language, which is the language of Joanna's studies.

Joanna's activities involve her interacting with various others (Community, in terms of the triangle). These others include her supervisor, her classmates, fellow postgraduate students, and relatives. The rules that are important for understanding her activities stem from the different communities she is interacting with. First of all, the university (and the department) dictates that Joanna needs to take courses in order to fulfill credit requirements. Second, the relationship with her supervisor this semester is such that Joanna is given the freedom to work primarily independently towards her goals. Third, her perceptions of her relatives' expectations of her dictate that she should improve her English while doing her MPhil. These rules are reflected in what Joanna does this semester ("Division of labor" in the diagram): Joanna is taking courses, spends a lot of time reading and thinking independently, occasionally meets her supervisor, and interacts with her fellow postgraduate students.

Tools = the English language, texts, library, lecture handouts

Subject: Joanna=Cantonese, BA in Language and Communication

Objects = acquisition of English verb tense and aspect by ESL learners; general linguistics

Outcomes: get an overview of the existing hypotheses; fulfill course requirement

Rules = Joanna needs to fulfill course credit requirements; needs to work independently on her research; needs to improve her English

Community = Supervisor, fellow postgraduate students, classmates, family

Division of labor = Joanna is taking classes, reading on her own, meeting Supervisor, exchanging ideas with fellow students

Figure 5.2: The activity system of Joanna's MPhil

5.2.3. The activity system of LING 5XXX

As mentioned in the previous subsection, Joanna's MPhil activity system involves both independent study and course work. One of the courses she was attending was "Linguistics and Language Teaching," offered by another university in Hong Kong. In the rest of the chapter I will refer to this course as LING 5XXX and in the rest of this

subsection I will describe this course as another activity system that Joanna actively engaged in.

LING 5XXX was offered by the university as part of the MA program in Linguistics. It met once a week for 3 hours each time. The course outline stated that "*[t]his course focuses on how linguistics research helps improve our understanding of how languages are acquired, used, and transmitted/taught, in various contexts*" (MLC, 2003). For Joanna, this course was an opportunity to extend her knowledge of linguistics research in general, and to see its applications for teaching, in particular. Joanna had no experience of teaching and had never taken a course on teaching before; therefore, LING 5XXX can be considered as her first experience of learning about teaching and teaching-related issues.

The majority of her classmates were secondary school teachers whom Joanna did not know but respected very much. She said it was interesting to hear their opinions on language learning related issues because they were experienced teachers and she could always learn something new from them. From the data, I observed that, when referring to these teachers, Joanna often used phrases such as "discuss", "raise a question", and "share experiences". When she referred to herself, however, she used verbs such as "think" and "listen". Overall, it appeared to me that Joanna saw herself as completely new to teaching and as a novice learning from listening to the discussions of experts.

The course was structured fairly strictly. Its outline had specific sections explicating the course requirements and detailing the evaluation scheme. The following vignette contains an excerpt from the course outline which deals with the specific rules set up in the class by the instructor.

Vignette 5.1. An excerpt from the course outline for LING 5XXX

Course requirements

Course requirements include regular attendance, prior reading of assigned articles, and active participation in class discussions and activities. Each individual or group will lead out in at least one class discussion (approximately 30-45 minutes each) based on chapters and selected articles assigned for class readings. In lieu of a final exam, each student will write a research or review paper on a topic to be approved by the instructor. The research/review paper (approximately 8-10 pages) is due on *April 29, 2003*. A 15-minute

oral presentation of the research/review paper (either in its final or in-progress version), followed by a 10-minute question session, will be scheduled for each student or group towards the end of the semester (i.e. in April).

As this excerpt demonstrates, the students were expected to work both individually and in groups for this course. Individually, they were responsible for attending the classes on a regular basis, for preparing for the discussions in the class by reading the assigned materials, for active participation in class by engaging in discussions, and finally for writing a research or review paper at the end of the course. Group requirements included preparing and leading a discussion of an assigned topic at least once during the semester. Joanna was registered for the course as a sitting in student; therefore, not all the responsibilities detailed in this course outline applied to her. Thus, she did not have to write the paper or lead a discussion; however, she still needed to attend the course and participate in regular discussions.

All class meeting was structured in a similar manner. Each meeting included a lecture based on the reading assigned for the class, a video viewed in class, and a session on reflections. Some meetings included presentations by groups or individual classmates which also led to reflections and discussions. Discussions were a major component of this course, so major that on the course outline each class meeting was referred to as "Discussion". The course was structured around one textbook, *Principles of language learning and teaching* by Douglas Brown (4th edition): students were expected to read assigned chapters in preparing for class meeting; the lecture given by the instructor of the course was itself structured around a textbook chapter (one chapter per each meeting), and the presentations that students prepared were also based on these chapters.

Figure 5.3 summarizes the discussion thus far in activity theoretical terms. The Subject of this course activity system is the person from whose perspective we analyze it, Joanna. The Object of this activity system is the role of linguistics research in language teaching. The outcome for Joanna is learning about linguistics in general. The community of the course is comprised of the instructor and various students from different

backgrounds, including but not limited to secondary school teachers. The rules that are important for Joanna are: she has to (1) prepare for meetings and (2) engage in regular discussions. Accordingly, the division of tasks and responsibilities, with respect to Joanna, is such that her activities are limited to preparing for and engaging in discussions. The Tools that mediate the activity system are textbook, videos, power point presentations, and other artifacts.
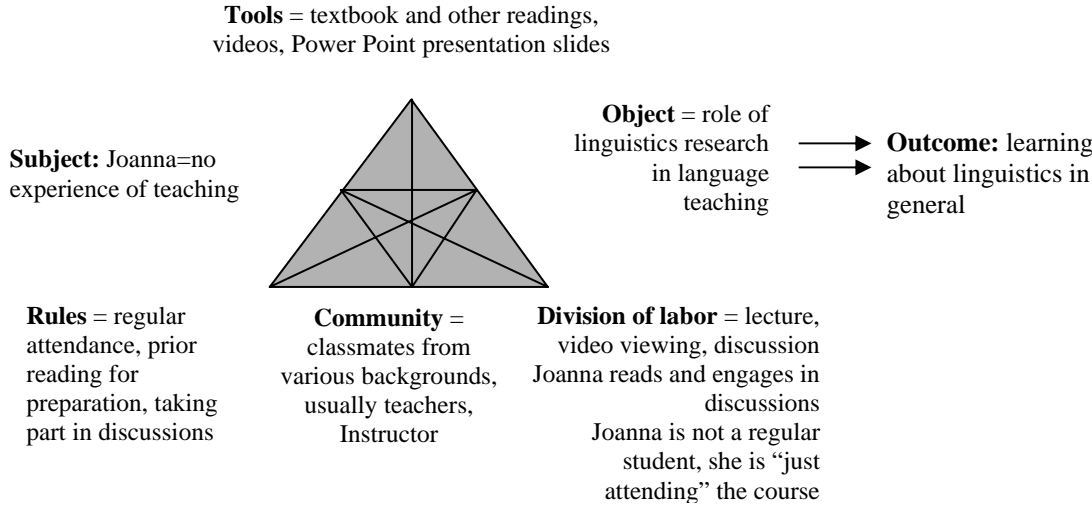
Tools = textbook and other readings, videos, Power Point presentation slides

Object = role of linguistics research in language teaching

Outcome: learning about linguistics in general

Subject: Joanna=no experience of teaching

Rules = regular attendance, prior reading for preparation, taking part in discussions

Community = classmates from various backgrounds, usually teachers, Instructor

Division of labor = lecture, video viewing, discussion Joanna reads and engages in discussions Joanna is not a regular student, she is "just attending" the course

Figure 5.3: The activity system of LING 5XXX

5.3. Reading episode

The information provided in the preceding sections will serve as the background against which Joanna's reading of Chapter 6 entitled "Personality Factors" of the textbook used in the course LING 5XXX will be analyzed. In the sections that follow, I will (1) present the data sources that were used to analyze this reading episode; (2) describe the physical and temporal settings within which the chapter was read; (3) introduce the chapter itself; and finally (4) conclude with a discussion of the initial goal which directed Joanna's reading.

5.3.1. Data sources

Multiple data sources were used in the analysis of the reading episode. The primary data sources, which provided direct information about Joanna's reading, are the text-based

interview, the text which was used as a stimulus for the interview, and the interpretative interviews which were used to elicit Joanna's views on my analyses of the reading episode. These primary data sources are shown in the left-hand column of Table 4.1 below. The sources in the right column are secondary but, nonetheless, important and provided further insights about the context against which this reading episode is analyzed.

Table 5.1. Data sources: The case of Joanna

Reading Episode		Other Data sources	
Text-Based Interview		Course Syllabus (LING 5XXX)	
TBI	26/02/2003	LING	2003
Chapter from Brown (2000)	Brown00	Confirmation Report	
		CR	02/07/2003
Interpretive Interviews			
InterI	03/04/2003	Text-Based Interviews	
InterI	18/05/2004	TBI	28/01/2003
		TBI	12/02/2003
		TBI	03/04/2003

5.3.2. Physical and temporal settings

The text was read at least on two occasions, on the 12th and 17th of February, 2003, for the class which was scheduled for the 18th of February, 2003. The temporal frame coincided with the season of holidays in Hong Kong, the Spring Festival widely celebrated in any Chinese city. Joanna mentioned not being able to concentrate on reading and finish reading the chapter at one sitting due to pre- and post-holiday moods. She further mentioned that she had to modify her reading plan, which made her feel somewhat guilty. In terms of physical settings, Joanna reported reading the text both at home and in a postgraduate students' office of the English Department where she is allocated an individual desk with a computer and a bookshelf. In both locations, she had a direct access to dictionaries, both monolingual and bilingual, Internet- and paper-based.

5.3.3. Text Brown00

The Preface of the 4ᵗʰ edition of Brown (2000) contains the following statement of

its purposes and intended audiences:

> In its first three editions, this book has served a number of purposes for many
> audiences around the world. For graduates or advanced undergraduates in language-
> teacher education programs, it is a textbook on the theoretical foundations of
> language teaching. For a surprising number of people it has become a book that
> Master's degree candidates pore over in preparation for comprehensive examinations!
> For experienced teachers, it has become a handbook that provides an overview of
> current issues in the field.
>
> Brown, 2000, p. x

We see that Joanna and her classmates fit the audience envisioned for the book: both

Joanna and her classmates are students of language-related departments, and many of her

classmates are also teachers. This excerpt is suggestive of the status the textbook has in the

field of language teaching, a status which is reflected in many reviews of the text. Dickey

(2004), for example, in his review of the textbook for ELT News, the web site for teachers

of English in Japan, highlights that it is "the classic primer on second language learning—

so much so that it continues to feature in many of the North American MATESL

programs" (p. 1).

Other reviews have praised the textbook for its easy-to-read and comprehensive

nature. Ostler (1995), for example, with regards to an earlier edition of the textbooks,

describes it as "a very readable, comprehensive review of current and relevant research on

the psychological, sociological and pedagogical factors which affect the learning and

teaching of languages" (p. 1). The preface of the textbook itself continues to say:

> For the most part, you do not need to have prior technical knowledge of linguistics or
> psychology in order to comprehend this book. An attempt has been made to build,
> from the beginning, on what an educated person knows about the world, life, people,
> and communication.
>
> Brown, 2000, p. x

Chapter 6 of Brown (2000) is entitled "Personality factors" and takes up the total of

34 pages. It deals with "personality factors within a person that contribute in some way to

the success of language learning" (p. 142). Consistent with the rest of the textbook,

Chapter 6 is written in an accessible language and structured in ways that enhances its

readability. For the most part, it contains definitions and explanations of various linguistic and psychological concepts. Constructs are defined; key terms are shown in bald; and various lists are provided to enhance the comprehensibility of the numerous constructs. As is common with the genre of textbooks (Myers, 1992), little controversy is presented in the sections, and though opposing views are given attention to, they are presented neatly and conflict free.

After introducing the focus of the chapter, the author (1) defines what "affective domain" is by drawing on Bloom and colleagues' work and discusses five specific personality factors and their importance in second language acquisition (the section "The affective domain"), (2) describes the Myers-Briggs test of character types and relates it to second language research ("Myers-Briggs character types"), (3) introduces and describes motivation as another frequently used concept in explaining second language acquisition success ("Motivation"), (4) briefly discusses the neurobiological bases of affect ("The neurobiology of affect"), and (5) concludes with a short list of issues involved in measuring affective factors ("Measuring affective factors"). In addition to content sections, there are 4 other sections which are provided to stimulate the reflection and application of the principles discussed in the chapter to readers' personal language-learning experiences (vignette, topics, journal entry). A comprehensive list of suggested readings is further given for a quick access to major studies in linguistic and psychological research.

In terms of visuals, the text contains only four tables, two of which appear in "Myers-Briggs character types" and the other two in "Motivation". The more or less linear text, however, is interrupted with numerous lists. The most intertextually dense section is "The affective domain" which is also the major section of the chapter and spans across 14 pages (out of the total of 34 pages). Table 5.2 presents the chapter according to the amount of references, figures, and lists comprising each section. In this thesis, I will refer to Chapter 6 of Brown (2000) as Brown00.

Table 5.2. Chapter 6 of Brown (2000)

Sections and subsections	N of references	N of figures	N of lists
Introduction	2		
The affective domain			
Introduction	2		1
Self-esteem	10		1
Inhibition	9		
Risk-taking	7		
Anxiety	**30**		1
Empathy	8		
Extroversion	5		
Myers-Briggs character types	17	Ts 6.1 and 6.2	2
Motivation			
Introduction	3	T 6.3	1
Instrumental and integrative orientations	12		1
Intrinsic and extrinsic motivation	12	T 6.4	
The neurobiology of affect	5		
Measuring affective factors	3		1
Vignette: In the classroom: Putting methods into perspective	5		2
Topics and questions for study and discussion	1		
Suggested readings	7		
Language learning experience: Journal entry 6	0		

5.3.4. Initial reasons for reading Brown00

As explained in the following excerpt, Joanna read the textbook, including the chapter of interest to this study, primarily as part of preparing for her class meetings:

> **Joanna:** *I am reading this book because it is asked, required for the lecture. Because this lecture is going to be on human learning. The lecture plan follows the book. The content is taken from the book. She highlights some main keys. More like an outline. The lecture lasts for three hours and the highlights for half an hour.*
>
> TBI, 28/01/2003

Though Joanna's primary goal was to prepare for the class meeting, reading the chapter mediated her engagement with various other actions, as will be described in the sections below.

5.4. From operations to actions and social others

In the remaining sections of the chapter, I will focus on analyzing Joanna's reading at three fundamental levels: operations, actions, and activity systems. At the level of operations, I will be concerned with how Joanna read Brown00 and what mediational means she relied on. At the level of actions, I will identify what she accomplished by reading and what immediate, defined purposes the text was used to achieve. Finally, at the level of activity systems, I will revision the question of the broader social motives and interactions which could explain her reading behaviors.

5.4.1. Textual operations

Overall, the reading of Brown00 proceeded in a linear fashion. Joanna read section by section, paid attention to both the contents and the language of the text, highlighted numerous segments and took some notes. All the content sections were read carefully; the vignette was skimmed through; and the remaining sections *Topics and questions for study and discussion*, *Suggested readings*, and *Language learning experience: Journal entry 6* were skipped altogether.

5.4.1.1. Notes

Since Joanna owned the textbook, she found it more effective to record her notes directly on the pages of the chapters, rather than in separate notebooks. The 34 pages of Brown00 contain the total of 56 notes. These are distributed across five sections: *Introduction*, *The affective domain*, *Instrumental and integrative orientations*, *Intrinsic and extrinsic motivation*, and *In the classroom*. The following sections, though there have traces of highlights, contain no handwritten notes: *Myers-Briggs character types*, *Motivation: Introduction*, *The neurobiology of affect*, and *Measuring affective factors*. As has been mentioned immediately above, the sections *Topics and questions for study and discussion*, *Suggested readings*, and *Language learning experience: Journal entry 6* were

not read and therefore also contain no notes. This initial look at the notes suggests that Joanna's attention is divided unevenly across the sections.

The notes can be divided into two sets: those containing words (verbal notes) and those consisting of numbers and one summative sign (non-verbal notes). The first category of notes can further be divided into summative notes, those which summarize a segment of the text, and vocabulary notes, those which contain a translation or an explanation of certain words. The distribution of these notes is as shown in Table 4.3 below.

Table 5.3. Types of textual notes

Kind	Count
Verbal	
Vocabulary	24
Summative	25
Non-verbal	7
Total	56

5.4.1.1.1. Non-verbal notes

As the table shows, there are 7 non-verbal notes on Brown00; these consist of six numbers (1 to 6) and one summative sign, **}** . The numbers are all circled and appear in the section of *Affective Domain.* Within this section, they are placed consistently to the left of the following sub-headings: Self-Esteem (p. 145), Inhibition (p. 147), Risk-Taking (p. 149), Anxiety (p. 150), Empathy (p. 152), and Extroversion (p. 154). They comprise a set with another note (N 5) which contains both numbers and words and is located between the end of the introduction into the chapter and the beginning of the introduction into *Affective Domain* (p. 143):

1. self-esteem
2. inhibition
3. risk-taking
4. anxiety
5. empathy
6. extroversion

Joanna explained that she did the following when reading the section *Affective Domain*: at the beginning of reading each of the six sub-sections in this section, she put a

number next to the sub-heading; upon finishing all the sub-sections, she leafed back to the beginning of the section and recorded the sub-headings on that page as a way of reminding herself of the contents in the future re-reading of the text. Overall, she was concerned with leaving marks for future references.

5.4.1.1.2. Verbal notes

None of the verbal notes were long and ranged from the minimum of 1 word to the maximum of 8 words. In terms of content, they were summative phrases (summative notes) and explanations or translations of certain words (vocabulary notes).

5.4.1.1.2.1. Summative notes

The summative notes summarized different kinds of content. Only one of them, N5 (see above), summarized content which spread across pages (14 pages) while the remaining 24 summative notes were limited to sentence or paragraph levels. Out of the 25 summative notes, 20 are of definitions. 14 of these definitional notes contain nothing but the terms being defined (i.e., N6 "affect", N44 "introversion"), while only 6 of these notes contain additional information from the actual definitions, this information being provided in the text (i.e., all the words of N35, "trait anxiety more permanent," and N36, "state anxiety—particular," can be found in the sentences on the basis of which these notes were derived).

Joanna explained that by recording notes such as these, she was trying to remember what concepts were defined in the text and leave pointers to these definitions. Upon a closer examination, I found that 13 of the definitions are already singled out in the text through either the bold or italicized font. Several of the definitions are also presented in groups in the form of lists. As I mention in section 5.3.3, Brown00 contains 10 lists. Five of these lists contain definitions, and 3 of these five lists are accompanied by Joanna's notes (9 definitions and 9 notes across the 3 lists). A section of one of the list is given below with Joanna's notes given in red to the right of the definitions.

Vignette 5.2. A segment of the list from Brown00 (p. 143), with Joanna's notes in red

1. At the first and fundamental level, the development of affectivity begins with *receiving*. Persons must be aware of the environment surrounding them and be conscious of situations, phenomena, people, objects; be willing to receive—to tolerate a stimulus, not avoid it—and give a stimulus their controlled or selected attention.

   Receiving= giving information

2. Next, persons must go beyond receiving to *responding*, committing themselves in at least some small measure to a phenomenon or a person. Such responding in one dimension may be in acquiescence, but in another, higher, dimension the person is willing to respond voluntarily without coercion, and then to receive satisfaction from that response.

   Responding

What we see from the analysis of these notes is that Joanna was considerably concerned with identifying and singling out definitions of various concepts presented in the chapter. Though some of these definitions had already been singled out by the author of the text, she left additional marks in her own hand.

2 of the remaining 5 summative notes summarize sentence level information, and the remaining 3 notes are the most interesting from the whole set. They are:

"trial & error vs. mistakes→frightening" (p. 149)
"alienation→defense→inhibit learning" (p. 149)
"motivation→orientation" (p. 162)

As we can see, these notes contain more than key concepts from the text, and in fact show relationships between various concepts. For example, the note "trial & error vs. mistakes→frightening" (p. 149) stands for the argument from pages 148 and 149 according to which (1) language learning is similar to testing hypotheses through trial and error, and mistakes are therefore unavoidable; (2) these mistakes can be frightening to student learners and therefore teachers should be careful when pointing out mistakes. These notes, however, are limited in numbers, and as I learned through the interviews, were recorded in the class. In other words, these notes do not present the operations Joanna engaged in while reading the text individually while preparing for the class. They do, however, point out that the text was visibly used during the class discussion.

5.4.1.1.2. Vocabulary notes

While reading Brown00, Joanna noted 24 words which she further explained in English or translated into Chinese. None of these words (see Table 5.4) present discipline-specific vocabulary, with the possible exception of "autonomy" but even this word is used in the following sentence which is not linguistics- or teaching-specific: "Jerome Bruner (1966b), praising 'the autonomy of self-reward,' claimed that one of the most effective ways to help both children and adults think and learn is to free them from the control of rewards and punishments" (p. 165). The amount of these vocabulary notes points to the possibility that an important aspect of reading Brown00 for Joanna was paying attention to unknown words and checking them up in a dictionary.

Table 5.4. Words noted by Joanna

Chinese translations	English explanations
Prevailing	Facets
Detriment	Encompasses
Ramifications	Elusive
Daunted	Coercion
Intricately*	Pervasive
Intertwined	Withstand
Apprehension	Impede
Disputed	Intricately*
Stockpile	Debilitative
Incongruity	Transcend
Autonomy	Reclusiveness
Absurd	
Resemble	

5.4.1.2. Highlights

The pages of Brown00 contain numerous yellow and green marks of Joanna's highlighters. Totally, there are 111 highlights, ranging from highlights of single words to complete sentences. Joanna explained that by highlighting certain segments of the text, she aimed to mark the main points presented in the Chapter.

Considering the previous observation that Joanna left notes pointing to various definitions presented in the chapter, it is unsurprising that 99 out of the 111 highlights have

to do with conceptual definitions (one definition would usually include several highlighted segments). Joanna highlighted most of the definitions which occur in those sections of Brown00 that she read. Only in the section *In the classroom: Putting Methods into Perspective*, which contains definitions of methodology, approach, method, curriculum/syllabus, and technique, she did not leave any highlights. This is probably due the fact that the concepts were not related to the theme of the chapter directly and had to do with the notions of curriculum design rather than personality factors, the central theme of the chapter. Table 5.5 displays the concepts whose definitions were left highlighted.

Table 5.5. Conceptual definitions highlighted on Brown00

Definitions of	In the section
Affect and the five personality factors which comprise the affective domain according to Brown00	"The Affective Domain: Introduction"
Self-esteem and the three general levels of it	"The Affective Domain: Self-Esteem"
"thin" and "thick" ego boundaries	"The Affective Domain: Inhibition"
Anxiety and kinds of anxiety	"The Affective Domain: Anxiety"
Transaction, empathy	"The Affective Domain: Empathy"
Introversion, extroversion	"The Affective Domain: Extroversion"
Categories of Extroversion-Introversion, Sensing-Intuition, Thinking-Feeling, and Judging-Perceiving	"Myers-Briggs Character Types"
Motivation from behaviorist, cognitive, and constructivist perspectives; six needs underlying the construct from the cognitive perspective; intrinsic and extrinsic motives	"Motivation: Introduction"
Instrumental and integrative orientations	"Motivation: Instrumental and Integrative Orientations"
Intrinsically motivated activities and extrinsically motivated behaviors	"Motivation: Intrinsic and Extrinsic Motivation"

The definitions were highlighted so that the words unessential to the definitions (words such as pronouns, helping verbs, articles, prepositions, etc.) were often left unmarked. Instead only the concept itself and the definition with further explanations were highlighted. As an example, let us look at an excerpt from the section "Myers-Briggs Character Types" provided in Vignette 5.3. This section of the chapter is structured in the following manner: an historical introduction, the styles of functioning tested by the authors of the test, possible combinations of these styles, and studies which utilized the test for

language learning research. The segments Joanna highlighted come from those two paragraphs which describe the test in terms of the styles or categories of functioning measured by the test.

Vignette 5.3. An excerpt from "Myers-Briggs Character Types" (p. 157) with Joanna's highlights

The ==Extroversion-Introversion (E/I)== category relates to an aspect of personality already discussed in this chapter, the way we ==either "turn inward" or "turn outward" for our sense of wholeness and self-esteem==. The ==Sensing-Intuition (S/N)== category has to do with ==the way we perceive and "take in" the world around us==. ==Sensing types are data-oriented and empirically inclined to stick to observable, measurable facts, while intuitive types are more wiling to rely on hunches, inspiration, and imagination for perceiving reality==. The ==Thinking-Feeling (T/F)== category describes ways of ==arriving at conclusions and of storing reality in memory==. ==Thinking== types are generally ==cognitive, objective, impartial, and logical==. Feeling involves more affectivity, a desire for ==harmony, a capacity for warmth, empathy, and compassion==. Myers and Briggs extended beyond Jung's types to add the ==Judging-Perceiving (J/P)== dichotomy, which has to do with one's attitude toward the "outer world". ==="Js" want closure, planning, organization, while "Ps" are spontaneous, flexible, and comfortable with open-ended contexts.===

Based on the brief analysis of the highlights as well as the analysis of the notes, we see how much attention Joanna allocated to noting and marking the definitions presented in the text. This appears to have comprised a major part of her action of preparing for the class and will be further discussed in the coming sections.

5.4.2. From operations to actions

The analysis of the textual notes and highlights shows Joanna's close reading of the chapter, with at least two major goals being attended to—preparing for a class meeting and learning new words. The text-based interview provided more insights into Joanna's engagement in the two goal-oriented actions. In addition, it revealed that there was another significant action Joanna engaged in while reading the text, this action not being revealed through the textual data presented above.

Through the discussion of Joanna's reading as a series of actions, I will synthesize the analysis of her textual operations, as revealed primarily by her highlights and notes,

and start mapping out the interpersonal and social factors involved in her reading of Brown00.

5.4.2.1. Preparing for the class meeting

As we know, the primary reason for which Joanna read the text was to prepare for a class meeting. As her notes and highlights reveal, her action of preparing for the course involved reading carefully to: (a) locate main points and especially definitions and (b) mark them by either highlighting or noting, or both. In our interviews, Joanna explained that in her reading of Brown (2000), in general, she was concerned with "*captur[ing] the main points*" (TBI, 28/01/2003) and could not engage in a critical evaluation of these points on her own.

The importance of knowing the main points of the chapter is obvious if we refer back to the role of the textbook in the activity system of the course. As a backbone of the course, the textbook was used in both lectures and discussions, and the students were expected to know the chapters and be able to discuss the major issues stemming from them. For Joanna, this expectation translated into the operations of locating main points and marking them for reference during class meetings. The issue of why she did not manage to go beyond locating the main points will be discussed in the section, where I analyze Joanna's action of reflecting and questioning her own practices.

5.4.2.2. Improving vocabulary

Joanna's detailed reading of the text was accompanied by her attention to unknown words. Her concern with individual vocabulary items can be explained in terms of her desire to know words in a "solid explicit way," as she explains during that part of the interview, when we discussed her note of "an aspect of sth" left on page 142 next to the word 'facet': "*Now here, I, that is what I have tried to do. I think I know the word facet but not in a very solid explicit way. So I tried to write it down. Some explanation*" (TBI, 26/02/2003).

Sometimes, checking up words in a monolingual English dictionary did not help Joanna to understand their meaning "in a very solid explicit way" and then she referred to her English-Chinese dictionary. Those were cases when the meanings were too abstract and difficult to explain even in her native language. On page 164, for example, Joanna left 2 notes in Chinese above the words "stockpile" and "incongruity". With respect to these particular notes, she said:

> **Researcher:** *Here you are using Chinese, ah?*
> **Joanna:** *Yeah, because this kind of 'incongruity' is very abstract. And this 'autonomy', I think, it's just like, ah, I know… in a sense that what it means. But if you ask me to define autonomy, I cannot. Even if you ask me the same questions in Chinese…It's better to put it there.*
>
> TBI, 26/02/2003

Considering the amount of vocabulary notes left on the pages of Brown00, it appears that vocabulary work was an integral part of Joanna's reading in this case. When we first discussed her reading of the textbook, Joanna explained that the textbook presented an interesting reading to her because it contained words infrequent in other genres. She explained that she consciously worked on remembering the words: "*Sometimes you come across some words which you will never come across if you are not reading a textbook. And I will use some time to memorize the word and try to look for it again and look it up in the dictionary*" (TBI, 28/01/2003).

Her concern about vocabulary emerged as a theme throughout our interviews. Several times, she complained that she could not remember the words she had already looked up. At one point, her perception that she had a problem remembering words led Joanna to read a research study about vocabulary learning by L2 students. Entitled "L1 and L2 vocabulary glosses in L2 reading passages: Their effectiveness for increasing comprehension and vocabulary knowledge", this article was given to Joanna by a fellow postgraduate student when Joanna complained to her about what she perceived were her problems. As the excerpt below suggests, Joanna felt uncomfortable to the point of feeling guilty because she could not remember words and their meanings and thought it was a problem uncharacteristic of others. What she realized after reading the article about

vocabulary glosses was that the problem of remembering words is shared by many students

of foreign languages and that she does not need to feel guilty when not remembering some

words. She said:

> **Joanna:** *I would say why I tried to analyze myself, why I put a lot of effort to look up in a dictionary, write down and I really tried to memorize it, but after all I forget all. Because those expressions you don't use, first of all, I don't use much English in my daily conversation and in my life. And second those words are actually came you know you can use another word to substitute that word. For example, if I say I look it up "memorize" in dictionary and I try to memorize it, and then I can always find another word, for example, "remember" to substitute this space. That's why I always say I can use another word and I don't have a great need. And especially those words somehow quite rare. So practical application is that I still try to remember the word but I won't feel guilty.*
>
> <div align="right">TBI, 12/02/2003</div>

Considering the importance Joanna assigned to learning new words, I was interested

in why she found this as such an important goal. Joanna explained that she wanted the

reading to be "cost-effective" (InterI, 20/04/2004) and considering the relative

insignificance of the course in her PhD activity system, she wanted to learn something

more useful than just the main points of the chapters. During one of our interviews Joanna

also pointed to the social forces which stimulated her focus on vocabulary when she

explained,

> **Joanna:** *At the same time I am doing my studies, I really want to improve my English, because I mean if I study in an Engineering department, I don't have that stress. But I am here. And whenever your relatives ask you what you study, I used to tell them oh I study English rather than I study tense and aspect in second language acquisition. And they assume you that your English should be improved and should have good English proficiency.*
>
> <div align="right">TBI, 12/02/2003</div>

What emerges as an important issue from this excerpt is that Joanna has strong

perceptions of what is expected of her as a student of an English department. Her MPhil

activity system therefore includes an important goal of improving her English abilities.

The textbook she read for the course provided her not only with new knowledge but also

with an opportunity to learn new words through reading.

5.4.2.3. Making sense of self

The last excerpt in the previous section contains "*I tried to analyze myself*" (TBI, 12/02/2003). Analyzing herself and her practices runs as a red thread through Joanna's reading. This analysis is often done at a conscious level of thinking and reflecting on various aspects. As I mentioned in section 5.4.2.1, Joanna's reading of Brown00 can be described primarily as information intake with little, if any, questioning on her part. In our interviews, Joanna pointed to this aspect of her reading without me asking her about it. From what she said, it emerged that she had been concerned with the inability to read the text critically. The question she seemed to be asking when reading Chapter 6 and may have been asking for a long time was "Why do I not have questions when reading this chapter?"

This is how she introduced the issue of questioning into our interview:

> **Joanna**: *Last week [we] discussed styles and strategies. This week sociocultural factors. It's interesting that when I first read the book for the first two chapters about language learning and teaching, about those kind of theories, approaches, I do have a lot of questions to ask during lectures. If I don't ask I still have questions in my mind to think about. And I think it is from last 2 weeks...*
> **Researcher**: [Joanna pauses to look through the textbook] *From styles and strategies?*
> **Joanna**: Yeah*, from styles and strategies and I don't have a lot of things to ask.*
> **Researcher**: *Why? Is it because it's very simple or you are not interested?*
> **Joanna**: *I think most of the things here are interesting but it seems like most of the content some kind of descriptive. Describing how your left brain or right brain work. You don't have questions to ask because you don't know anything about it. You just absorb what the author wants to say. And for example for last week lecture talking about personality factors. About affective domain, about Myer-Briggs.*
>
> TBI, 26/02/2003

Joanna here explained that she had been concerned why she did not have questions in her mind to ask in class when reading the last two chapters (including Chapter 6). The main reason, she believed, was because she had very little background about the issues and concepts being presented in the chapter. These concepts were interesting to her, yet their presentation was limited to descriptions which she believed, did not help her to assume a questioning attitude towards the text. Interestingly, she did not read the section of the chapter entitled *Topics and questions for study and discussion* which, if read, could have

helped her to come up with her own questions and take a more questioning stance to the chapter, in general. As she explained later, she used to read this section before (in the previous chapters) but found it too long and useless since most of the tasks required group work.

Joanna emphasized the descriptive style and the limited amount of information in the chapter later in the same interview when she said: "*For this, for this kind of book, I mean if you really want to be critical you need much more information than what is presented here*" (TBI, 26/02/2003). Still later, when discussing with me her highlighting and note-taking practices with respect to this chapter, Joanna changed the topic to the issue of questioning again. This sudden change of topic suggests that the issue was considerably significant to Joanna; additional aspects got uncovered as well:

> **Joanna:** *And what I really want to tell you as I have told you before, I found I have got no questions. When I read. But when. When... During the lecture, we have some kind of presentation. They quote some of the sentence from the book and then and then at that time professor asks about, questions, about quoting what they mean. What I am saying or something like that. This kind of thing. And I realize that when I read the book, I don't have why, the reason why I don't have any questions I am already in the side of the book.*
> **Researcher:** *Aha...*
> **Joanna:** *I am following the views of the book. So when he concludes something, I am already like thinking in that way. But when you quote something, that means you are not reading the whole book, then you will see some problem.*
> **Researcher:** *I see. That's very interesting.*
> **Joanna:** *Yeah, and I feel this is worth to, to have another presentation even though they are extracting from the book and they, and they expect you to read the book first before you go to the lecture.*
> **Researcher:** *Aha, aha. That's very interesting.*
> **Joanna:** *And that's why I think you, you, ah. It is very difficult to be critical because when you read a book. When you go through the chapters you, you are already in the same flow. Except some exceptional case, you've got some kind of example. And you stop and think. If you don't have any experience about it, you will just like in here, accept right or wrong, is the sample correct, and then will go. Go.*
> **Researcher:** *You'll just have to believe, don't you? Very interesting...*
> **Joanna:** *Yeah... That's, I think that's the most, I mean...I mean that's the most important thing I've got from this.*

<div align="right">TBI, 26/02/2003</div>

This excerpt is extremely interesting because it leads to several insights about Joanna's understanding of what it means to be "critical" when reading and about Joanna's

understanding of additional aspects which prevent her from being "critical". First of all, Joanna seems to believe that being critical means being able to "see some problems" with what is being said in the text. With this definition of "critical" in her mind, she explains that when she reads by herself about issues which are unfamiliar to her, she follows the text so that she is "already like thinking in that way", i.e. in the way of the textbook. However, when she and her classmates in the class meetings are given quotes from the text, instead of the complete text, she is more able to identify "problems" with those quotes and raise questions.

5.4.3. Social others in Joanna's reading

Through the analysis of the textual operations such as highlighting and note-taking which Joanna engaged in while reading Brown00, I was able to identify two major goals which guided her reading: her need to prepare for a class and her wish to learn new words. What the textual operations did not convey and what the interview data highlighted was that an additional action span through Joanna's reading that of trying to understand her own literacy practices. These literacy practices involved learning new words (itself an action) and reflecting on questioning texts.

While moving from the level of operations to the level of actions, I already began to shift from the individual nature of reading to its social situatedness in communal expectations, rules, and practices. In this section, I will extend the analysis of the social Others and discuss whether and how Joanna referred to the author of the text and to the authors of other texts as well as whether and how her classmates and the instructor of the course affected her engagement with the text.

5.4.3.1. The author

Joanna mentioned the author of the text on very few occasions throughout the text-based interview. In fact, she mentioned the author only twice, once as "the author", and once as "he". Both of the references occurred in the section of the interview when Joanna

explained why she did not engage in critical reading of the text. There, she referred to such features as the descriptive nature of the text and said, "*You just absorb what the author wants to say*" (TBI, 26/02/2003). Later she says, "*I am following the views of the book. So when he concludes something, I am already like thinking in that way*" (TBI, 26/02/2003). It appears that Joanna recognized that the author had a specific view on the issues he presented; however, she could not do anything but follow and trust these views.

5.4.3.2. Authors of other texts

As section 5.3.2 shows, Brown00 contains a great amount of references to other authors. Some of these references follow extended quotes incorporated into the text. An interesting pattern emerged upon another analysis of the highlights, which showed that Joanna highlighted several quotes, yet she did not include the names of the authors into any of the highlights. For example, on page 151, we see the following sentence where the quote is highlighted and the names of the authors are left without marks: "*Most of these studies conclude that "foreign language anxiety can be distinguished from other types of anxiety and that it can have a negative effect on the language learning process*" (MacIntyre &Gardner 1991c:112)". A similar pattern is found higher on the same page and on pages 142, 150, and 164, where quotes or paraphrases are followed by the names of the original authors ignored by Joanna in her highlights.

It appears that Joanna was concerned with noting the main developments, findings, and definitions in the chapter rather than with the researchers whose findings were being presented in it. This would be consistent with Myers' (1992) observations that textbook readers are likely to "separate facts from researchers" (p. 13).

5.4.3.3. Classmates and instructor

The class meetings provided Joanna with an opportunity to review the chapters and to engage with them at deeper levels of reflection and evaluation. The instructor's practices and interactions with classmates afforded Joanna the scaffolding she needed in order to

critically evaluate the texts. One technique the instructor used in stimulating discussions was presenting quotes from the textbook out of the textual context. This technique, according to Joanna, was catalytic in triggering students' critical responses to the material presented in the textbook. Though Joanna herself did not engage in the critical reflection regarding the text when reading it on her own, she participated in the group endeavor of critically evaluating the propositions of the text with the external stimulation from the instructor.

Other classmates provided Joanna with even more food for thought and reflection. Unlike Joanna, many of her classmates were experienced teachers and came from diverse backgrounds. The diversity of backgrounds, according to Joanna, led to diverse discussions where a question on one issue would trigger another question regarding a related issue and so on. Joanna said:

> **Joanna:** *Because of different background, they will have different focus and then they ask different questions. But if you yourself read, you wouldn't have such a lot of questions because... and if one question, for example, then triggers other questions.*
>
> TBI, 26/02/2003

If there were no classmates and discussions in the course, the attitude of Joanna towards the text would mostly likely remain at the level of unconditional acceptance. Being able to listen to and participate in these discussions provided Joanna with a chance to extend her engagement with the issues presented in the textbook, even if that critical engagement happened after she'd read the text.

5.5. Conclusion

In this chapter, I have attempted to present one student's growing understanding of herself and her reading practices by analyzing her reading of a chapter from an introductory textbook. I showed that Joanna's reading could be understood in terms of three sets of actions: preparing for a class meeting, enhancing vocabulary, and understanding personal practices.

With respect to the first action, I highlighted that Joanna's reading is characterized by what some may call "surface level" information reception, which itself is characterized by lack of a questioning stance from the reader towards the text. I explained this lack of questioning in terms of the relationship between Joanna's MPhil activity system and the activity system of the course and in terms of the characteristics of the text as well. With respect to the second action, I highlighted that Joanna's reading cannot be separated from her desire to improve English and explained this concern of hers by tracing her perceptions of what other people expect from her. Finally, with respect to the third action, I highlighted that it would be wrong to assume that Joanna's reading is a process void of reflection and questioning. I especially stressed that her questioning stance is not towards the text being read but towards herself and her own practices.

Finally, in analyzing the presence of social others in Joanna's discourse about the text, I identified the role of her classmates and the instructor in her interactions with the text and stressed the scaffolding opportunities that text-based discussions incorporated into the course presented to Joanna. In the next chapter, I turn to a rather different case of another student, Hugo, whose reading of a research article was highly intertextual, multimodal, and somewhat problematic.

CHAPTER SIX: Hugo

Chapter 6 focuses on Hugo's reading of a dated research article from computational geometry. Its main elements are presented in Figure 6.1 below.

Tools:

Text: research article Bowyer81
Graphs, pictures, computer programs, EndNote files, 3d wooden objects
Highlighter, pen

Operations: note-taking, highlighting, evaluating, skipping, referring to the computer, using wooden objects

Hugo:
3rd semester PhD student of GIS

Goal-motivated actions:
Making sense of the algorithm
Expanding the textual base

Object: prototype of a GIS system from an algorithmic point of view

Rules:
Need to develop knowledge of various fields related to GIS

Community:
Computational geometry around 1980s and 2000
Author of the text
Other writers who have referred to or explained Bowyer81
Other writers referred to in Bowyer81

Division of labor:
Author: famous researcher
Hugo: a beginning PhD student
Many others have summarized Bowyer81 in terms of more recent practices;
Hugo can refer to them to better understand Bowyer81

Figure 6.1. Preview of Chapter 6: The case of Hugo

6.1. Introduction

In the previous chapter, I presented a case of a beginning postgraduate student reading an introductory textbook as part of her preparation for a language teaching course. In this chapter, I will present a case study of Hugo, a third-semester PhD student of Geographic Information Systems. The reading episode covered in this case study captures Hugo's reading of a dated and very important text of computational geometry. The highlights of the case study are in the following findings: Hugo read the text for highly social reasons, situated it within ongoing discussions of the disciplinary activity system of computational geometry, and managed to make sense of it by utilizing multiple tools and other texts which he brought into the reading. Moreover, his reading of the text stimulated an expansion of his textual map of computational geometry.

The structure of this chapter mirrors the structure of the previous one. It will progress from the description of the student's prior L2 literacy experiences and his PhD activity system to the analysis of the text he read and finally to the analysis of the reading episode. Similar to the previous chapter, the analysis of reading will be presented according to the operations, actions, and the social others identifies in the case.

6.2. Participant: Hugo

Hugo is a 25-year-old PhD student from Quebec, Canada. He came to Hong Kong with a very specific purpose to study under the supervision of a professor he had known since the years at his previous university. At the time of the study, he was a third-semester PhD student of the Department of Land Surveying and Geo-Informatics. He was chosen for a detailed case analysis because of his extended involvement with this study, in which he was engaged since its pilot stages.

6.2.1. Hugo's English literacy experiences

A native speaker of French, Hugo, like Joanna, can be considered a fluent speaker of English. His experiences with English began back in Canada when he was a secondary

school student; there he had to take EFL courses both at school and later at the university. Before coming to Hong Kong, however, Hugo had not used English as a means of communication outside of English language classroom settings; it was in Hong Kong that he began using English on a daily basis, both for academic and general communication purposes within and outside of the university. By the time our interviews with Hugo began, Hugo had been in Hong Kong for about 9 months and spoke English very fluently.

On the basis of the interviews, my impression is that though he preserves a characteristic French accent, Hugo possesses a wide range of vocabulary and grammatical structures. When compared to the other participants in the study, Hugo's English proficiency can be labeled as advanced. In terms of general reading habits, he enjoys reading novels, and, for example, in the first nine months he stayed in Hong Kong, he read his first three novels in English. He began reading novels in English because novels in French were not easily available, and though he said he would prefer reading in French, he found the English novels enjoyable.

In terms of academic reading, most of the time the texts he read were in English, though an occasional article in French was also available. As Hugo told me, he would prefer to read research-related texts in French; however, he acknowledged that even French researchers publish their work in English. When reading academic texts, he said "*reading for reading's sake is boring*" (IntroI, 24/07/02), pointing out that he had to have a purpose when reading academic texts. When asked to describe his latest reading during our introductory interview, he said "*I am not really reading*" (IntroI, 24/07/02). For him, reading, especially reading mathematical and computer science articles, was like "following the recipe" because it involved such practices as following the author's solutions and trying them out on his own computer, or trying something out and then reading about similar issues in others' texts.

The role of reading in Hugo's daily schedule around the time of the reading episode was considerable. Like Joanna, he was engaged in long hours of reading (approximately 4 hours per day), but unlike Joanna, he was engaged in other parallel tasks such as

141

programming, trying out algorithms, and meeting with his supervisor. One other task Hugo was involved in along with reading was "building a bibliography". In the month preceding the interviews, Hugo discovered EndNote, referencing software, and he was starting to make a full use of it by actively constructing his own database of texts through the medium of EndNote.

6.2.2. Hugo's PhD activity system

A PhD student of the Department of Land Surveying and Geo-informatics, Hugo locates his PhD research within the area of Geographic Information Systems (GIS), defined as "the field of scientific and engineering activities involved in the application of computer and communication technologies to the capture, storage, analysis, presentation, distribution, and management of spatial information to support decision making" (Forrest, 1998, p. 340). As this definition suggests, GIS as a discipline was born on the intersections between various disciplines, two of the more important ones being computer science and geography. The object of this disciplinary activity system is the development of geographic information systems (hence, the name of the discipline is also Geographic Information Systems). It is usually associated with a broader discipline of geomatics, which, in addition to GIS, includes remote sensing, photogrammetry, geodesy, and other disciplines.

Hugo received his Bachelor of Science degree from Universite Laval, the first university in North America to implement a formal undergraduate program in geomatics in 1984-1985 (Forrest, 1998). As part of his education, Hugo additionally received a certificate in computer science. At the start of his PhD, then, Hugo was not a "true beginner" (Gee, 2002) to GIS—he had some preliminary background in both computer science and programming, on the one hand, and geomatics, on the other.

Hugo came to the Hong Kong Polytechnic University (PolyU) as a full-time PhD student right after his undergraduate program. Since he had had no postgraduate education prior to applying for his doctoral study, Hugo was admitted for a four-year PhD program. Thus, instead of the 3 years normally allocated for PhD studies in PolyU, Hugo had 4 years

to finish his PhD. This semester was Hugo's third semester at PolyU. He had not taken taught courses in any relevant field yet, and his activities involved programming algorithms individually, meeting his Supervisor to discuss his progress, and independent reading.

To understand Hugo's PhD and the object of his activity system, let us consider a slide from Hugo's confirmation report (see Vignette 6.1). Hugo entitled this slide as "Main Objective of the Research" and included three points. Point 1 suggests that the object of Hugo's PhD activity system is the development of a prototype of a geographic information system, which involves developing algorithms for the prototype. Point 2 suggests one of the outcomes of this activity—the prototype is to be used for various marine-related applications. Point 3, though markedly different in the way it is expressed, seems to explain that Hugo's PhD activity system spans across various disciplinary activity systems, and that to achieve his ultimate object, he needs to extend his interactions with them.

Vignette 5.1. A slide from Hugo's confirmation presentation (taken verbatim)

<div align="center">

Main Objective of the Research

</div>

1. Developing a prototype Marine GIS from an algorithmic point of view.
2. For many different applications at sea: hydrography, oceanography, navigation, fisheries, etc.
3. It requires expertise in different fields: GIS, computational geometry and computer graphics.

<div align="right">

(Confirmation Presentation, 10/06/2003)

</div>

Hugo's PhD summarized in activity theoretical terms and presented as a triangle is shown in Figure 6.1 below. We see that he is primarily concerned with his PhD study in this semester and hence his Object is the development of a GIS prototype which is envisioned to be applied to real-world problems (Outcome). To achieve his object, Hugo uses computers, his knowledge of programming languages, texts, algorithms, software and other material and semiotic artifacts (Tools). The others most saliently present in his work now are the department, the supervisor and his research group, other researchers of GIS

and related disciplines (Community). Among the various rules, two seem to be particularly

significant: the university requires that Hugo finish his PhD within 4 years, and a

successful achievement of the Object requires that that he develop knowledge of various

fields. Around the time of the reading episode, Hugo is engaged in mostly independent

work which includes reading, programming, solving algorithmic problems, etc (Division of

labor).

Tools = the English language,
computers, programming languages,
texts, algorithms, software, etc.

Subject: Hugo= French
Canadian, BS in
geomatics

Object =
prototype of a GIS
system from an
algorithmic point
of view

Outcome:
Prototype to be applied
to real-world situations

Rules = Hugo needs
to finish his PhD in 4
years and to develop
knowledge of various
fields

Community =
department, supervisor
and his research group,
researchers of GIS and
related disciplines

Division of labor =
2nd year of PhD, mostly
independent
work=programming+rea
ding+solving problems,
etc.

Figure 6.2: The activity system of Hugo's PhD

Hugo situated the text which is at the heart of the reading episode within the

discipline of computational geometry. Moreover, he situated it within both the earlier and

later stages of the activity system. Therefore, it is important to present the activity system

of computational geometry in some detail, and while doing so, to move between earlier

and later stages of its development.

6.2.3. Activity system of computational geometry

According to Sack and Urrutia (2000), computational geometry as a discipline was

born in early 1970s. The subject of this activity system is communal rather than individual

and can be loosely defined as a broad range of people interested in developing and

improving algorithms used as solutions for problems expressed in geometric terms

(Object). In the beginning of its development, the disciplinary community of the activity system was comparatively small and its members resided in academic departments of computer science and mathematics. Since the discipline was in its early stages, the conventions governing the activities of its members were at the stage of embryonic development. The terminology used within the field was not standardized yet, and for example both Voronoi triangulation and Dirichlet tessellation were used to denote the same data structure (Aurenhammer and Klein, 2000, p. 203). The division of labor was characterized by frequent occurrences of simultaneous developments of similar algorithms by two or more scholars independent of each other.

Since its early beginnings, the activity system has undergone substantial transformations, especially due to the intense developments in computer technology. Though the algorithms being developed by computational geometricians have gradually become more and more complex, the object of the activity system remains essentially the same. Its community, however, has changed dramatically—it has become much larger and cross-continental. Since 1985, there are annual symposiums on computational geometry (which also publishes its proceedings), and since 1991 two journals called "Computational Geometry" and "International Journal of Computational Geometry and Applications" have been published with the hopes that they "will promote and further establish the field of Computational Geometry" (Sack and Urrutia, 1991, p. vii). The activities of the community are now characterized by more stable conventions: technical vocabulary has become standardized; some practices have become more conventionalized. For example, with respect to the data structure which used to be called both Dirichlet tessellations and Voronoi diagram, the latter term became the standard in the community. One major development in the activity system has been its extended interactions with various other disciplinary activity systems, one of them being GIS.

6.2.4. Computational geometry and GIS

Computational geometry provides GIS with "a solid theoretical background" for representing and processing the geometric aspects of geographic data used in GIS (de Floriani, Magillo, and Puppo, 2000, p. 335) and with the algorithms and data structures which are necessary in GIS (Wikipedia, 2004). The Voronoi diagram is a particularly useful data structure for algorithms and is used in GIS to solve multiple problems such as navigation queries, polygon labeling, point insertion and others (de Floriani, et. al., 2000, p. 343). Thus, computational geometry provides GIS with major tools for its development of geographic information systems.

With respect to Hugo's PhD activity system, as I mentioned in Section 6.2, Hugo's achievement of his object (i.e., his development of a new prototype of a geographic information system from am algorithmic perspective) requires that he develop "expertise", as he says, in the field of computational geometry, among several other fields. In the period covering the reading episode, he was not a complete newcomer to computational geometry and as the reader will see in the coming sections, Hugo had read several texts circulated in the disciplinary activity system, had programmed himself, and had learned about several algorithms.

6.3. Reading episode

This chapter centers on Hugo's reading of a 1981 article, entitled "Computing Dirichlet Tessellations" (called Bowyer81 in the rest of the chapter). In this section, I will first present the data sources that contributed to this case study; second, I will describe the physical and temporal settings within which reading took place; finally, I will engage in a close analysis of Hugo's reading in terms of the research questions posed above.

6.3.1. Data sources

Table 6.1 summarizes the main data sources that contributed to the analysis of the reading episode presented in this chapter. The sources from the left column comprise the

primary data which were used to describe, analyze, and interpret the reading episode, while the sources from the right column comprise the secondary data which further contributed to the interpretation of the reading episode and the questions that it raised.

Similar to another student whose reading will be analyzed in detail in this thesis (see Dewey, Chapter 7), Hugo participated in a think aloud session which provided a window into the richness of his reading. This think-aloud session, therefore, is the primary source for the description and analysis of his reading episode. It is supplemented with several interpretative interviews and a reading log (as has been explained in Chapter 4, Hugo was the only student who kept detailed reading logs about the texts he read).

Table 6.1. Data sources: The case of Hugo

Reading Episode		Other Data sources	
Think-aloud session		Introductory Interview	
TA	19/08/2002	IntroI	24/07/2002
Explanatory Interview		Reading Logs	N=18
ExplanI	23/08/2002	RL	02/08/2002-21/02/2003
Reading log		Interpretive Interviews	
RL	19/08/2002	InterI	16/03/2003
		InterI	31/03/2003
Interpretive Interview			
InterI	25/02/2004	Power Point presentation of the confirmation report	
		CR	10/06/2003

6.3.2. Physical and temporal settings

Hugo read the text in his cubicle situated in a large office, a home to about 10 more postgraduate students and research assistants. He began reading at around 9 am in the morning, when there were very few people in the office. As the time went by, more people came in and, since Hugo's cubicle is close to the door, he got distracted several times. About an hour later, by the end of the think-aloud session, the office became considerably noisy, with phones ringing and the office occupants talking. Hugo was sitting at his desk, facing the computer and with the computer keyboard in front of him. The computer was

turned on. On the left side of his desk, at a distance of a hand reach, Hugo had a pile of books and papers; on the right, he had a cup of water and a computer mouse.

The video camera stood to the right from Hugo (as can be glimpsed from the picture provided in Figure 6.3). I was sitting behind the wall of Hugo's cubicle, with only occasional attempts to look inside the cubicle and very few reminders to think aloud. Hugo was aware of the camera, yet he seemed to be comfortable with it.

Figure 6.3. Hugo at his desk

6.3.3. Text Bowyer81

"Computing Dirichlet Tessellations" is a research article written by Adrian Bowyer and published in 1981 by *The Computer Journal*, a well-known journal of the British Computer Society. In the rest of the chapter, I will refer to this article as Bowyer81. Bowyer81 describes an algorithm "for computing the Dirichlet tessellation and Delaunay triangulation" in a three-dimensional space (Bowyer, 1981). As I mentioned in section 5.2.3, the phrase "Dirichlet tessellation" denotes the same data structure as "Voronoi diagram". In today's computational geometry, Voronoi diagrams present a major data structure. Hence, *The Handbook of Computational Geometry* (2000) has a whole section on Voronoi diagrams (Ch. 5), while according to Aurenhammer and Klein (2000), about one out of sixteen papers in the discipline has to do with some aspects of this structure.

Since its publication, Bowyer81 has been cited in at least 222 texts in diverse disciplinary research publications (the ISI Web of Science, 2004), which suggests a relatively high circulation value of the text in and across disciplinary activity systems. Additionally, Okabe and colleagues (2000), the authors of "Spatial Tessellations: Concepts and Applications of Voronoi Diagrams" cite Bowyer81 as one of the influential articles on the topic of Voronoi Diagrams.

As Table 6.2 shows, Bowyer81 contains three major sections. Section 1, the introduction, first presents the definitions of the Dirichlet tessellation and Delaunay triangulation; then it describes the properties of Delaunay triangles; and finally it discusses some of the applications for which the Dirichlet tessellations were used before 1981. The second main section of Bowyer81, Section 2, is about the new algorithm developed by the author. It starts with the description of the data structure and means of storing it, and then it presents an algorithm for adding a new point to the structure and modifying the record. The third section of the article deals with major issues that have to do with the implementation of the algorithm presented in Section 2. Since algorithms are implemented with technological tools, this section has to do with the kind and specifications of computers used in implementing the algorithm, the time taken to compute the Dirichlet tessellation, and 3 dimensional representations of the computed structure.

The analysis of manifest intertextuality reveals that ten references are used in the text, ranging from 1962 to 1980. These references comprise various publications from the fields of mathematical and computer sciences. As can be expected generically, the most intertextual section of the article is Section 1. Introduction, and within it Section 1.3.Applications has the highest number of references (9 out of 10).

The analysis of Bowyer81 in terms of visuals incorporated in it reveals that it is characterized by a high level of multimodality—nine visuals are used on the total of five pages. Out of these nine visuals, 8 are figures and 1 is a table. Figures 4 and 5 have two visuals each while the rest of the figures have one visual each. The textual references as well as the visuals are summarized for each subsection of Bowyer81 in Table 6.2 below.

Table 6.2. Bowyer81

Section	Subsection	Number of references	Visuals
Abstract	--	0	--
1. Introduction	1.1. Definitions 1.2. Properties 1.3. Applications	3 0 9	Figure 1 Figure 2 --
2. The algorithm	2.1. Data structure 2.2. Adding a point	1 2	Figure 3, Table 1 Figure 3
3. Implementation	Degeneracy Programming Pictures Timing	0 0 0 0	-- -- Figures 4 and 5 Figure 6
Acknowledgements	--	0	--
References	--	10	--

A note should be made that an algorithm similar to the one developed by Bowyer was concurrently developed by another scholar, called Watson, without the two authors apparently knowing about each other's developments. Watson's article is published in the same issue of *The Computer Journal* and in fact comes right after Bowyer's article. The editor of *The Computer Journal* included the following note on the first page of Bowyer81: "Editorial note: This paper and that by Watson (this issue) cover some material in common. As these contributions were received at approximately the same time, the Editor feels it only right to include both papers" (p. 162, there is a similar note on the first page of Watson81). The algorithm developed by these two authors is now called the Bowyer-Watson algorithm (Okabe et. al., 2000).

6.3.4. Primary reasons for reading Bowyer81

In Section 6.2 above, I showed that the object of Hugo's PhD activity system is a prototype of a three dimensional geographic information system. Developing a prototype means developing algorithms for solving three-dimensional geometrical problems. Hugo was motivated to read Bowyer81 because of the algorithm it presents. This is what Hugo said regarding this particular issue:

> **Hugo:** *It's an interesting article. They explain the first algorithm, not the first algorithm. There are different algorithms. This one is the first one; it's called*

*the Bowyer algorithm. The other guy. Now called Bowyer-Watson algorithm…
they* [the previous algorithms] *were only in 2 dimensions. And this is the first
one in 3 dimensions. I am working in 3d, so I am interested. This is interesting
for me.*

<div align="right">TA, 19/08/02</div>

What we see from this excerpt is that Hugo was interested in the text because of the
algorithm, which was among the first ones to be applied to three dimensional problems.
Since Hugo's object of activity comprises 3 dimensional algorithms, he was interested in
knowing about the first one in the area. This, however, was not the sole driving force
behind Hugo's decision to read the text. At least an equally important factor, as I learn
from the data, is the status accorded to Bowyer81 within the current community of
computational geometry. In Section 6.4, I mentioned that Bowyer81 is a highly-circulated
text and is mentioned by the authors of a textbook on Voronoi Diagrams as one of the most
influential articles (Okabe, et al., 2000). The high circulation and use value of this text
within the activity system of the discipline seems to have contributed significantly to
Hugo's decision. Hugo came to know about the high status of the text from his previous
readings of more recent texts which mention or explain Bowyer81 in some way or another.
It is this multiple co-occurrence of Bowyer's name in these texts that led Hugo to read this
text, and hence he said "*I need to read it because everybody cites it*" (TA, 19/08/02).

In terms of the future use of the text, Hugo thought he might "*need to explain it in
my own dissertation*" (TA, 19/08/02). Though he said he did not use the text in his own
work directly, he believed he "*should know exactly what it is about*" (TA, 19/08/02). I
interpret this as meaning that Hugo was consciously trying to appropriate the text which
was assigned a high status within the community into which he was socializing and is even
thinking of a possibility to refer to it in his own thesis, the outcome of his PhD in which he
would have to display his knowledge of the disciplinarily valued texts.

Thus, Hugo's personal interest in the text stems from the broader social contexts in
which the text itself is situated and circulated. His personal reasons to read the text can be

traced to the status the community affords this text and to the overlap between his object of PhD activity system and the author's own research contributions described in the text.

6.4. From textual operations to actions to social others

As a first step in understanding the nature of Hugo's reading, I analyze what happened when Hugo read Bowyer81. In this section, I will detail the operations I was able to observe and deduce from both Hugo's think-aloud data and the notes, highlights and underlines he left on the text. Then, I will analyze what actions these operations realized and what role they played in his overall activity system.

6.4.1. Textual operations

As a way of introduction into the textual operations of Hugo, I will first describe his reading in terms of his progression through the sections of the text. Table 6.3 below shows that Hugo allocated considerably more time to Section 2.2, compared to any other section. The two sections that were not read during the think aloud session were Abstract and Acknowledgement. While Hugo had read the abstract the day before our meeting, the Acknowledgement section was left unread.

Note that this table may be misleading in suggesting a linear process of reading. While it is true that Hugo read in the general progression of 1.Introduction → 2.The algorithm → 3.Implementation → References, when he concentrated on a particular section, he would read both forward (References) and backwards (previous sections). The time shown in the table is not the total time afforded to the section overall, but the time which Hugo spent concentrating on the section. Thus, for example, Hugo concentrated on reading References at the end of his reading process and then he spent approximately 2 minutes reading it. However, while reading other sections, he had already glanced at the References section twice, and this "glancing" time is not included into the 2 min shown in the table.

Table 6.3. Reading time distribution

Section	Subsection	Time
Abstract		0
1. Introduction	1.1. Definitions	~5 min
	1.2. Properties	~5 min
	1.3. Applications	~5 min
2. The algorithm	2.1. Data structure	~6 min
	2.2. Adding a point	~15 min
3. Implementation	3.1. Degeneracy	~3 min
	3.2. Programming	~3 min
	3.3. Pictures	~3 min
	3.4. Timing	~1 min
Acknowledgements		0
References		~2 min

In the sections that follow, I will describe Hugo's reading of Bowyer81 in terms of the major specific operations he engaged in.

6.4.1.1. Concurrent verbal comments

Like Dewey (see Chapter 7), Hugo had agreed to think aloud while reading Bowyer81. In terms of data analysis, this means that thinking aloud was one of the operations he engaged in as part of his reading. This operation, in turn, revealed other operations which contributed to Hugo's textual actions. Totally, there were 34 verbal comments in the session, some of these being limited to a sentence, others extending to include much longer sequences (please refer to Appendix 6.2 for a complete matrix of data including verbal comments). Five major categories were identified in the verbalizations: evaluations, complaints, comparisons, explanations, and restatements. The same verbalization often belonged to several categories; i.e., the categories were non-exclusive.

6.4.1.1.1. Evaluations

Evaluations comprised a major category in the think aloud data, where 14 out of the total of 34 verbalizations contained some sort of evaluation (please see Table 6.4 below). These evaluative comments were either positive or negative, with the latter being considerably more predominant. The positive evaluations were of certain aspects of the

text Hugo was reading. Verbalization 8 (V8) involved the adjective "interesting" which was used with respect to a sentence explaining some property of Delaunay triangles. V22, also involving "interesting", and V24 "useful" referred to the author's explanation of how adding a point changed the properties of the Dirichlet tessellations. V25, containing the last occurrence of "interesting", involved Hugo's evaluation of another article mentioned in Boweyr81. Finally, V30 containing "cool" was about the author having a 3d picture in a research article. These positive evaluations show that Hugo was interested in certain segments of the text, found the algorithm useful, noticed another article mentioned in the text and was amused by a 3d picture included in the article.

Most of the time, the evaluative comments, however, were negative. V1 and V6 referred to the author's terminology (his use of Dirichlet Tessellations instead of Voronoi diagram) and involve "weird" and "difficult". V16 included 4 evaluative comments about the author's algorithm which, contrary to Hugo's expectations, starts with the data structure rather than the Delaunay triangulation. V21 involves 3 similarly negative comments referring to the same aspect of the algorithm. Finally, in V26, Hugo says "complicated" when complaining about the author's presentation of the problem in terms of polygons, rather than in terms of triangles, which Hugo is used to. What we see from these comments is that Bowyer81 presented a considerable difficulty to Hugo, these difficulties arising due to the terminology used in it, the steps involved in the algorithm, and the conceptualization of the problem in terms of polygons.

An additional group of comments in this category of negative evaluations involves statements such as "not important" and "not very relevant" (V3, V26 and V27). Interestingly, V3 refers to a statement which Hugo highlighted (H2) and which contains a definition of Dirichlet; while in V26 and V27 these evaluations refer to Hugo's ability to understand the text completely. Finally, the last group in this category of comments is that of comments such as "stupid" (V12 referring to an application for which the algorithm is developed; V16 referring to the use of data structure instead of Delaunay; and V30 referring to the author's decision to include a 3d picture).

Based on the evaluative comments, overall, we see that (1) Hugo had mixed feelings about the text he was reading; (2) he wanted to understand everything about it, though he couldn't and knew that he did not have to; and (3) he found it difficult due to several reasons.

Table 6.4. Evaluative comments in verbalizations

N	Evaluative adjectives	Evaluated aspect	Textual location
V1	weird	terminology	1.1. Definitions
V3	not that important	highlighted sentence (H2)/definition	
V6	difficult	terminology	1.2. Properties
V8	interesting	highlighted sentence (H3)/ Delaunay triangles	
V12	stupid	application	1.3. Applications
V16	strange worse cumbersome and stupid	algorithm / using data structure instead of Delaunay Triangulation	2.1. Data structure
V21	confusing weird complicated	algorithm/working directly with Voronoi	2.2. Adding a point
V22	interesting	underlined sentence (U3) / Dirichlet tessellation	
V23	complicated	algorithm / true in 3 dimensions	
V24	useful	explanation of algorithm	
V25	interesting	idea in another article	
V26	not important complicated	understand everything thinking in terms of polygons	
V27	[not] very important not very relevant	understand everything problem	3.1. Degeneracy
V30	stupid cool	images in 3d images in 3d	3.3. Pictures

6.4.1.1.2. Complaints

The second largest category of verbal comments is that of complaints, these being often accompanied by comments such as "not important" described above. Out of the total of 34 verbalizations, 8 involved some sort of complaint (see Table 6.5 below). V2, V3, and V11 convey Hugo's frustration about a certain segment of the text (a definition and a phrase). V26 and V27 convey his frustration with the text in general or rather, his inability to "understand everything". V16 shows that Hugo could not understand why the author

chose to work directly with Dirichlet rather than with Delaunay. V18 shows that he did not understand why it was important for the author to store the vertex structure, and V22 shows that he was not sure whether the algorithm was be applicable to three dimensional problems.

These complaints confirm that Hugo was frustrated with Bowyer81, and especially with the author's use of Dirichlet rather than Delaunay as the initial step in the algorithm. They confirm that he was concerned with not being able to comprehend everything in the text, though he finally decided that it was not important that he did. They additionally show that he was situating Bowyer81 with respect to three dimensional problems.

Table 6.5. Comments on understanding or being sure

N	Comment	Problem	Textual location
V2	I just don't understand this sentence	Highlighted sentence (H2)/definition of Dirichlet	1.1. Definitions
V3	I just don't know what he means by this		
V11	I don't know what he means by this	Phrase "spreading epidemics"	1.3. Applications
V16	I don't know why they were doing it.	Starting with data structure instead of Delaunay	2.1. Data structure
V18	I don't see why	Why to store the vertex structure of the tessellation	
V22	Not sure	If a statement true in 3d	2.2. Adding a point
V26	I am not sure I understand everything	The algorithm	
V27	I don't understand everything	Algorithm	3.1. Degeneracy

6.4.1.1.3.Comparisons

Another category in Hugo's verbalizations was that of comparisons. Thus, in V1 and V6, he compared the terminology used by computational geometricians at the time of Bowyer's writing and the terminology he was aware of. In V8, V9, and V19 he compared Bowyer's algorithm to his own work on three dimensional problems. In V16 and V17 he compared the author's use of the data structure to the current practice of using Delaunay triangulations. Finally, in V28 and V32, he compared computers then with computers now.

Often, these comparisons were accompanied with negative evaluations as shown in the previous sections.

What these comparative statements highlight is that Hugo was interacting with an earlier stage of computational geometry by reading Bowyer81 and these interactions were situated in his knowledge of the present stage of computational geometry. Therefore, he could not help comparing the two stages of the disciplinary activity system in terms of the practices and terminology used at different points of its development. They further confirm that his interactions with Bowyer81 were also situated in his own work on three-dimensional problems and hence he could not avoid comparing his algorithms to the author's.

6.4.1.1.4. Explanations

The next group of comments include Hugo's explanations of his own operations. In V4, V5, and V13 Hugo explained that he was checking a certain reference in his database. In V14 he explained the need to read one of the references in the future and thus previewed a future action. In V7, he explained that he needed to concentrate on the section "Properties" because "*I must make sure I understand every sentence*" and that he needed to look at Figure 1 to do so. In V15 and V17, he explained why he was looking at another figure, Figure 3. In V9, he explained his reference to the program on the computer. In V25 he referred to his past action of reading another text. In V28 and V32, he explained that he did not have to read certain sections because of changes in computer technology. Finally, in V29-V31 he explained his use of 3d images.

This category of comments is particularly interesting and will be further revisiting in the coming sections. Here, I will mention that what these comments are starting to reveal is that Hugo was conscious of the intertextual nature of Bowyer81 and occasionally checked certain references. They also reveal that he made use of the visuals in the text as well as his computer. The comments additionally suggest that Hugo was planning future actions while

reading Bowyer81. They confirm that at least at some point, Hugo was concerned with understanding the text in detail.

6.4.1.1.5. Restatements

The final category of verbalizations is that which contains Hugo's occasional restatements of the author's words (V24, V25, V26, V31, and V33) and Hugo's direct readings of sentences from the text (V18 and V24). Both the restatements and the direct readings were followed by extensive explanations. The relatively low number of verbalizations in this category suggest that Hugo's thinking aloud process was not limited to reading from the text (the latter being more characteristic of another student, Dewey; see Chapter 7).

6.4.1.2. Notes

Similar to John's case (see Chapter 8), Hugo's reading episode culminated in two sets of notes. First, there were notes Hugo left on the pages of Bowyer81 while reading it and then there was an additional note which he wrote afterwards and included into his EndNote.

6.4.1.2.1. Notes on the pages of Bowyer81

In comparison to the other cases, there were relatively few notes (11) on the pages of Bowyer81, ranging from stand-alone stars and exclamations marks to complete phrases. In terms of content, these notes can be categorized into the following groups: evaluations, rephrasals, comments about 3d and notes of other texts. Please refer to Appendix 5.2 to see the complete notes and their relationship to verbal and observational data or Appendix 5.1 to see a copy of the text containing all the notes.

6.4.1.2.1.1. Evaluative comments

In the first category of evaluative comments we see Note 2 (N2), "interesting! For 3d" (p. 162), which is accompanied with his explanation that he had never noticed the aspect described by the author in his own work (V8). Two more notes, N4 and N9 which contain nothing but an exclamation mark each, also belong to this category. N4 is left on page 162 next to the segment explaining convex polygons and in fact relates to the same segment as N2. N9 is left on page 164 in the section explaining an aspect of the algorithm and is accompanied by Hugo's explanation that he found it very interesting though he was not sure of how applicable the proposition was to three dimensions (V22).

Interestingly, there were no negative evaluations in the notes Hugo had left, while his think-aloud protocol had more negative comments than positive ones. It appears that the role of these notes is to point to the aspects (and their textual location) which are new and interesting to Hugo rather than to record his reactions to the text.

6.4.1.2.1.2. Rephrasals

The largest category of notes is the category of rephrasals, containing four notes:

N5 = Voronoi data structure (p. 164)
N6 = → Voronoi vertices! (p. 163)
N7 = incremental algo (p. 164)
N8 = swap (p. 164)

I call this category rephrasals because the notes refer to particular aspects of the text, but instead of using the words from the text, Hugo used other words not found in the text. Thus, the words "Voronoi", "incremental", and "swap" occurring in these notes do not appear in Bowyer81. Through these notes, we are starting to see that Hugo may have been familiar with certain concepts in the text; however, he was more using terms not used by the author to refer to these concepts. He was using these phrases to translate, in a way, the terms used by Bowyer.

6.4.1.2.1.3. Comments about 3d

Two comments include mentions of three-dimensionality. Through Hugo's verbalizations, the issue of 3 dimensions was already apparent as an important one for Hugo. We see that his notes, as well, reflect his focus on three-dimensional problems.

N2 = "interesting! For 3d" (p. 162)
N3 = 3d: polyhedron is always convex (p. 162)

6.4.1.2.1.4. Notes of other texts

In the last group of notes, we first come across N1 laconically stating "to read". It is left next to the circled phrase in the text, "Green and Sibson (1978)" (p. 162). Later, we see something that looks like "W" (N10) next to the Sibson's (1978) algorithm (p. 164). Finally, at the end of the text in the section References, we come across the last note belonging to this category. It, too, has to do with Green and Sibson (1978) and this time is limited to an asterisk (*). The analysis of the think-aloud protocol already pointed out Hugo's conscious concern with Green and Sibson's article (1978). Through his notes, we further see that his concern with other texts gets materialized through his notes and includes even a reminder for future actions--"to read".

6.4.1.2.2. The note from EndNote

On the same day as the think-aloud session but after I left his office, Hugo added Bowyer81 into his EndNote database. In addition to the basic bibliographic information about the text, consistent with his usual habit, Hugo also left a note about the text. As he told me later, to write this note, he scanned through both the text and his textual notes again and summarized them for the note in EndNote. The following vignette presents the note in its entirety.

Vignette 6.2. Hugo's reading note

Same algo as Watson81.

He is working directly with Voronoi for every thing: data structure, walk algo, to update the tessellation. In fact, he is really computing DIRECTLY the Voronoi diagram, both in 2d and 3d, without explicitly computing the Delaunay triangulation. The Voronoi vertices are the main thing stored with their data structure. WEIRD!. And it is confusing! To understand what he is doing, it is much better to read Shewchuck97 (p. 26+).

Algo can be extended to 3d; actually this is valid in any dimensions.

"In 3d the territory of each data point is a convex polyhedron: the region of space nearer to the point than to any other. The faces of the polyhedra will be convex polygons: the territorial boundaries shared by contigious points. Each convex polygon will lie in the plane that bisects an edge of a Delaunay tetrahedron." I didn't know, but it seems true when I look at my program. But there is no proof of that in the article…

(RL, 19/08/02)

Hugo started the note by pointing out that Bowyer81 explained the same algorithm as Watson81, which reveals that Hugo had known about the two authors' concurrent work on the similar issues before reading Bowyer81. The second paragraph is reminiscent of the complaints Hugo had raised during the think aloud session and here he pointed to the difficulty and confusion the author's use of Voronoi presented to him. Notice that he used the capitals for "directly" and "weird" which further stress his puzzlement. This paragraph ends with a reference to another text, much more recently published Shewchuck97 which suggests that Hugo had read other texts about Bowyer81 and interpreted it in terms of other texts.

The next paragraph is a sentence which states that the algorithm is valid in all dimensions including 3 dimensions, the focus of Hugo's work. Finally, the last paragraph contains a quote from the text (without page numbers) and a comment following it. The quote has to do with convex polygons, and note that it was commented on by Hugo in the think aloud session as well as in the notes he left. His comment here further stresses the point raised in the think aloud that this was a new aspect for him. It additionally shows that Hugo had to check his computer program to see whether this was true and that he would have liked to seen a proof for this in the article as well.

161

6.4.1.3. Highlighting and underlining

While reading the text, Hugo constantly had either a highlighter or a pen in his hands. There were 13 highlights and 3 underlined segments left on the pages of Bowyer81. The highlights start with the title of the article and, in terms of length, range from phrases to complete sentences. The largest amount of highlights occurs in section 1.2. Properties. One highlight is that of a part of a figure heading (Figure 3), and two are those of section headings (H8 and H13). As Appendix 5.2 will show, all operations of highlighting and underlining were accompanied by either notes and/or verbal comments and are reflective of the aspects which Hugo focused on: 3 dimensionality, polyhedron, tessellations.

It is more interesting to see which sections of the text contain neither highlighting nor any other signs, and these are 3.2.Programming, 3.3.Pictures, 3.4.Timing, and Acknowledgements. It appears that Hugo's interactions with these sections were not as intense and deep.

6.4.1.4. Use of visuals

As has been mentioned in section 6.3.3, there are 6 figures and 1 table in the text. The observational data along with Hugo's verbalizations showed that Hugo paid a considerable attention to these visuals and some of them were particularly crucial for his reading.

Figure 1 mentioned several times in section 1.1. Definitions and is a combined presentation of the Dirichlet tessellation and Delaunay triangulation borrowed by the author from Green and Sibson (1978), the text that Hugo had isolated for future reading. Hugo referred to this figure when reading both 1.1.Definitions and when reading 1.2.Properties, though the figure is not mentioned in the latter section. The think aloud protocol contains the following comment: "It's a technical paper. This is a definition, oh not definition but properties of Delaunay triangulation. So I am reading quite slowly because I must make sure I understand every sentence. So I must look at the diagram to make sure I understand" (V7, TA, 19/08/2002).

Figure 2 is first referred to in 1.2.Properties and presents a "3 dimensional Delaunay tetrahedron and its associated vertexes" (p. 163). Hugo looked at this figure only once when he reached the section of the text which referred to it. Being interested in 3 dimensions, he highlighted "3 dimensional" in the heading of the figure.

The next two visuals are situated in 2.1.Data structure. Table 1 is referred to at the end of the section and contains "the vertex structure of the tessellation" (p. 164). Hugo looks through the table and leaves a note "Voronoi data structure" (N5) next to it. As has been pointed out before, "Voronoi" is not used in the text, though Hugo's written notes contain 2 references to "Voronoi".

Figure 3, which first occurs in the same section, is the most interesting visual when it comes to its role in Hugo's reading. It is referred to in both 2.1.Data structure and 2.2.Adding a point. Hugo referred to it at least six times, later leafing back to it and leaving extensive marks on it. He made most use of this visual when reading 2.2.Adding a point. This is a section which details the algorithm for inserting a new point (as the heading suggests). The section about the algorithm per se starts with "Suppose we wish to insert a new data point (Q in Fig 3)" (p. 164). When reading this sentence, Hugo went back to the figure which is placed on the previous page and circled the Q point mentioned in the text (see Figure 6.4 below). The algorithm then involves 6 steps which Hugo traces in the figure as well, as we can seen from the red lines he left on the figure.
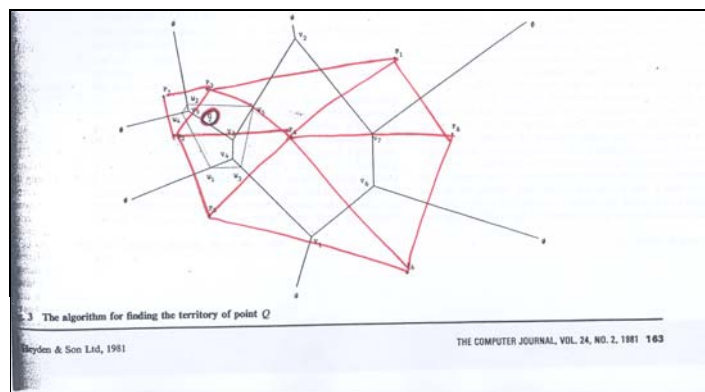
Figure 6.4. Hugo's marks on Bowyer's Figure 3

The remaining three figures appear on the last page of the article. Two of these (Figures 4 and 5) attracted Hugo because he had never seen 3d pictures in published articles. He enjoyed looking at the pictures and when I asked him what he was doing he said, "*I am just checking to see in 3 dimensions. Actually it is stupid because we cannot see anything but it is cool to put images in 3d*" (TA, 18/08/2002). The last figure, Figure 6, Hugo ignored completely, just like the section it was part of (3.4.Timing). His explanation was that computers were too slow at the time of this article's publication and hence, he did not need to know about timing.

What the analysis of these visuals and their importance in Hugo's reading show is that reading for Hugo involves interpreting some of the visuals provided by the author. The importance of one figure in particular, is that it facilitated Hugo's understanding of the algorithm. Hugo did not contend with what the text told him and what the figure showed, he added his own marks to the figure to trace the steps outlined in the text.

6.4.1.5. Use of a wooden object

When reading 2.2.Adding a point, in addition to referring to Figure 3, Hugo also used a hand-made object. The object was right on top of the computer and he took it after a period of restless reading and nail biting. As Figure 6.5 below shows, it is an object made of 5 points and 10 sticks. This figure was used after Hugo underlined the sentence "Each line in the tessellation has k points around it (the line V3-V2, for example, is formed by P3 and P4)" (p. 164). A lot of operations were triggered by this sentence. First of all, Hugo had to refer to Figure 3, then he underlined the sentence and put an exclamation mark next to it, then he checked his computer program, went back to Figure 3 and finally looked at his object. When I asked Hugo later about this object, he explained the following:

> **Researcher:** What is this object you were using?
> **Hugo:** *Ah. The wooden thing. Yes, that helps me.*
> **Researcher:** How does it help you?
> **Hugo:** *It's a pyramid in three dimensions. So I am working with this. I have three. Points are like this, like this, like this.* **(Hugo uses his hands to explain the configuration of points)**
> **Researcher:** I see, but how does it help you in reading?

Hugo: *I don't know. If the guy is talking about something, if he wants to extract Voronoi, and then you have let's see configuration of two subjects and feature. And it can be like this and like this.* **(Hugo is gesticulating to show the possible configurations)** *And he says if those points…***(Hugo pauses to think)**
Researcher: Do you want to say that it helps you to visualize what he is talking about?
Hugo (excited): *Yeah! To visualize! Yes. Because you cannot see…I am using it each time I read about Voronoi.*

<div align="right">InterI, 31/03/03</div>

It appears that Hugo used the object to visualize the various configurations of points discussed by the author, and to understand how adding another point changed the current configuration. Like the visuals used in the text, this object was a significant mediator of Hugo's reading.
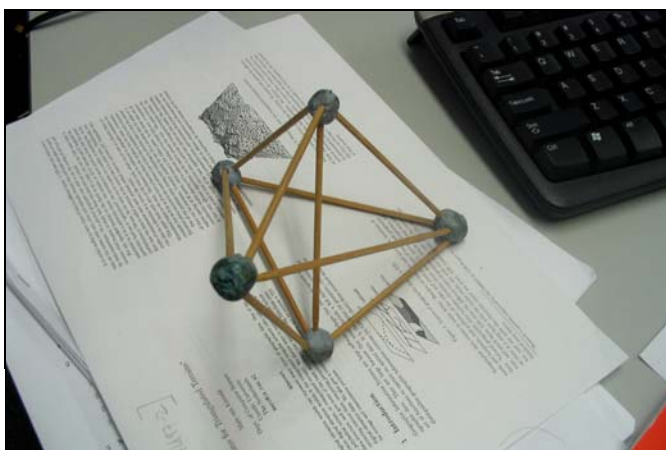
Figure 6.5. Hugo's hand-made object

6.4.1.6. Use of a computer

I was able to record five times when Hugo had to check something on his computer. Two of these times involved him checking his EndNote records, while the remaining 3 times involved him using a program he had created and stored in his computer.

6.4.1.6.1. EndNote

The first time Hugo referred to his EndNote records was when he came across Green and Sibson's 1978 article in 1.1.Definitions. He checked his records, found the article recorded in his database and further checked whether he had specific notes about it. After

this, he commented, "*I've got it. I've never read it. So I should read it*" (TA, 19/08/2002). The second time when Hugo went back to his EndNote database was when he was in the middle of reading 1.3.Applications, where the author referred to Lawson's 1972 article. Upon checking his computer, Hugo's face showed traces of puzzlement and anxiety. He began looking around his desk, going through the pile of papers stocked on the left side of it. Scratching his head, he said that he remembered he had the paper somewhere but obviously had problems finding it. After a couple of minutes, he finally found some paper, yet it was not Lawson72. Instead it was Lawson77, which Hugo immediately scanned through, checked its references and finally said, "*I don't have the article they are citing but I have another one by the same guy and he is citing the 1972 articles. And he explains it, so I don't think I need to read it. It should be ok*" (TA, 19/08/2002).

Through these snapshots, we can see Hugo using his EndNote database for two reasons: (1) to see whether he had records of particular texts, and (2) if he had the records, whether he had actually read the text. We see that EndNote serves as a computerized database substituting the need to remember which texts Hugo had read and as a tool mediating his decisions with respect to future readings. In a way, EdnNote serves as a link between Hugo's reading of previous texts, his immediate reading of Bowyer81 and his future reading of other texts, which stem from Bowyer81.

6.4.1.6.2. Computer program

Three times during his reading, Hugo referred to his computer to check a specific program he had stored in it. When reading 1.2.Properties, Hugo highlighted the sentence "The faces of the polyhedra will be convex polygons: the territorial boundaries shared by contagious points" (pp. 162-163; H5). Right after this, he opened the program on his computer and said, "*Something I have never noticed and now I am looking at. Because I made a program and I am not sure if it* [the description] *works*". After more work on the text and leafing back and forward, he observed "*Yeah, it seems to be true*" (TA, 19/08/2002) and put an exclamation mark next to the highlighted segment (N4).

When reading section 2.2.Adding a point, Hugo's eyes constantly moved from the page he was reading to Figure 3 on the previous page, back to the page he was reading, and to his computer screen. The segment he was concerned about was the underlined sentence: "Each line in the tessellation has k points around it (the line V3-V2, for example, is formed by P3 and P4)" (p.164; U3). He said, "*This is interesting again. But I am not sure this is true in three dimensions*" (TA, 19/08/2002). Eventually, he did not manage to come to a definitive conclusion and after about 3 minutes of anxiety he concluded, "*It is complicated*" and moved on. Later, when reading a later part of the same section, he checked his computer once more, his feelings again being those of anxiety. He explained, "*I am not sure I understand everything*" (TA, 19/08/2002).

The analysis of Hugo's use of his computer during the reading episode shows that his reading was not limited to the pages of Bowyer81. In addition to the verbal text, the visuals incorporated into the text, and the material object, it involved the computer screen displaying the program he had created and which he used to understand the text he was struggling with and to make sure the algorithm worked in his own program.

6.1.4.7. Skipping

As I suggested in the previous sections, Hugo did not find all sections of the text particularly relevant to his work, and as my observational notes confirm, he skipped certain sections. At one point in the think-aloud session, Hugo said, "*I just don't understand this sentence. I just don't know what he means by this. I guess it is not that important*" (TA, 19/08/02). It was not important because, as Hugo explained to me later, he had read at least one more other text which summarized this particular one point:

> **Hugo:** *I know what they are doing. I've read another article and it explained the images and it's much simpler. This I don't know why. They are stupid not stupid it is weird why they are working with Voronoi. I don't need to understand everything. I just need to know what they are doing.*
> TA, 19/08/02

At a later stage in the think-aloud session, he said, "*The problem for me is that I am used to thinking in terms of triangles, but here they are talking about polygons like the dual structure. I know what they are doing because a guy summarized it but he summarized it in terms of triangles*" (TA, 19/08/02). As we saw in the note left in EndNote, Hugo mentions Shewchuck97 and says that this text is much easier to understand.

Thus, Hugo skipped certain sections because understanding every single idea and every single word would take him too much time. Besides, it was not necessary since other authors explained the text in easier terms, terms that Hugo was familiar with.

The last sections of the text were skipped for a different reason. Section 3 contains subsections which have to do with the technical part of implementing the algorithm. Hugo scanned through the section, yet skipped most parts of it because, as he said, the computers were "10 million times slow" and "totally different" (TA, 18/08/2002). The only section which attracted him somewhat was 3.3.Pictures which included the 3d pictures described above.

Skipping was essentially a part of Hugo's reading, and while some sections were skipped or had to be skipped due to the amount of energy and concentration they required, others were skipped purely for technological reasons. What these skipping operations show is that for Hugo, it was not necessary to understand every single section of the text, though in the beginning he kept suggesting that he wanted to "understand everything".

6.4.2. From operations to actions

In the section above, I detailed the numerous operations which comprised Hugo's reading of Bowyer81. In this section, I will attempt to summarize these operations and analyze them in terms of the actions which Hugo appears to have accomplished. There were two major actions, which I believe formed the essence of Hugo's reading of Bowyer81: he managed to make some sense of the algorithm and he expanded his textual base of the disciplinary texts.

6.4.2.1. Making sense of the algorithm

In order to understand how Hugo managed to make sense of the algorithm, we first need to re-examine why Hugo experienced so many problems when reading the text. Both the negative evaluations (see section 6.4.1.1) and Hugo's non-verbal behavior which included him scratching his head and constantly biting on the pencil support the observation that Hugo was somewhat frustrated with the text. Reading research literature is abounding with research on reading comprehension and readers' failures in comprehending texts. Comprehension problems have often been discussed with respect to such factors-variables as language proficiency, vocabulary, background knowledge, and others (see Chapter2, Literature Review).

Engeström (1987), Russell and Yañez (2003) and other activity theorists refer to the psychological concept of double binds to describe and analyze inner contradictions arising within a person due to the dialectical contradictions of an activity system or between activity systems (see Chapter 3 for a detailed explanation of the concept). The data of this case study suggest that Hugo was also in a double bind situation. On the one hand, at the outset of his reading of Bowyer81, he believed it was important for him to understand everything about Bowyer's algorithm. On the other hand, as soon as he started reading the first section of the text, he realized that there had been profound changes in computational geometry since 1981 and that it would take him a lot of time to understand "everything" in the text.

I interpret the double binds he was experiencing by the fact that Hugo, by reading Bowyer81, was interacting with the activity system of computational geometry at its earlier stage, while his own PhD activity system at the period of data collection was much closer to the more current stage of activity system of computational geometry. In a way, Hugo needed to extend his interaction with the activity system of computational geometry beyond the stage of its currents developments and into the earlier stages of its beginnings. In activity theoretical terms, Hugo expressed his perception of the difference in the rules

and established practiced of the activity system which he spoke of in terms of terminology, conceptualization, and algorithmic practices.

When I asked Hugo if he had any idea why the terminology was different around 1981, interestingly, he explained the reasons in terms of the community, and more specifically, in terms of the early stages of the community at the time when Bowyer wrote the text in 1981. He said:

> **Hugo:** *I don't know. They didn't know much about Voronoi. Yeah. They knew, you see this is computational geometry. Now it is big, 1000 researchers in the world. A lot of people are working in this. But back then it was just beginning. This is probably like the first article written about how to create Voronoi incremental. This one and the one attached. They were published in the same journal. It's if you read somewhere else and it says the same algorithm. If I read those quickly I won't even notice they are doing the same thing because one talks in terms of Voronoi, and the other in terms of triangles. So you have to spend a lot of time with the paper. They are doing the same thing, but it is not obvious.*
>
> <div align="right">TA, 23/08/02</div>

Hugo was more aware of the current stage of the activity system and was therefore finding the practices and the conventions of the earlier stages overwhelming. Though Hugo complained of experiencing numerous problems with the text, at the end he still managed to make some sense out of or with it. Overall, the data illustrate that the meaning making process Hugo engaged in depended on some elements of the local and more immediate context: the computer program he had stored on his computer, the material object, and the visuals integrated into Bowyer81. However, the fact that Hugo referred to other texts so often suggests that it also depended on other meanings made by others of this text, specifically, as well as of the issues presented in it, in general, in other times and places (Lemke, 2002). Hugo's meaning making of Bowyer81 was not constrained to the text alone. In fact, if it were constrained to the text, he would not have been able to go beyond the stage of frustration that I described above. He managed to make sense of the text at least partially because he had already begun constructing the meaning of it through his previous readings of other texts before even finding a copy of Bowyer81, and because he realized that it was more useful for him to understand how the text was being interpreted by the community of computational geometricians at the current stage of its development.

6.4.2.2. Expanding the textual base

Reading to understand was not the only goal that guided Hugo's reading of Bowyer81; another goal Hugo consciously attended to was finding texts for future reading. In section 6.3.3, I analyzed Bowyer81 in terms of manifest intertextuality by looking at the references to other texts within Bowyer81. Hugo picked up on the intertextual nature of the text he was reading and noticed at least some of the manifest linguistic markers of intertextuality—direct references to two specific texts within Bowyer81. The following diagram (Figure 6.6) summarizes the decision making processes Hugo engaged in when locating texts for future reading. In it, I trace the other texts that Hugo noticed while reading Bowyer81. I further note whether he decided to read the text or not, and the role of EndNote in his decision making process. As this diagram suggests, Hugo used Bowyer81 as a means of extending his interactions with the activity system of computational geometry and of enhancing his awareness of the other texts circulated in it.

Note that Green&Sibson78 was later included into his EndNote database, the note for it reading "One of the first to describe the 'walking algo' in 2d (point-location algo)" (RL, 2002). Lawson72 was also later recorded in EndNote and is accompanied by a lengthy note including various quotes (from Lawson72 as well as later texts). The note starts with "1st algo based upon edge flips" (RL, 2002).
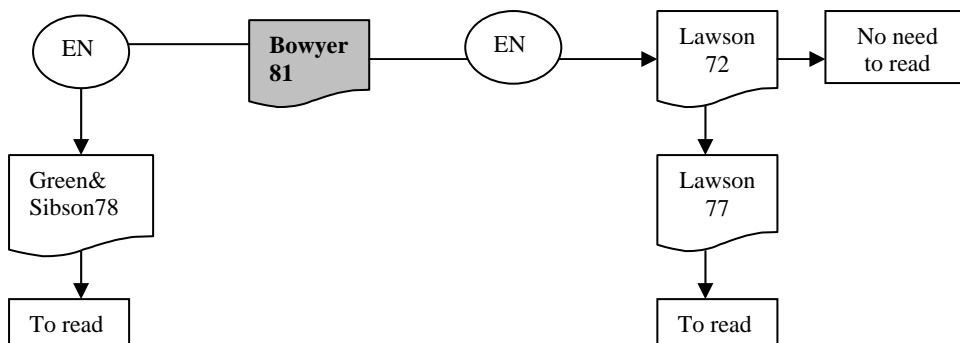
Figure 6.6. Expanding textual interactions with the disciplinary activity system

171

6.4.3. Social others in Hugo's reading

Several types of social others were involved in Hugo's interactions with Bowyer81. In this last major section of the chapter, I will trace these others and analyze the relations which characterize their importance to Hugo. I will show that these are primarily "textual" others rather than specific individuals, and explain why Hugo is particularly concerned with textual products of others.

6.4.3.1. Other texts

In the previous sections, I showed that Hugo's reading was "emplotted" (Ricoeur, 1983), that is situated in dialogue with other readings (Smagorinsky, 2001), and that other texts emerged as a particularly important element in Hugo's reading. The role of these texts is multifold. First of all, other texts motivated Hugo's decision to read Bowyer81 (see Figure 6.7 below). Secondly, other texts mediated Hugo's attempts to understand Bowyer81. Though the data suggest that multiple "other texts" may have contributed to Hugo's action, only Schewchuk97 and Sibson78 were mentioned by him explicitly (see Figure 6.8)
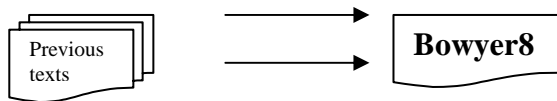
Figure 6.7. The role of other texts in Hugo's decision to read Bowyer81
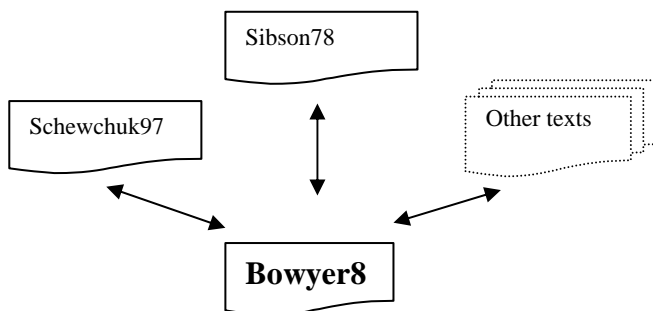
Figure 6.8. The role of other texts in Hugo's understanding of Bowyer81

In the immediately preceding section, I additionally showed how Hugo was developing awareness of other texts based on Bowyer81. When Figure 6.6 is combined with Figures 6.7 and 6.8, we get something that looks like a node (see Figure 6.9). At the center of this node is Bowyer81, and it is connected to multiple other texts. In this diagram I use different kinds of arrows: solid arrows to show the connections that Hugo himself made during the think-aloud session, and dotted arrows to show all the other possible connections.
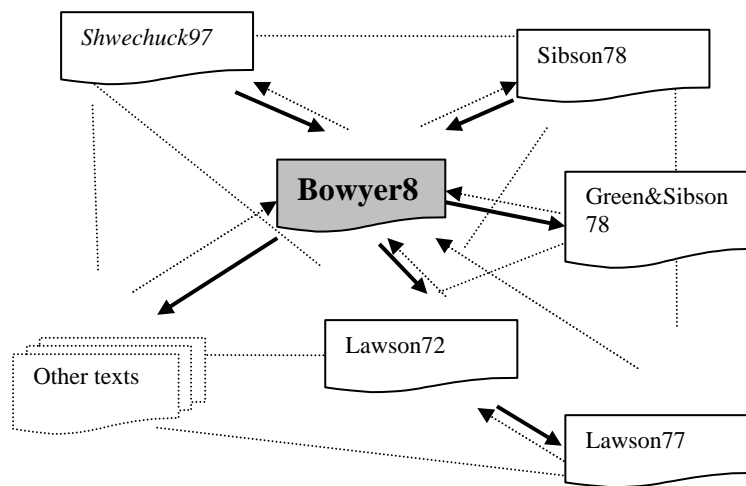
Figure 6.9. A node from Hugo's textual map

Another look at Hugo's PhD and his interactions with the activity system of computational geometry may explain why other texts were so important in Hugo's reading of a single text. At this stage of his PhD, Hugo was not taking courses in computational geometry, and his most immediate means of learning about it were disciplinary texts he read. He was not a complete novice to the activity system of computational geometry anymore: he had worked with some algorithms before, had even programmed parts of those algorithms, and, more importantly, had read more recent texts circulated within the activity system. Through his initial engagements with the activity system of computational geometry and especially through reading texts of this activity system, Hugo seemed to have appropriated the current conventions of the discipline and its conversations

surrounding various algorithms, especially those related to Voronoi diagrams. At the current stage of his PhD, Hugo was engaged in expanding his textual interactions with the disciplinary activity system of computational geometry, and one direction in which he seemed to be expanding and which I was able to capture was the earlier texts of the discipline.

6.4.3.2. The author

Though the text was primarily discussed in terms of the algorithm presented in it and the author did not appear to be particularly significant for Hugo, there were numerous references to the author. Two pronouns were used to refer to Bowyer: "they" and "he". At first, I found it strange that Hugo referred to a single author in predominantly plural forms. I do not have a clear explanation for why he did so, and I suspect he was not conscious of his use of pronouns. However, what emerges as interesting is his juxtaposition of "they" and "he", on the one hand, and "everybody" (V12) and "nobody" (V16), on the other.

The verbal protocol suggested that Hugo was relating to two groups of researchers by reading Bowyer81: the researchers "now" and the researchers "then". Hugo seems to have been interpreting Bowyer81 and the activity system of computational geometry in the early 1980s with its conventions and conversations (Berkenkotter et. al, 1991) then, in terms of its more current conventions and conversations. The author, Bowyer, was clearly situated in "then" for him.

6.5. Conclusion

In this chapter, I presented an analysis of a student "negotiating the complex world of texts" (Bazerman, 2004, p. 84) by describing Hugo's reading and interpreting it in terms of his interactions with multiple stages of the same activity system as he read one text. The approach I have used afforded my understanding of his reading as an interaction not only between him, the reader, and Bowyer81, the text, but also between him, the text, the author of the text, many other authors who have since appropriated the text, the changing

practices of the disciplinary activity system of computational geometry, and various tools such as computer programs, diagrams, and hand-made objects.

I first identified such operations in Hugo's reading as evaluating, restating, comparing, raising questions, highlighting, note-taking, using tools such as visuals, objects, and a computer program. The reading which I was able to capture through the analysis at this stage was highly non-linear, often problematic, intertextual, and mediated by various semiotic and material tools. Next, I attempted to analyze Hugo's reading as the actions which were realized through these operations: reading to understand and reading to expand a textual base. With respect to the first action, I highlighted that Hugo's reading was ridden with difficulties because by reading Bowyer81, he was interacting with an earlier stage of the activity system of computational geometry. I also argued that he managed to go beyond the complications he encountered and to make some sense of the text because his interactions with the earlier stage of computational geometry were enhanced by his awareness of the current state of computational geometry and because he was able to utilize the tools available to him. With respect to the second action, I illustrated that Hugo's reading of Bowyer81 was essentially intertextual in nature: it was stimulated by the other texts he had read, was interpreted in light of these other texts, and led to Hugo's interest in more texts.

Finally, by analyzing the presence of others in Hugo's reading, I further highlighted that reading Bowyer81 provided Hugo's textual pathways for his expanding involvement with the activity system of computational geometry. I also showed that he often juxtaposed between Bowyer and earlier researchers, on the one hand, and the researchers engaged in computational geometry now, on the other. In the next section, I will analyze the reading of Dewey, a PhD student of Rehabilitation Sciences. While some of the operations Dewey engaged in were comparable to those of Hugo, the actions he was accomplishing were significantly different; moreover, the social others involved in his reading were of different, though interacting, activity systems.

CHAPTER SEVEN: Dewey

The third case study presented in detail in this thesis centers around a first-year PhD student's reading of a review article from cognitive rehabilitation sciences. The major aspects of his reading are previewed in Figure 7.1 below.

Tools:
Text: theoretical review paper Wilson00
Highlighter, pen
Computerized dictionary

Operations: note-taking, highlighting, evaluating, skipping, guessing, checking vocabulary, reflecting, sub-vocalizing, gesturing

Dewey: 1st year PhD student of Rehabilitation Sciences

Goal-motivated actions: Learning about treatment techniques
Learning about epistemological discussions

Object: a cognitive rehabilitation program for patients with traumatic brain disorders

Rules: need to prepare for meetings with the supervisor
Need to know theories and their epistemologies
Need to update knowledge of current medical practices

Community:
Author of the text
Other writers referred to in Wilson00
Patients
Doctors and rehabilitation practitioners
Supervisor

Division of labor:
Author: famous researcher
Dewey: a beginning PhD student, but an experienced practicing doctor and student supervisor
Supervisor: model for Dewey
Dewey spends time reading and meeting with Supervisor

Figure 7.1. Preview of Chapter 7: The case of Dewey

7.1. Introduction

The previous two chapters presented the reading of a student in the relative beginning of her postgraduate career (Joanna, Chapter 4) and the reading of a student at a more advanced stage of his postgraduate work (Hugo, Chapter 5). In those chapters, I showed that while Joanna's reading was situated in her concerns with understanding her own practices and others' expectations of her as a postgraduate student, Hugo's reading was situated in his ongoing actions of extending his textual knowledge of a disciplinary activity system. In this chapter, I will present a case study of another student, Dewey, whose reading is inseparable from neither his extended participation in professional medical practice nor his comparatively recent participation in postgraduate research.

Similar to the previous chapters, I will first introduce Dewey, then preview the reading episode and finally engage in the analysis of his reading. The analysis of his reading in terms of actions will show that, like Hugo, Dewey was reading the text for the most immediate goal of extending his knowledge of the current disciplinary developments, but unlike Hugo, he was concerned not only with the current practices but also the epistemologies underlying their use. Moreover, like Joanna and Hugo, Dewey engaged in diverse operations to accomplish his goals. The analysis of his reading in terms of the social others will further show that Dewey's reading was populated with the presence of some very real people—the author of the text, his supervisor, his medical colleagues and his patients.

7.2. Participant: Dewey

One of the more mature participants of this study, Dewey is a 42-year-old PhD student from Mainland China. He is enrolled with the Department of Rehabilitation Sciences of PolyU, which he chose as a site of his postgraduate education because of his prior acquaintance with his current PhD supervisor.

7.2.1. Dewey's English literacy experiences

A resident of Guangzhou, a city in the southern part of Mainland China, Dewey is a native speaker of the two main varieties of the Chinese language—Mandarin and Cantonese. He continues to actively use Mandarin and Cantonese for his interactions with colleagues and his supervisor, though the latter encourages him to use English in order to improve it. Among the four students described in the cases, Dewey has the longest experience of studying English, which began 25 years ago when Dewey was an undergraduate student of a Mainland Chinese university. Though his English learning experiences span across a considerable time period, before his coming to Hong Kong, they had been limited to an EFL context with few opportunities to use English for communication, both academic and personal. Like many postgraduate students from Mainland China, Dewey has been enthusiastically attending the various language improvement programs offered to postgraduate students by the Department of English of PolyU. Like John (see Chapter 8), he joined this study seeing it as a chance to use English with a non-Chinese speaker and hopefully improve it.

His own assessment of his English proficiency is that it is "poor". As the transcript excerpts from the various interviews I present in this chapter will show, Dewey's English is indeed far from being native-like. His spoken speech is characterized by numerous fillers such as "Ah" and "the" which evidence that he takes an effort to formulate his thoughts before speaking. His sentences are often incomplete and sometimes involve incoherent structures.

Reading appears to be a central task for Dewey at this stage and he explains it by comparing his PhD study with his work in Mainland China: "*In Mainland China, I, my work is very busy, so I have no time to read or read a little. Come here, my work is reading. So every day I reading*" (TBI, 27/01/2003). Like Hugo and Joanna, then, he spends a considerable amount of time on reading, and like Hugo, he is concurrently engaged in other tasks such as writing e-mails, visiting patients, and learning new neuropsychological tests and technology. With respect to academic reading, in particular, it is interesting that

Dewey has weekly meetings with his supervisor during which they, in addition to other aspects, discuss Dewey's reading of various texts. Dewey refers to his supervisor when terminology becomes a problem and he cannot solve it on his own. Similarly, when he comes across new tests and technological tools in his readings, he asks his supervisor to explain and sometimes demonstrate them to him.

7.2.2. Dewey's PhD activity system

At PolyU, Dewey is doing his PhD with the Department of Rehabilitation Sciences, which he joined in October of 2002. His PhD study is within the area of cognitive rehabilitation. The object of his PhD is a cognitive rehabilitation program for patients with traumatic brain injury, which he needs to develop and evaluate. Vignette 7.1 contains a slide from Dewey's confirmation report, which presents the main objectives of Dewey's study.

Vignette 7.1. A slide from Dewey's confirmation report (taken verbatim)

Objectives of the present study

- to develop a new memory rehabilitation model based on enriched environment and errorless learning (EE & EL) theories,
- to evaluate the applicability of EE & EL for the memory training of traumatic brain injury (TBI) survivors,
- to compare an innovative, culturally relevant computer-assisted memory rehabilitation (CAMR) programme with a conventional therapist-administered retraining programme and a control group.

(CR, 31/03/2004)

The activity system of Dewey's PhD during the period of our interviews can be summarized as the diagram shown in Figure 7.2 below. Here, our Subject is Dewey, who is a first-year PhD student with a substantial amount of professional experiences: he is an Associate Professor of a Mainland Chinese university and Director of its rehabilitation center. Dewey is engaged in the development of a cognitive rehabilitation program, which in time should contribute to his acquisition of a PhD degree as well as his professional development. In order to achieve the Object of his PhD, Dewey uses multiple tools such as

computers, neuropsychological tests, medical technology, statistics, and various theories. Medical technology is particularly important and its relatively advanced stage of development in Hong Kong was one of the reasons that brought Dewey here. One aspect of the importance of computers is the fact that the program Dewey is going to develop will be computer-based. Psychological tests play a particularly important role because they are often used to assess various components of cognitive functioning. Statistics are important because the study will involve statistical analyses in the future.

Dewey's PhD activity systems involves a variety of key participants. On the one hand, he is working closely with his supervisor, and thus every Wednesday, for example, Dewey and his supervisor meet to discuss Dewey's reading and other matters related to his PhD. On the other hand, Dewey continues to visit his patients in Guangzhou and work with them while doing his PhD. Some of the rules and regulations which characterize Dewey's PhD activity system at the moment are that he needs to acquaint himself with the various theories of cognitive rehabilitation and their epistemologies, he needs to update his knowledge of the most current practices and programs in cognitive rehabilitation, and finally, he needs to prepare for his weekly meetings with the supervisor.

Dewey's time and efforts are distributed across multiple tasks, one of them being his preparations for and the actual meetings with his Supervisor. Another major task he attends to during this period of his PhD is reading. Reading is such an important task for Dewey at this moment that he, like Joanna, has specific plans for readings, and for example during the week of 27/01/2003, his plan is to focus on reading about attention: "*According to my plan, I will, must reading the papers about attention*" (TBI, 27/01/2003).

Thus, Dewey's time is primarily devoted to reading; however, other tasks come in-between, and he feels frustrated because there never seems to be enough time. Some of the additional tasks he mentions during our interviews are writing e-mails, visiting patients, and learning new neuropsychological tests and technology. The role of the supervisor is to provide support and guidance to Dewey, yet the primary responsibilities lie with Dewey himself and much of his work is still individual.

Tools = medical technology including computerized programs, neuropsychological tests, stats, texts, etc.

Subject= Dewey, 2nd semester PhD student, an Associate Professor and Director of Rehab Center

Object = A cognitive rehabilitation program for TBI patients

Outcome= acquisition of PhD, professional development

Rules = need to know theories and their epistemologies; need to update knowledge of current practices; need to prepare for meetings with Supervisor

Community = Supervisor, patients, disciplinary researchers

Division of labor = reading, meeting with Supervisor, learning new tests and technology, writing

Figure 7.2. The activity system of Dewey's PhD

7.2.3. Relationship to the activity system of Neuropsychology

The text Dewey read during the reading episode covered in this chapter belongs to the disciplinary activity system of neuropsychology. In order to understand Dewey's relations with this activity system and his role and status within it, we have to re-examine his status and participation in two other activity systems: the academic activity system of Chinese medical doctors and the professional activity system of a rehabilitation center.

Dewey is quite an accomplished researcher in China and has co-edited 3 medical books which were published by a very prestigious medical publisher, Health Care Press in China. Dewey is also an accomplished practitioner who has been practicing medicine and treating patients for the last twenty years, and who has recently been heading a rehabilitation center in Guangzhou. One of his concerns is, in fact, upgrading his knowledge of the current practices in rehabilitation sciences, in general, and in neuropsychology, in particular. Still more, Dewey is an Associate Professor of a Mainland Chinese University and as such supervises two Master's theses. His attitude towards the meetings with his supervisor, whom he values very highly, reveals his professional interests as a supervisor when he says, "*Give me good demonstration. Let me how to teach my students*" (TBI, 27/01/2003).

In other words, Dewey is not a PhD student who is just starting his enculturation into the disciplinary activity system of neuropsychology. His status and accomplishments within other related activity systems suggest that he is far from being a "true novice" to it.

7.3. Reading episode

The reading episode discussed in this chapter is based on Dewey's reading of a review paper entitled "Compensating for cognitive deficits following brain injury". I will start the discussion of the reading episode by summarizing the data sources which have contributed to the analysis of Dewey's reading. Then I will present the physical and temporal settings within which reading took place and will conclude the section with the introduction of the research article read.

7.3.1. Data sources

In the period of about three months, Dewey and I conducted two think-aloud sessions and two text-based interviews, in addition to introductory and post-think-aloud interviews as well as a think-aloud training session. Dewey and I kept in touch after the primary data collection stage, and as a result, I was aware of Dewey's major PhD developments and one year later, I was able to read through his confirmation report.

Similar to Hugo's case, the analysis of this reading episode is built on a think aloud session (with the following clarification interview) conducted on the 17th of February, 2003. Additionally, it involves data from a text-based interview conducted on the 11th of April, 2003. Dewey had a chance to read through a draft of this chapter and the interview which was aimed at eliciting his comments and reactions to the chapter took place on 20 April, 2003. I summarize the data sources involved in the analysis of this case in Table 6.1 below. In it, the left column contains the sources which have contributed to the analysis of the reading episode and the right column contains all the other sources which, together with the sources from the left column, have contributed to the analysis of the salient features of the context within which John's reading is situated.

An important aspect of this reading episode, which makes it different from the others is the fact that it is based on Dewey's reading of only a part of the text. After 45 minutes of reading during the think-aloud session, he expressed a wish to stop reading for that day and hence the reading episode covers that part of the text which Dewey read during the think aloud session.

Table 7.1. Data sources: The case of Dewey

Reading Episode		Other Data sources	
Think aloud session		Introductory Interview	
TA	17/02/2003	IntroI	20/01/2003
		Power Point presentation of the confirmation report	
Text-Based Interview		CR	31/03/2004
TBI	11/04/2003	Think aloud training session	
		TA training	12/02/2003
Interpretive Interview		Think aloud session	
InterI	20/04/2004	TA	25/02/2003
		Text-Based Interviews	
		TBI	27/01/2003
		TBI	11/04/2003

7.3.2. Physical and temporal settings

The text, the reading of which will be analyzed in the coming sections, was read on the 17th of February 2003, about four months after Dewey began his PhD. Following his usual habit, Dewey read in his dorm room which has all the facilities he needs (mostly his computer and software) and, as opposed to his office, is a quiet place where he can easily concentrate. The think aloud session took place late in the afternoon and lasted for approximately 50 minutes (followed by approximately 20 more minutes of a clarification interview). Figure 7.3 contains a snapshot from the video and shows Dewey's working desk. He sat at the desk while reading the text, facing and occasionally using his laptop. On the desk, there were several pens and highlighters, as well as a few printed articles. Above the desk, there was a shelf which had several books and pictures.

The video camera stood to the right and somewhat behind Dewey. I stayed on the same side as the video recorder and attempted to limit my intrusions into Dewey's reading to occasional reminders to think aloud.

Figure 7.3. Dewey's desk

7.3.3. Text Wilson00

Entitled "Compensating for cognitive deficit following brain injury", the text is a theoretical review paper written by Barbara Wilson and published in *Neuropsychology Review*. The journal is a quarterly referred publication "devoted to publishing integrative, state-of-the-art review papers on substantive content areas in general neuropsychology" (Kluwer Academic Publishers, 2004). Articles published in the journal are written by "leading specialists in the field" (Kluwer Academic Publishers, 2004).

Barbara Wilson, the author of Wilson00, is a Senior Scientist at the MRC Cognition and Brain Sciences Unit in Cambridge and Director of Research at the Oliver Zangwill Centre (Medical Research Council, 2000). The author is one of central figures in the disciplinary activity system of neuropsychology. She has published numerous articles and books on rehabilitation of patients after brain injury. The article itself was named one of "This week's top articles" in the electronic medical discussion group Pain Alert (Kaiser, 2001). The ISI Web of Science, unfortunately, does not contain any information on how frequently the text is cited in others' work, but this is due not to the status of the text per se but to the fact that the index does not include the journal *Neuropsychology Review*.

There are nine sections in the article, including the abstract and the references (see Table 7.2 below). According to the abstract, the paper aims to accomplish four purposes: it

presents a theoretical framework for understanding compensatory behavior (sections "Compensation should address disability and handicap rather than impairment" and "A framework for understanding compensatory behavior"); discusses various forms of compensation (section "How do people compensate for cognitive deficits?"); analyzes compensation in the context of several cognitive disorders (section "Compensating for different cognitive deficits"); and finally suggests ways for predicting which patients may compensate easily compared to others (section "Which people are likely to compensate well?").

Compared to the text read by Joanna, Wilson00 is highly argumentative. There are several textual features that highlight the argumentative nature of this review article, one of them being the headings used in the text. As you can see, one of these headings is a complete affirmative sentence involving a modal ("should"), while two others are presented as questions. Upon a brief analysis of other articles in *Neuropsychology Review*, I infer that such headings are a unique feature of the author's writing style and do not present a common trend in this disciplinary publication.

The analysis of manifest intertextuality (Bazerman, 2004) of Wilson00 reveals that the total of 55 texts are referred to within the paper, and the amount of references is unsurprising considering the genre of the text. The most intertextually dense sections of the article are Introduction (25 references) and the section entitled "How do people compensate for cognitive deficits?" (18 references). Among the 55 references, 13 present the author's own work dating from 1984 to 1999, from which 6 are individual publications and 7 are co-authored with others.

The analysis of the article in terms of visuals reveals that only two figures and one table are used in the text. The figures occur in the section entitled "How do people compensate for cognitive deficits?" and both of them present results from two independent studies reviewed in this section: Figure 1 relates to a study by Clare and others (1999, 2000), while Figure 2 relates to a study by Wilson and her colleagues (1997). The table comes at the end of the text in the section "Which people are likely to compensate well?"

and summarizes the results of an empirical study conducted by Wilson and Wilson (1996).

Table 7.2 summarizes the analyses of references and figures across the sections and subsections of Wilson00.

Table 7.2. Wilson00

Sections and subsections	N of references	N of visuals
Abstract	0	0
Introduction	**25**	0
Compensation should address disability and handicap rather than impairment	4	0
A framework for understanding compensatory behavior	5	0
How do people compensate for cognitive deficits?	**18**	**Figs 1, 2**
Compensating for different cognitive deficits		
Memory	5	0
Language	1	0
Reading	7	0
Visuoperceptual and visuospatial difficulties	3	0
Which people are likely to compensate well?	4	**Table 1**
Conclusions	0	0
References	55	0

7.3.4. Initial reasons for reading Wilson00

On the 12th of February, Dewey and I met for a think-aloud training session. Consistent with my approach, I had prepared a text for his reading on that day and, also consistent with my approach, I chose it on the basis of the resemblance between the title of the article and the title of Dewey's PhD proposal (see Chapter 4 and Appendix 4.2 for a more detailed review of the think aloud training procedures). The article which I happened to bring to the training session on that day was "Towards a comprehensive model of cognitive rehabilitation", a review article authored by the same Wilson and published in 2002. During this session, Dewey had already exhibited being familiar with Wilson's work and was very enthusiastic about reading the text I had prepared for him. The article he read during the think-aloud session, Wilson00, was one of the seven texts he had decided to read on the basis of the references cited in Wilson (2002).

He explained after the think aloud session that he read the text because it was directly related to his research project and when I asked him in what ways he saw the text being useful to him, he said he might use the methods for treating the patients described in the text for treating his own patients in Mainland China. It appears that Dewey was thinking of this text because in terms of his professional activity system as well as in terms of his PhD study.

7.4. From operations to actions and social others

To understand the particulars of Dewey's reading against the information which has been provided in the previous section, I will detail what exactly happened when he read Wilson00. Starting from the operations I was able to observe and deduce from both Dewey's think-aloud data and the marks he left on the text, I will describe the actions he engaged in when reading Wilson00 and the interactions which characterized them.

7.4.1. Textual operations

During the think aloud session, Dewey read only the first two major sections of the text, in addition to its abstract. These sections were Introduction and the following section entitled "Compensation should address disability and handicap rather than impairment". Based on my observations, the progression of his reading was much more linear than Hugo's, and there were only two instances when Dewey read either backwards (a previous page) or forward (References). The total time spent on reading was around 45 minutes, out of which approximately 5 minutes were spent on the abstract, 25 minutes on the introduction, and the remaining 15 minutes on the following section.

Dewey and Hugo engaged in some similar kinds of operations in their reading: concurrent reporting, underlining, highlighting, using the computer, and note-taking. Unlike Hugo, however, Dewey additionally engaged in intensive sub-vocalizing and gesturing. These last two operations will be described in addition to the other operations

which were similar between the two students. As in Hugo's case, I will start the analysis with the student's concurrent verbal comments.

7.4.1.1. Concurrent verbal comments

Asking Dewey to engage in a the think-aloud session while reading Wilson00 meant that verbalizing his thoughts would be a major operation he would engage in, in addition to others. His verbalizations can be divided into guessing comments, evaluative comments, restatements of textual content, and direct reading. These categories differ somewhat from those of Hugo's verbalizations. The category of "complaints", for example, were not found in Dewey's data.

There were 21 verbalizations, only 3 of which did not contain restatement of the content of the text or John's explanation of it (please refer to Appendix 7.2 containing verbal, textual, and observation data of Dewey's case). These were V2 where Dewey asked me whether he needed to read silently or loudly, V20 where Dewey asked whether he had to continue to think aloud, and V21 where he said he would like to stop reading for the day. The remaining 18 verbalizations were often long, stretching from the minimum of 8 words to whole paragraphs.

7.4.1.1.1. Guessing comments

The two guessing comments came in the beginning of the think-aloud session. Upon reading the title of the article, Dewey suggested that the author may discuss the various methods of compensation used in treating cognitive disorders (verbalization 1, V1). Just a bit later, upon reading the abstract, he again suggested that the author would present several methods of compensation (V2). Thus, Dewey expected to read and learn about the various methods of compensation at the start of his reading. Restoration, another approach to cognitive rehabilitation, which the author contrasts with compensation, did not come up in the guesses of the student. This, however, is explained by the fact that the words itself does not appear either in the title or the abstract of the text.

7.4.1.1.2. Evaluative comments

There are only four verbalizations which contain evaluations, and three of these came up when Dewey read the section entitled "Compensation should address disability and handicap rather than impairment" which itself suggests the argumentative nature of this section. The first two verbalizations in this category contain "important". V15 shows that Dewey found the author's argument for the need address disability and handicap very important. V13, which shows the same sentiment, is pronounced in response to the title as well and includes: *"Ok, this is subtitle. I feel it is very important…Before I neglect the problem"* (TA, 17/02/2003). Finally, the last verbalization in this category states: *"This is a different view. I approve the view. Return to work, school, real life"* (TA, 17/02/2003). Dewey said this in response to the author's argument that the ultimate measure of how successful rehabilitation, in general, and compensation, as an approach to rehabilitation, are should be judged from how functional the patients are in the real world rather than from the scores of neuropsychological test.

The other evaluative comment (including "important") came when Dewey read about the theories underlying the choice of approaches in cognitive rehabilitation. He said the plasticity theory which is at the heart of restoration may not apply to all patients and therefore, compensation should be used (V7). What we see in these verbalizations is that Dewey evaluates the propositions advanced by the author of the text. He does not engage in evaluating aspects beyond the level of the text. His close reading of the Wilson00 is further stressed in the coming section.

7.4.1.1.3. Direct reading and restatements

As mentioned above, all verbalizations but one contained some restatement and/or direct reading from the text which suggests that Dewey was closely interacting with the content of the text. An analysis of these restatements and direct readings shows what particular points and arguments raised by the author Dewey focused on. Verbalization 4-

11 referred to the introduction of the article, and we see that here Dewey is concerned with two major points: that compensation is an important method of rehabilitation and that there are several techniques of compensation. Verbalizations V4 to V8 are related to Wilson's point that compensation is a major method of cognitive rehabilitation, which is necessary when restoration fails. These comments, apart from V6 are restatements of Wilson's words, while V6 involves a direct reading of a passage in which Wilson described and juxtaposed the beliefs underlying the two methods of cognitive rehabilitation: restoration and compensation. V7, in addition to a restatement also includes a personal evaluative comment "I think this is important".

V9 is a summary restatement of Wilson00 that there are multiple kinds of cognitive deficits. T10 to 11are Dewey's explanation of the difference between compensation and restoration in his own terms. He uses examples to explain unilateral neglect, a deficit mentioned in Wilson00. V11 took place after Dewey finished reading the introduction and includes Dewey's reading directly from the text, reflecting his concern with the three compensation techniques described in Wilson00. In the last comment here, Dewey explains that his reading is accompanied with writing comments and thinking.

Comments 12 to 17 are regarding the second section of the text. Several times, he reads the heading (V12 and 12) and also suggests that it is very important (V13). He immediately continues that he himself did not think of the issue before (V13). V14-16 are restatements of the author's argument that functional consequences are more important than test results, and in fact V16 involves reading directly from the text to stress the point. V17 is a personal observation where Dewey suggests that Wilson's view is "a different view" compared to others, and V26 afterwards is a follow-up comment that he, Dewey, personally approves Wilson's view and that functional consequences are important for consideration in cognitive rehabilitation.

These verbal comments suggest that Dewey was deeply attentive to Wilson's arguments and examples and had personal opinions and reflections regarding them. The

lack of negative statements suggests that Dewey was not experiencing problems when reading the text and did not find or look for faults with the arguments presented in it.

7.4.1.2. Notes on the pages of Wilson00

Unlike Hugo's and John's, Dewey's notes were limited to the notes left on the pages of Wilson00. Like Dorothy's notes, these notes were diverse in nature and numerous. While reading, Dewey left the total of fifteen notes on the three pages covering the two sections he read (pp. 233-235 of Wilson00; see Appendix 6.2 for a complete list of notes left on the pages of Wilson00). In terms of content, these notes can be grouped into three major categories: vocabulary notes, summative notes, and reflective notes.

7.4.1.2.1. Vocabulary notes

The first category includes two notes and presents translations of two English words into Chinese. These words are "offset" and "circumvent" and appear in the introduction section of the text (pages 233 and 234, respectively). This category of notes has been observed on Joanna's text as well and signifies that the student is attentive to certain vocabulary items. Similar to Joanna's case, these words do not appear to represent a discipline-specific register and are rather general.

7.4.1.2.2. Summative notes

5 entries in this category of notes include numbers. All these notes appear in the introduction, and relate to two main points raised by the author of the text, each of them containing several examples. For example, notes 2 and 3 contain "1" and "2" respectively and relate to the two examples presented in Wilson00 to show that in certain environments patients can avoid using their damaged cognitive skills. Notes 5, 6, and 9 relate to three compensatory methods discussed in Wilson00: structured environments, alternative strategy teaching, and encouraging the use of residual skills. These notes enumerate the points raised by Wilson.

The last and largest category of notes here contains 11 comments Dewey left with respect to the text. Like the notes of the first category, most of the comments are written in Chinese. Only one of the eleven comments is in English and contains three words "maybe voice books" (Note 7), which is in fact related to the phrase used in Wilson00 of "talking books". Three of the Chinese notes include one English phrase each, and those are performance, functional consequence, and handicap, all three appearing in the text immediately related to the note.

These comments reflect the gist of Wilson00 and are mostly translations of the main points into Chinese. Four notes in this category relate to the introduction section of Wilson00. These highlight the following points: the importance of providing structured environments to patients with TBI in order to compensate for their limited cognitive functioning (Notes 2 and 4), the importance of teaching alternative strategies (Note 8) and the additional importance of encouraging patients to use residual strategies (Note 9). As a total, then these present the three major compensation techniques discussed in the introduction of Wilson00. Compensation is compared to restoration in this section, and while restoration is discussed in the first half of the introduction, compensation is discussed in the second half of the section. It is with regards to compensation that Dewey leaves his notes.

Six notes from this category relate to the second main section of the text, "Compensation should address disability and handicap rather than impairment". As the heading suggests, the section is highly argumentative and juxtaposes the following: disability and handicap, on the one hand, and impairment, on the other. It is with regards to the heading of the section that one of these notes is left (Note 10). Dewey's other comments here are related to the following main point advanced by the author in the section: that the purpose of cognitive rehabilitation is not improvement in test scores which would correspond to impairment (Note 11) but improvement in real-life functioning which would correspond to disability (Note 12) and reduction of handicap (Note 14). Note 15

further reiterates the fact that neuropsychological test score improvement is not an indicator of a successful rehabilitation program.

7.4.1.2.3. Reflective notes

Most of the notes discussed under the heading of summative notes are also reflective notes. These reflections include Dewey's note "can quote" (N4) with respect to the techniques described by the author; a question "what is the difference between 3 and recovery" (N9) with respect to the third method of compensation; an evaluation "this point is very important" (N10) with respect to the author's argument that compensation should address disability; and another evaluation "this point is important" (N15) with respect to the author's argument that good scores do not equal rehabilitation.

In addition to adding to our previous understanding that Dewey is concerned with specific arguments the author raises and that he finds them important, we see that he is also thinking in terms of future quoting and engages in comparison of the various methods of compensation.

7.4.1.3. Highlighting

Like Hugo, Dewey, engaged in frequent highlighting along with taking notes and commenting on his reading. Like Hugo, he also constantly had either a pen or a highlighter in his right hand. Dewey lefts twenty highlights on the two sections of Wilson00 he read during the think-aloud session (see Appendix 7.2 for a matrix of all the highlights). These highlights range from isolated phrases (Hs 4, 7 and 11) to complete sentences and even half a paragraph (H8). Twelve highlights are located in the introduction of Wilson00, and the first five of them are of various segments in which the author argues that compensation is a common method of cognitive rehabilitation (H5). More specifically, these are highlights of segments about restoration (H1), its limitations as a method of cognitive rehabilitation and the subsequent need to employ compensation (Hs 2 and 3).

The last seven highlights within Introduction are of segments about the various techniques of compensation, and H6 is a general statement regarding the issue. The next two highlights are related to the first technique—environmental control systems (H7), and highlight 8 additionally contains examples of this technique. The following three highlights relate to the second technique—teaching alternative strategies (H9), with Hs 10 and 11 explaining the principle behind this technique. The final highlight in Introduction is that of the third technique, use of residual skills, and of accompanying examples.

Through these highlights, we see that Dewey is concerned with the two main points of the author: her argument that compensation is a necessary method of cognitive rehabilitation and her further description of several techniques which could be used for compensation. These highlights were accompanied with substantial notes, both of summative and reflective nature which intensifies the significance these points have for Dewey.

The second main section of Wilson00, "Compensation should address disability and handicap rather than impairment," contains eight highlights, one of them being a highlight of part of the heading itself. All these highlights are related to Dewey's six notes regarding this section of the text which I have discussed above. H14 is of a segment which relates to the positive outcomes of using neuropsychological tests. H15 is of a segment relating to the argument that neuropsychological test score improvement should not be the goal of cognitive rehabilitation. H16 is where the author suggests that the goal of rehabilitation is improvement in real-life functioning. H17 is where the author reiterates the importance of functioning over test scores. And finally Hs 18-20 is where she concludes that test scores are not an indicator of successful rehabilitation.

Overall, then, in the second section of the text, Dewey is concerned with the argument that functional consequences of rehabilitation are more important than improvement in test scores. The fact that he also leaves numerous notes with respect to this argument further highlights the importance of it to Dewey at this stage.

7.4.1.4. Use of the computer

As mentioned in section 6.5.2.1, two of Dewey's notes are translations of two words from English into Chinese, these words being "offset" and "circumvent". As in the case of Hugo's reading, the chance which I had to observe Dewey as he was reading Wilson00 provided me with an opportunity to see how he translated words such as the one which I have just mentioned with the use of his computer. Like Hugo, Dewey made an extensive use of the laptop he had in his dormitory room, but, unlike Hugo, he used it for one single purpose of looking up the words he did not know.

In addition to "offset" and "circumvent", throughout the course of the think-aloud session Dewey noted and checked the meaning of three other words: "signposts", "wonder", and "exclusive." Similar to Joanna's case, none of these words are specific to a certain discipline and all could be classified as belonging to the general academic register.

To find out what these words meant, Dewey referred to the online medical dictionary which he had on his computer. In each case, right after coming across the word, Dewey went to the dictionary program, typed in a word in a Microsoft Word document, highlighted it and clicked on the right mouse. As a result, a window would appear which would give him the translation of the word in Chinese as well as the transcription of the pronunciation (please see Figure 7.4 below for a snapshot of the computer screen). Dewey then would repeat the word in English, and would either write down the translation on the text or move on with his reading without recording the translation. At least in one case, that of "circumvent", Dewey had to decide which meaning of the word fit best his context and in his notes he recorded only one of the several meanings provided in the dictionary.

In our interviews before and after the think-aloud session, Dewey mentioned his dictionary several times. He had installed it on his computer several months before the think-aloud session and was very proud of it. During the second think-loud session, for example, he pointed out the user friendly nature of the software and the efficiency it brought into his reading in terms of time spent on reading: "*Medical dictionary. Automatic demonstration of meaning in Chinese or English. If I write down Chinese, they will show*

English meaning. If I write English, show Chinese. Very convenient. Improve my reading

time" (TBI, 27/01/2003). Though not the most important operation in his reading of

Wilson00, checking vocabulary items was a visibly significant aspect of reading.

The snapshot below shows Dewey reading the translation of the word "circumvent"

provided in the highlighted section of the Word document. Here, he is in the middle of

deciding which meaning fits the passage he was reading.

Figure 7.4. Dewey's online dictionary

7.4.1.5. Sub-vocalizing

A chance to observe Dewey led to my understanding of the importance of yet

another operation for his reading: sub-vocalization. Upon hearing the tape, one might think

of sub-vocalization as part of the think-aloud protocol. However, I believe sub-vocalization

is such an integral part of reading for Dewey that it is an operation in its own right.

When reading Wilson00, Dewey constantly sub-vocalized certain textual segments,

which again were as short as a word and as long as several sentences. Unfortunately,

Dewey's sub-vocalizations were not as easy to understand and therefore, I did not analyze

them for content. However, I did notice that sub-vocalization increased and intensified in

terms of volume when Dewey came across certain phrases, some of which were the words

he further translated into Chinese. Some other phrases he highlighted this way were:

"talking books", "functional", "performance", "functional consequences" and "handicap".

This intense sub-vocalization adds to my previous observation that certain arguments are particularly important to Dewey—that functional performance is more important than test scores and that handicap (and disability) should be considered in addition to impairment.

Sub-vocalization was not limited to reading, and even when Dewey wrote his notes, he was vocalizing his thoughts as if he were talking to someone.

7.4.1.6. Gesturing

Another benefit of direct observation was the fact that I noticed the role of gestures in Dewey's reading (please refer to Appendix 6.2 which contains the transcript of the think-aloud data for the comments I had about Dewey's gesturing). In addition to occasionally scratching his head, and changing between a pen and a highlighter, Dewey constantly used his hands in such waving movements as if he were conducting a symphony. These gestures, intensified with his sub-vocalizations, reminded me of a man who was engaged in a conversation with somebody regarding some very important issue, trying to explain to the other the significance of it. To me, his gesturing emphasized how much effort Dewey put into reading Wilson00 and how engaged he was with it.

The gestures particularly intensified when Dewey read section 2. Here his hands were moving along with his lips and you could imagine a person in communication with another person. This section is the one containing the argument that functional performance is a primary measure of the significance and effectiveness of cognitive compensation with patients suffering from traumatic brain injuries. In the snapshot I provide in Figure 6.4, we can see Dewey's right hand in a waving movement as he is concentrated on section 2 of the text. We can also see that his lips are moving along with his hand and the page is covered with green highlights.

Table 7.4. Dewey's gestures

7.4.2. From operations to actions

The analysis of the textual notes, highlights, verbalization comments, gestures, and sub-vocalization shows Dewey's close engagement with the text he read, with at least two major goals being attended to—learning about new techniques of compensation and learning about the theoretical frameworks underlying the use of various rehabilitation techniques. Though another potentially important goal surfaces from the analysis of operations, i.e. learning new words, this goal appears to be secondary to the other two and is not given as much attention.

In the following section, through the discussion of Dewey's reading as a series of actions, I will synthesize the analysis of his textual operations and start mapping out the interpersonal and social factors involved in his reading of Wilson00.

7.4.2. 1. Learning about techniques and learning about epistemologies

In Section 6.3.3, I explained that Dewey read Wilson00 on the 17th of February, 2003, because he came across a reference to it in another article by the same author. I explained that Dewey is aware of the author and considers her work being very relevant to his own. His comments then reflected that he hoped and envisioned that he would learn

new methods and techniques for treating patients with traumatic brain injury. His comments about the text at that time were in terms of his professional activity system.

As became clear through the think-aloud, observational, and textual data, learning about new techniques was part of what Dewey eventually accomplished by reading the two sections of Wilson00. However, this was not the only focus for him. What emerged as equally important is his focus on the theories which inform the practices in cognitive rehabilitation, on the author's interrelated arguments that compensation should be a major method in rehabilitation and that the practitioners should be concerned not with the patients improvement on test scores but rather improvements in their daily life functioning.

In other words, Dewey was concerned with the new techniques described in Wilson00 as examples; however, he was also and no less concerned with the epistemologies and theories that inform these techniques and strategies. Several times, he mentioned that he had never thought of Wilson's arguments when he was a doctor and before he became a postgraduate student. It appears that if prior to his PhD study, professional techniques and practices were seen as something to be learned and used in practice, now these same practices were seen as being situated in certain epistemological beliefs. These beliefs were regarding such issues as what kinds of treatment are best for the patients and how the major concepts of disciplinary activity system such as handicap, disability, compensation, rehabilitation should be understood.

If we think of Latour's referencing to "blackboxing", which he uses to discuss scientists' practices of assuming the non-problematic nature of certain scientific propositions, we see that professional techniques Dewey used before were in a way "black boxes" which now he began to unlock for himself and to explore the epistemological baggage which is inherently part of these black boxes. His prior experiences were of a practitioner dealing with the "ready made science" (Latour, 1987), while now he was experiencing "science in the making" (p. 4).

In a way, Hugo was also opening up his "black boxes" by reading Bowyer81. His case, however, was different from Dewey's because for the latter there was little chaos and

frustration as he started to unlock the doors of the boxes he read about. I would explain this by my understanding that Dewey was in full consensus with the author, experiencing great alignments with her work and her epistemological beliefs.

7.4.3. Social others in reading

In section 7.4, by analyzing the textual operations which Dewey engaged in while reading Wilson00, I was able to show that he accomplished two major actions: learning about new practical approaches to treating patients and learning about the epistemological beliefs underlying the practices of the communal practices. By so doing, I began unraveling the social factors involved in the student's reading. In this section, I will present a more focused analysis through which I will further highlight the socially situated nature of reading. By revisiting the think aloud data and additionally analyzing the text-based interview, I will show that Dewey is conscious of both the more immediate members of his PhD activity system—his supervisor and his external co-supervisor, and of the members of his professional activity system—his past, present, and future patients as well as fellow medical practitioners.

7.4.3.1. The author

The most immediate other that can be traced in the think-aloud data is the author of Wilson00. The analysis of Dewey's references to the author of the text reveals that out of the total of six references, five are in the form of the noun "author" and one in the form of the pronoun "she". All these references co-occur with reporting verbs "said", "describe", and "address" and are part of his restatements of the content presented in Wilson00. Two of these restatements contain Dewey's evaluations of the content. Thus, he says "*This is a subtitle. I feel it is very important. She says Compensating should address disability and handicap rather than impairment*" (TA, 17/02/2003). And later he says, "*So the author address the disability and handicap is important. Give me think*" (TA, 17/02/2003).

From the think-aloud data, it appears Dewey is aware of the author and values her opinions as being important and thought-provoking. Think-aloud data, however, does not reveal the complexity of Dewey's interactions with the author. It is the interviews, both preceding and following the think-aloud session, that provide more insights into the importance of the author in Dewey's reading, as well as other activities.

As it turns out, John is personally familiar with Prof. Wilson, whom he met when visiting PolyU two years prior to his PhD. He met her through his current supervisor, who was at one point supervised by Prof. Wilson and who eventually suggested that Dewey have Barbara Wilson for an external co-supervisor. Though he is not in touch with Prof. Wilson, he has been acquainting himself with her work for some time now. As early as the think aloud training session, when Dewey was asked to read a text which I had found for him, he displayed his awareness of the author. The main thing he explained then was that he was familiar with the style of the author:

> **Dewey:** *The author have a habit to write article. I read the many article written by her. In general she used the question sentence, for example "What need to be rehabilitated in cognitive rehabilitation?"…The author first citation, cited others' view, then give herself view—focus on real life, functional problems. Answer the questions. So I familiar with the author.*
>
> TA training, 12/02/2003

In this excerpt, as examples of Wilson's writing style, Dewey explains that the author often uses a question to raise an issue and answers it by first reviewing others' opinions and then providing her own (note that section "How do people compensate fro cognitive deficits?" of Wilson00 is structured in exactly this manner). Overall, Dewey summarizes, her style is "very effective" and "easy to read".

In the text-based interview, we discussed four texts, including Wilson00, written or co-authored by Wilson. Then Dewey referred to Prof. Wilson as primarily "Barbara Wilson" or even "Barbara", and several times he repeated that reading Prof. Wilson's texts was thought-provoking to him: *"Barbara…give me thinking. Give the readers thinking"* (TBI, 11/04/2003). He added that he knows the author's main views which primarily

advocating compensation for cognitive disorders and social life of patients (as compared to restoration). By that time he was also able to say that he has traced her developments through different articles (earliest I had was 1989) and saw her develop her views through the "*different states of history*" (TBI, 11/04/2003). He thought he knew her well enough to say "*I know her views*" (TBI, 11/04/2003). When I finally asked Dewey whether he knew in what ways he would be using Wilson's ideas, he said: "*Research design. I will write the research design, I cite it. Cite the paper. And the research I will practice the method... I think we will use the Barbara Wilson view to instruct my work. I think this is good*" (TBI, 11/04/2003).

We see from this excerpt that Prof Wilson would be relied on extensively in Dewey's future work in general, and in his development of his research design, in particular. The confirmation report Dewey presented in 2004 contained references to Wilson's work in his discussion of his proposed cognitive rehabilitation program and his explanation of the theory of errorless learning which formed one aspect of the program.

7.4.3.2. Authors of other texts

As the analysis of manifest intertextuality (see Section 7.4.4 above) shows, the article contains 55 references, most of which occur in Introduction and "How do people compensate for cognitive deficits?" During the think-aloud session, Dewey did not show many signs of attending to the names of the authors of those texts which were cited as references. In fact, he skipped the authors' names altogether while reading out those sections of the text to me which contained references to others. He did check one reference in the References section during the think-aloud session, however, even though he did not mark it on the page.

It was from the text-based interview that the role of other authors in Dewey's reading became more apparent. It is during this interview, that I learned that contrary to my initial understanding, Dewey did pay attention to the references in Wilson00 and in fact highlighted seven of them the same day as the think-aloud session, when I had already left

the dormitory room. All of these texts are mentioned in the two sections Dewey read during the think-aloud session.

These references can be divided into twp groups: those supporting restoration, and those advocating compensation. Thus, Kolb (1995), Robertson et al. (1995), and Thomas et al. (1997) are mentioned in Wilson00 as examples of those who claim that some areas of cognitive functioning can be successfully restored, and Taub et al. (1993) appears as an example of very few cases which show that restoration of function can occur even several years after an injury. Schacter and Glisky (1986) is used as an example to show that memory is comparatively more resistant to restoration. Finally, Baddeley and Wilson (1994) and Wilson et al. (1997) appear as examples of studies which show that compensation leads to effective cognitive rehabilitation. The fact that Dewey highlights studies clearly supporting restoration and studies clearly advocating compensation suggests that he is attentive to both strands or theories underlying the current understanding of cognitive rehabilitation in neuropsychological and plans to continue acquainting himself with both of them.

7.4.3.3. Patients

Since Wilson00 involves a discussion of treating patients and since Dewey has himself been working with patients for the last 20 years, it is not surprising that references to patients are among the most frequent ones in the think-aloud data. Patients are referred to as "patients (13 times), "people" (2 times), and "individuals" (1 time). Both "people" and "individuals" are read out from Wilson00 directly, while "patients" occurs both in restatements and direct readings.

Patients comprise a major element of Dewey's professional activity system of a rehabilitation center and therefore a major element of his PhD activity system. His motivation in doing his PhD is providing better service to patients suffering from traumatic brain injuries. In the very first interview we had, for example, Dewey told me that he disliked reading. When I asked to elaborate, he said:

Dewey: *Spend much time and need to [be] patient. Very difficult. I like to work. I like to do something. Help my patient. In my original department I visit patients every day from morning to afternoon. Because in our department we have 24 wards. We receive traumatic brain injuries, stroke...*

<div align="right">IntroI, 27/01/2003</div>

Dewey mentioned patients every time we met. For him, patients comprise an integral part of his life, and hence the traces of patients in his reading of Wilson00 are nothing but expected. The constant reference to patients in his talk is probably the result of both the author's references to patients in general and Dewey's concern with his own real patients in Mainland China.

7.4.4.4. Other medical practitioners

The last significant category of others that populate Dewey's reading is the category of professional medical practitioners and contains 10 references in the think-aloud data. The most frequent reference to medical practitioners comes in the form of the pronoun "we" (8 times). The other references used are "medical doctors" (1 time), and "clinicians" (1 time). Only one of these references appears in the direct reading of a segment.

References to medical practitioners often come along with references to patients as in the excerpt below:

Dewey: ***We*** *told the <u>patients</u> not unilateral, the <u>patients</u> receive my suggestion and maybe correct the deficit. This is called the restoring. Now **we** use another method. For example **we** left the neglect, **we** use the attractive method. For example the, color.*

<div align="right">TA, 17/02/2003</div>

Patients and medical practitioners comprise a dialogic pair of participants within the same activity system—that of rehabilitation centers such as Dewey's and other medical institutions. Dewey's use of "we" to talk about medical doctors or clinicians is reflective of his status within the professional activity system. In section 7.2, I described him as an experiences practitioner heading a rehabilitation clinic. His use of "we" is very different from Joanna's use of "they". Both referred to some professional activity systems, but while Dewey associated himself with other doctors, Joanna separated herself from other teachers.

When including other medical practitioners into his discussions, Dewey seems to refer to Mainland Chinese medical doctors in particular. For example, when we discussed his reading after the think-aloud session, he said that one of the usefulness of this text was in the fact that it described new and simple techniques for treating patients. The latter point was particularly important because the professional activity system of rehabilitation is in its early beginnings and therefore simplicity of administering techniques is a major issue.

Reading Wislon00 occurs at the intersection between Dewey's concerns with research matters as well as the professional practices he has been engaged with. He does not see the two as being separate activity systems.

7.5. Conclusion

In this chapter, I attempted to present Dewey's reading at three levels: at the level of operations, actions, and activity systems. First, I analyzed his reading of Wilson00 in terms of the goals that guided his reading and in terms of the specific operations that realized his goal-oriented actions. Here I demonstrated that Dewey read with two goals in mind: to update his knowledge of the recent techniques used in cognitive rehabilitation and to enhance his understanding of theories which underlie these techniques. I also demonstrated that he engaged in such identifiable operations as sub-vocalizing, gesturing, translating vocabulary items, highlighting, note-taking, and underlining to achieve his goals. He also engaged in intense thinking and reporting of some of those thoughts.

Second, I analyzed Dewey's reading specifically in terms of the social factors which emerge through his talk about the text and through his think-aloud data. Here, I showed that Dewey was particularly aware of two groups of social others: those related to the research activity system of neuropsychology and those related to the activity system of the rehabilitation system. His reading of a single text is thus situated at the intersection of several activity systems he participates in. In the next section, I turn to the last case in the series of four detailed case studies and present the reading of a PhD student who is about to finish his studies.

CHAPTER EIGHT: John

Figure 8.1 below previews the main findings from the last case study presented in detail in this thesis.

Tools:

Text: research article Khoury84
Graphs, note-pad
Highlighter, pen

Operations: note-taking, highlighting, drawing

Goal-motivated actions:
 Verifying simulation results
Developing definition of settling time
Preparing for writing

John: last-semester PhD student of mechanical engineering

Object: a numerical simulation method for calculating thermal cracks in heated concrete

Rules: need to verify own results with respect to previous findings, need to contribute something new, need to persuade future readers

Community:
Authors of the text
Future examiners
Mechanical engineers

Division of labor:
Authors: "Big Professors"
John: 3rd year PhD student, 2nd PhD
John spends time reading, conducting simulations, experimenting, verifying results, writing

Figure 8.1. Preview of Chapter 8: The case of John

8.1. Introduction

In the previous three chapters, I presented the analysis of three students' reading three texts. This is the last chapter in the series of four chapters detailing the case studies. Here, I will present the case of John, a final-semester PhD student of Mechanical Engineering, whose reading is strongly reflective of his concerns about writing and presenting himself to others. Like Joanna, John is concerned about his literacy practices and others' expectations of him and his PhD thesis. Unlike her, however, he is at the very end of his postgraduate career. Like Hugo, John is highly aware of the intertextual nature of the text he reads; unlike him, however, his awareness of the voices of others in a single text is reflective of his concern to incorporate voices of others into his own thesis for political reasons of aligning with the powerful others. Finally, like Dewey, John's reading is populated with a presence of real, though still unknown, significant others—his future examiners; unlike Dewey's, however, his comments about these others contain traces of sharp power and status divisions.

Consistent with the previous chapters, this chapter will move from the introduction of the participant to the analysis of the reading episode. By analyzing John's operations, I will demonstrate that John read the text for the most immediate goal of verifying his research results and further used it in his development of a definition of a disciplinary concept. Both of the actions were further related to the ongoing action of preparing for writing his thesis. By tracing the mentions and references to various others in both his talk around the text and his notes on and off the text, I will show that John was particularly aware of two groups of social others: the authors of the text and the future readers of his own writing. I will highlight that John was very conscious of his status as well as the status of the authors in the disciplinary activity system and that his reading of the text was situated in a persuasive argument with the future reviewers of his PhD thesis.

8.2. Participant: John

Like Dewey, John is a Mainland Chinese PhD student. He is 30 years old, and the last three years he spent in Hong Kong. He is a final-year PhD student who came to Hong Kong for novel research experiences and has been enrolled with the Department of Civil and Structural Engineering of PolyU. Along with Hugo, he began his participation with this study during its pilot stage and was chosen for a detailed case study because he was the only student at the very end of the PhD spectrum.

8.2.1. John's English literacy experiences

A native speaker of Mandarin Chinese, John studied Russian as his first foreign language. His English learning experiences started relatively late, when John began his postgraduate studies at a university in Mainland China. Then, realizing the role of English in academia, he became highly motivated to learn the language and spent a considerable amount of effort and time on studying English individually by using a variety of self-instructional materials. Hong Kong was the first place where John used English for authentic general communication and academic purposes. It was also the place where he attended his first formal English classes.

Since joining PolyU, John has taken every advantage to improve his language abilities and has attended numerous workshops and various courses offered by the English Department of the university. In addition he has extensively used the library resources and has borrowed several books on how to improve reading and writing skills. When I visited his office, the first thing that struck me was one of the few posters hanging on the walls of his office cubicle. To my great surprise, it was a printout of an article entitled "How to read effectively" from a magazine called *The world of English*, published in China. Though he may have purposefully placed this printout on the most visible wall of his cubicle for me to see it, it did strengthen my impressions that John was a highly motivated learner of English.

While John is highly motivated, there is still a lot of room for improvement when it comes to his English abilities. Though his speech can be reasonably comprehensible, the listener has to get used to his strong accent. His listening ability is noticeably weak, and there were occasions when he would not understand my questions. Moreover, when I sat through his oral defense presentation, I noticed that he had manifest problems understanding the questions he was asked by his examiners, which had a tremendous effect on his ability to respond to them. With regards to his writing, I was surprised to see that his drafts of several PhD chapters were relatively well-written. Though they contained a fair amount of grammatical mistakes, the organization was easy to follow. John's self-assessment of his vocabulary is that it is satisfactory for academic purposes, yet is very limited for more general purposes, such as eating out, shopping, or discussing everyday issues.

When we first met for an introductory interview, John said that he was looking for "*a good efficient way of reading*". Concerned that students have "*paper mountains*" to read and considering that they are non-native speakers, he thought there should be effective ways of reading and in fact he told me several time afterwards that he hoped I would discover these effective ways and write a book detailing them to non-native readers. During the same introductory interview, John brought in writing into the discussion of reading by pointing out that he often copied certain sentences from the texts he read to his computer files and said: "*Because it is difficult to write in good English. Native speakers have a better ability to write well. Good sentences can explain research problem very well. These good sentences can improve my English*" (IntroI, 23/07/02).

Reading and thinking were another issue we discussed during our first interview. It was brought up by John when I asked him whether he read academic texts in Chinese. His response was that he consciously preferred to read in English because he saw reading as a means of "*training thinking way*" (IntroI, 23/07/02). He said that Chinese articles contained fewer pages and somehow did not reveal how the scientists think. When

approaching texts, he tried to be interested in it because with interest, there was a purpose to read and having a purpose was very important.

Around the time of our reading episode, John was engaged in final simulations for his project and writing up his thesis. Reading was not a major task and did not take much time, unlike in the other cases.

8.2.2. John's PhD activity system

At PolyU, John is doing his PhD with the Department of Civil and Structural Engineering. This is a second PhD study for John, who began and yet has to finish his first PhD at a university in Mainland China. Several factors have contributed to John's decision to come to Hong Kong for his PhD studies; some of these are the relative abundance of material resources, the higher chances of meeting and communicating with people from other countries, and the different research environment. The factor which John particularly emphasized in our discussions is that Hong Kong universities possess a research culture which is different from the research culture in China. During our last interview, for example, John said the following and I choose to present his words verbatim here to show the specific language John used to express his point:

> **John:** *I want to improve myself... And then actually I want to train myself in research study.*
> **Researcher:** *Train yourself?*
> **John:** *Yeah, yeah. Because the, I think the requirement is more, more strict, more strict than in Mainland China. So I want to improve myself.*
> (InterI, 07/11/2003)

Twice in this short excerpt, we see John repeating "I want to improve myself". More specifically, he explains, he wants to "train" himself as a researcher. The reasons that Hong Kong is a better place for his training is that the requirements to researchers are much more strict than in China. Being aware of various requirements and wanting to improve are characteristic of John and his research in Hong Kong.

The object of John's current PhD is the development of a numerical simulation method for the calculation of thermal cracks in concrete when it is heated. According to

Biswas (2003), numerical simulations, as a research method, have become increasingly significant in various subfields of engineering and are used along with experimental and theoretical investigations. Numerical simulations have great benefits over experimental studies: they are cost- and time-effective and usually do not present security problems. Their main drawback, however, is their validity. This drawback stems from the fact that simulations are based on theories, and thus their validity depends on the validity of these theories and their underlying assumptions. To account for the validity of their simulations, researchers often have to refer to previous experimental and theoretical results and investigate whether their simulation results match those of experiments and/or previous theoretical investigations, and thus previous experimental and theoretical studies present validations tools for simulation-based research.

Though the ultimate object of John's activity system is a simulation method, his research activities include a fair amount of experimenting. The following slide is taken verbatim from the Power point presentation John prepared for his oral PhD defense. Entitled "Research Objectives," it presents three major foci that John is attending to in his PhD study. As you can see, both experiments and numerical simulations are included into these objectives.

Vignette 8.1. A slide from John's final examination presentation (taken verbatim)

Research objectives

- **Experimentally** observe thermal cracking process of concrete at elevated temperatures
- **Numerically simulate** the thermal cracking process in concrete at elevated temperatures
- Explore the mechanisms of explosive spalling of concrete

(OE, 31/10/2003)

The activity system of John's PhD can be summarized as the diagram in Figure 8.2 below. Here, our Subject is John, who is in the process of developing his numerical simulation method for the calculation of thermal cracks in heated concrete. This numerical method is further to materialize as a software package that would allow its users to

simulate and calculate the properties of thermal cracking of concrete when it is under heated conditions. The development of the object should lead to John establishing himself as a member of the community of disciplinary researchers, especially those who are interested in thermal cracking of heated concrete. In order to attain the Object of his PhD, John uses multiple tools such as computers, existing software, and academic publications which he prefers to read in English, though occasionally Chinese publications are also used. Both English and Chinese are used by John for communicating with others.

Some of the others who are significant in his PhD at this moment are his supervisor with whom John meets on a regular basis, his Department and especially his fellow research colleagues from the Mainland China, and importantly, his future examiners. The names of the future examiners are not known to John yet; nevertheless, he refers to "reviewers" and "examiners" frequently during our interviews. Some of the rules which characterize John's activity system are as following: he needs to verify the results of any simulation he conducts; his contribution to the disciplinary activity system needs to be significant; and he needs to convince his future examiners that his research is valuable and reliable. John's time and efforts are distributed across multiple tasks: reading, conducting simulations, verifying the results achieved with the use of simulations, experimenting, writing, and meeting with his Supervisor.

Tools = computers, software, texts, English and Chinese

Subject= John, 2nd PhD

Object = A numerical simulation method for calculating thermal cracks in heated concrete

Outcome= acceptance by the disciplinary community

Rules = need to verify own results against previous findings, need to contribute something new, need to persuade future readers, need to write

Community = Supervisor, Department, future examiners, reviewers, disciplinary community

Division of labor = reading, simulation, experiment, verification, writing, meeting with Supervisor

Figure 8.2. The activity system of John's PhD

8.2.3. Relationship with the activity system of Mechanical Engineering

Though he is doing his PhD with the Department of Civil and Structural Engineering, John situates his own work within the discipline of Mechanical Engineering. In terms of his research activities, John is already a member of the disciplinary activity system. He is fully engaged in experimenting, simulating, analyzing results, developing research problems and research plans, attending conferences, etc. In terms of writing, as well, John has already begun establishing his name in the community. He has published four research articles in disciplinary journals and two research reports in conference proceedings.

John's participation in the activity system of Mechanical Engineering, though legitimate, is still peripheral, however. It is peripheral in terms of his status within the community of disciplinary researchers. John is strongly aware of his status in the disciplinary community and often compares himself to others who have already established themselves in the discipline. Passing the oral PhD defense and getting a PhD degree would ideally advance John's status within the disciplinary activity system and would lead to the recognition of his participation in it.

8.3. Reading episode

The reading episode discussed in this chapter is based on John's reading of a research article entitled "Radial temperature distributions within solid concrete cylinders under transient thermal states". I will start the discussion of the reading episode by summarizing the data sources which have contributed to the analysis of John's reading. Then I will present the physical and temporal settings within which reading took place and will conclude the section with the introduction of the research article read.

8.3.1. Data sources

John first participated in my study in July 2002 when I was piloting my research tools; he continued to participate in it till he left Hong Kong in November 2003. During this time, we conducted the total of four text-based interviews and three interpretative interviews. I had a chance to read three of John's PhD thesis chapters and to attend his PhD oral defense, which was open to the public.

The analysis of this reading episode is built on the text-based interview conducted on the 20th of February, 2004, and on two interpretative interviews conducted on the 27th of March and 7th of November 2003, which centered on the discussion of two drafts of a paper I was writing about John's reading at that time. I summarize the data sources which have contributed to the chapter in Table 8.1 below. In it, the left column contains the sources which have contributed to the analysis of the reading episode and the right column contains all the other sources which, together with the sources from the left column, have contributed to the analysis of the salient features of the context within which John's reading is situated.

Table 8.1. Data sources

Reading Episode		Other Data sources	
Text-Based Interview		Introductory Interview	
TBI	20/02/2003	IntroI	23/07/2002
Interpretive Interview		Power Point presentation of the oral exam	
InterI	27/03/2003	OE	31/10/2003
InterI	07/11/2003		
		Text-Based Interviews	
		TBI	27/01/2003
		TBI	27/03/2003
		TBI	31/04/2003
		Interpretative Interview	
		InterI	21/08/2003

8.3.2. Physical and temporal settings

The text, the reading of which will be analyzed in the coming sections, was read on the 16th of February 2003, about 8 months before John's PhD oral defense and 4 months before he submitted his PhD thesis. Following his usual habit, John read in his office,

which is a home to about five more research staff members and postgraduate students of his department. John's cubicle in the office contains a computer and several shelves. On these shelves, among other items, John keeps various collections of articles, which he has compiled over his years at PolyU (see Figure 7.2 below for some of these collections). The text which John decided to read on the 16th of February came from one of these compilations, given the code of Fu-017(P) and entitled "Stressed Test".

Figure 8.3. Collections of John's readings

8.3.3. Text Khoury84

Published in a 1984 issue of the *Magazine of Concrete Research*, the research article is authored by Gabriel A. Khoury, Patrick J.E. Sullivan, and Brian N. Grainger. The last name of the first author and the last two digits of its publication year will be used to refer to the article as Khoury84 in the remaining sections of this chapter. As the first page of Khoury84 indicates, the first two authors of the article at the time of its publication were affiliated with the Department of Civil Engineering of the Imperial College of Science and Technology, an institution highly recognized for its research and teaching both in the UK and internationally. The third author was affiliated with Central Electricity Research Laboratories, a leading research laboratory in England.

The article does not appear to have been highly circulated within the disciplinary activity system. After John told me that, to his knowledge, nobody had cited it, I referred to both ISI Web of Science, an electronic index used to trace citations of particular

academic publications, and Google, a popular Internet search engine, to verify John's observation. According to the ISI Web of Science index, Khoury84 has been cited only once within an article published in 1994; a comprehensive Google search did not return any results for the paper. Thus, it appears that Khoury84 has been cited in very few subsequent publications.

The research article presents findings from analytical, numerical, and experimental investigations concerning the nature of radial temperature gradients and the factors influencing their magnitude. Khoury84 starts with a synopsis followed by a short paragraph explaining the notation used in the text. Its introduction, which comes next, situates the research within previous studies and previews the three investigations which form the core of it. Then, each investigation is discussed separately in the following order: the analytical investigation, the numerical investigation, and the experimental investigation. After the three investigations, there follows a discussion of three major issues: prediction of maximum temperature differentials, evaluation of thermal diffusivity, and minimizing radial temperature differentials. The discussion ends with the section of Conclusions, where each investigation is summarized first and then some practical applications of the results are suggested. The article concludes with acknowledgements and references.

The analysis of manifest intertextuality (Bazerman, 2004) of Khoury84 reveals that the total of 16 texts are referred to within this research article. The most multimodally dense section of the article is, unsurprisingly, Introduction. The section Experimental Investigation contains the second highest number of references to other texts (the total of 12). The sections which do not contain a single overt reference to other texts are Synopsis, Notation, Evaluation of thermal diffusivity, and Conclusions. The reference which is used most often is a PhD thesis written by Gabriel Khoury, the first author of Khoury84.

The analysis of the article in terms of visuals reveals that the total of 19 figures and 2 tables are used in the text and the largest numbers of these visuals are found in Experimental Investigation (13 visuals) and Numerical Investigation (10 visuals). A further comparison of the amount of the mathematical language used across the sections of the

texts indicates that the section Analytical Investigation contains 12 equations, the

subsection Analytical Investigation of the section Conclusions contains 5 equations, while

the remaining sections contain no equations at all. All the main sections of Khoury84

contain numerous numbers, often followed by the Celcius notation (°C). Table 6.3 below

summarizes the analyses of the textual features of Khoury84 across its sections and

subsections.

Table 8.2. Khoury84

Sections and subsections	N of references	N of figures	N of equations
Synopsis	0	0	0
Notation	0	0	0
Introduction	**14**	0	0
Analytical investigation	2	0	**12**
Numerical investigation (Introduction)	1	0	0
Mesh design	1	**1**	0
Binary conditions	0	0	0
Results of numerical investigation (no Introduction)	--	--	--
Development of temperature profile with time	2	**3**	0
Effect of length/diameter ratio	0	**3**	0
ΔT versus R, D, and a	0	**3**	0
Experimental investigation (Introduction)	**4**	**2**	0
Effect of end heating	**4**	**2**	0
Profile and characteristics of ΔT	**4**	**9**	0
Prediction of maximum temperature differentials	2	0	0
Evaluation of thermal diffusivity	0	1	0
Minimizing radial temperature differentials	1	0	0
Conclusions (Introduction)	0	0	0
Analytical investigation	0	0	**5**
Numerical investigation	0	0	0
Experimental investigation	0	0	0
Practical application of results	0	0	0
Acknowledgement	0	0	0
References	16	0	0

8.3.4. Primary reasons for reading Khoury84

Like Hugo, John read a comparatively dated text. While Hugo intentionally read an earlier text because it was highly circulated within the disciplinary activity system, John read Khoury84 for a different reason. In the period immediately preceding the reading episode John was busy with verifying several of his simulation studies. More specifically, he had simulated and calculated temperature distributions and was about to calculate thermal stresses needed for the simulation of the fracture process and the calculation of thermal cracks. His most immediate concern now was the verification of his results for which he referred to numerous publications detailing previous studies of concrete under thermal states. One of the publications he referred to was the research article "Radial temperature distributions within solid concrete cylinders under transient thermal states".

8.4. From operations to actions to social others

As in the previous cases, I will analyze John's reading at three interrelated levels, and I start the discussion of his textual operations.

8.4.1. Textual operations

When reading Khoury84 on the 16th of February 2003, John read it directly from one of his article compilations. It had marks of previous reading/s which John used at first as a means of scanning for specific information. After his initial scanning through the text, he read certain sections of the text in more detail and during this detailed reading, he left marks on the pages of the text by using pink and orange highlighters. Stimulated by the text, he additionally wrote notes on a separate notepad which he further continued developing over a period of several days. Keeping in mind this overall process, let us know examine the notes and the highlights as a way of understanding John's reading in terms of how he read and what aspects of the text he focused on.

8.4.1.1. Notes

Like Hugo, John's data involves two sets of notes: those he left on the pages of Khoury84 and those he later recorded on a separate notepad. The notes on the text had been left there by John on his prior reading of Khoury84. I will briefly present them here because they show what he had focused on during his previous reading of Khoury84 and what textual features he scanned for at the initial stage of this reading.

8.4.1.1.1. Notes on the pages of Khoury84

The first set of notes were left by John on the pages of Khoury84 during his initial reading of the text about a year ago. Table 8.3 summarizes these few notes. In the table, I give the notes in their complete form and indicate the number of the page on which each note is recorded as well as the textual segment to which it relates.

Table 8.3. Notes on the pages of Khoury84

Number	Page	Note	Location with respect to textual segments
N1	p. 146	36 (128) 1984, 146~156	Above the title
N2	p. 146	Temperature, moisture and stress gradients are the research objectives. They cause the structural effects and distort the material strain.	Connected, with arrows, to the second paragraph of the section "Introduction"
N3	p. 147	Problem: (1)dimension (2) heating rate	Under the section "Analytical Investigation"
N4	p. 149	$D=k/ec$	Under Figure 2 of the subsection "Development of temperature profile with time" (part of "Results of numerical investigation")

As we can see from the table, during his initial reading John recorded some important bibliographic information about the text (N1), summarized the main objectives of Khoury84 (N2), noted the problem addressed by the analytical study of Khoury84 (N3), and wrote down an equation describing a graph (N3). During his initial reading, John also singled out numerous phrases in the text by either circling or underlining them. These phrases are given in Table 6.5 below, where, as before, I indicate both the page number and the location of the phrase within the text.

Table 8.4. Underlined (U) and circled (C) phrases in Khoury84

	Page	Segment marked	Textual location
U1	146	Khoury	Last name of the first author
U2	146	Sullivan	Last name of the second author
U3	146	Imperial	In University of London: Imperial College of Science and Technology
C1	146	structural effects	Synopsis
U4	146	invariable material properties	Synopsis
C2	146	is at 58% of the radius	Synopsis
U5	146	structural effects	Introduction
C3	147	of 100°C	Introduction
C4	147	than 200°C were	Introduction
U6	147	functions of both time and temperature	Introduction
U7	150	settling time	Results of numerical investigation: Development of temperature profile with time
C5	151	L/d is greater than about 1 to 1.5	Results of numerical investigation: ΔT versus R, D, and a
U8	152	1984	Running head, the year of publication

The first three underlined phrases (U1-3) suggest that John paid a careful attention to the last names of the authors and to their affiliation when reading Khoury84 a year ago. In general, it appears he was especially interested in the synopsis and introduction parts of the text (U4-6; C1-4). He further noted some segments in the section detailing the results of the numerical investigation (U7, C5). As John explained to me, he usually focused on the introduction and results sections of research articles when reading them for the first time because he wanted to know what the authors of the research article aimed to accomplish and what they managed to achieve in their research. The notes and the underlined/circled segments show that during the previous reading John focused on the problem researched by the authors (C1, N2, N3) and the results they accomplished (C2, C3, C4, C5)

8.4.1.1.2. Separate notes

As has been mentioned above, while reading the text on the 16th of February 2003, John took some notes off the pages of the text on a separate notepad. These notes were further extended on two separate days that followed. Overall, about 5 pages written on

three separate days comprise this second set of notes; the notes are written both in English and Chinese and some of the pages contain graphs. Table 8.5 presents the basic information about the notes; for a complete set of these notes, please refer to Appendix 8.3.

Table 8.5. Notes recorded in the notepad

Date	Number of pages	Language	Number of graphs
16/02/2003	1.5	English	2
17/02/2003	2	Chinese	0
20/02/2003	0.5	English	1

As we can see, the notes on the 16th of February, the day of the reading, are recorded in English and contain 2 graphs. When comparing these notes to the sections of Khoury84, we can notice that the graphs John draws in his notes resemble two of the graphs in Khoury84: Figure 2 of John's notes is half of Figure 2 of Khoury84, while Figure 1 of John's notes is half of Figure 4 of the text. Both Figure 2 and Figure 4 of Khoury84 come from the subsection of the article entitled "Development of numerical profile with time" from the section "Results of numerical investigation". Upon further comparison, we can notice that the first sentence of John's notes closely resembles the first sentence of the same subsection in Khoury84. Table 6.7 juxtaposes the two sentences.

Table 8.6. Comparison of John's notes with Khoury84 (emphasis added)

John's notes	Khoury84
The thermal cracking by temperature gradient is formed occurred before reaching **settling time**, <u>after which the temperature increases at the same rate throughout the specimen's cross-section.</u> (p.1)	As predicted analytically, the relative radial temperature distribution develops during heating to reach, for invariant material properties, a fixed profile (Figure 2) <u>after which the temperature increases at the same rate throughout the specimen's cross-section</u>. (p. 149)

The notes dating to the 17th of February are recorded in Chinese, and as John explained to me, they were based on a Chinese text he read on that day. Finally, the notes dating to the 20th of February were left again in English and are not based on any text directly. This note, unlike the other two, has a heading, which says "Definition of settling

time". "Settling time" is one of the phrases singled out by John during his reading a year ago (see Table 6.5 above). It occurs both in the section of Khoury84 called "Results of numerical investigation" and in the first sentence of the first note John recorded on the 16th of February (see Table 6.7 immediately above). I will return to this set of notes in the sections that follow, when I analyze John's reading in terms of actions he accomplishes.

8.4.1.2. Highlighting

In addition to notes and other marks on the text, Khoury84 exhibits some highlighting. These highlights were left on the text by John during his reading on the 16th of February. Table 7.8 below presents these highlights in the following order: highlights in orange and highlights in pink. Here, the highlighted segments are provided within the immediate contexts of the sentences in which they are located. The section of the text in which the sentence itself is located is indicated in the last column.

Table 7.8. Highlights on Khoury84

Num ber	Page	Highlighted segment within immediate textual context	Section of Khoury84
Orange highlights			
H 1	p. 146	36 (128), 1984	Hand-written note
H2	p. 146	Radial temperature gradients develop within typical concrete test cylinders during heating and can introduce structural effects which distort the material strain response of the concrete.	Synopsis
H3	p. 146	A weighted average temperature was calculated which suggests that the most suitable location to place a thermocouple to measure the average specimen temperature is at 58% of the radius.	Synopsis
H4, H5	p. 147	The upper limits of radial temperature differentials obtained by previous research workers were in excess of 100°C (7) and in some cases (2) temperature differentials greater than 200°C were obtained during the heating of unsealed concrete specimens of 150 mm diameter at heating rates of up to 8-9°C/min.	Introduction
H6	p. 155	The corresponding temperature gradients at 0.2°C/min would be one-fifth of the value for the higher rate of heating and can be regarded as negligible.	Minimizing radial temperature differentials

Pink highlights			
H7	p. 152	Such temperature- and time-dependent transformations are indicated by an apparent transient increase in the specific heat of the material (13) and can be conveniently followed by techniques such as differential thermal analysis (DTA).	Experimental Investigation
H8	p. 156	The ΔT curves were, however, significantly influenced by variations in thermal properties during first-time heating which are caused by transient thermally activated physical and chemical transformations.	Conclusions: Experimental Investigations

As the table indicates, five orange highlights out of the total of six are located in the introductory sections of the text, while only one highlight (H6) is located in a later section, on p. 155. H1 is part of the bibliographic note John had left a year ago; H2, H3, H4, and H5 are highlights of phrases; and H6 is a highlight of a complete sentence. When we compare these highlights to the phrases which John had underlined or circled one year prior to the reading episode, we can see that H3 had been underlined, while H2, H4, and H5 had been circled previously. Additionally, H3-H6 contain numbers which appear to be some results of the authors' investigations. This analysis shows that John was still concerned with the textual segments he had identified previously and that numbers, in particular, comprised a major focus of his attention.

Both of the pink highlights, however, come from later sections, and both of them relate to the experimental investigation of Khoury84. While H7 comes from the section "Experimental Investigation", H8 comes from that part of the section Conclusions which summarizes the experimental investigation. The importance of these highlights was revealed in our text-based interview with John, during which he explained every single highlight he had left on the text. The information from the interview will be incorporated into the immediately following sections where I will revisit the textual operations in order to discuss some of the actions John accomplished by reading Khoury84.

8.4.2. From operations to actions

In Section 8.3.3, I have explained that on the 16th of February, 2003, John chose the text in order to verify his research results. As the analysis of the highlights shows, John did pay a careful attention to the results reported in Khoury84. Therefore, we can suggest that research verification was one of the actions he accomplished by reading the text. This, however, was not the only action he engaged in; the other two significant actions were developing a definition of settling time and preparing for writing. In the sections that follow, I will focus on each of these actions independently. I will use both the textual evidence from the previous section and the text-based interview (TBI, 20/02/2003) to analyze the actions.

8.4.2.1. Verifying simulation results

On the 16th of February 2003, John, in order to verify his simulation results, first scanned through Khoury84 for specific numbers. These numbers were easy to locate because they had already been circled or singled out in some other ways during the previous reading one year prior to this occasion (see his textual notes). The numbers he was particularly attentive to, John further highlighted in orange this time. When we discussed the highlights he left on this text, John explained each of the numbers he had highlighted.

Highlight 3 (H3) is the first highlight where a particular number appears. It is the textual segment "is at 58% of the radius" from the synopsis of the study. John explained that this is a result of the theoretical calculations conducted by the authors of Khoury84, and that he needed this result to compare to his own calculations. Highlights 4 and 5 (H4 and H5) within the section Introduction, are of numbers which stand for specific temperature differentials, and these numbers, as John says, are "very crucial" and come from numerical simulation studies. Highlight 6 (H6) comes from the experimental study reported by Khoury84. Here the highlight extends to include a whole sentence rather than just a phrase: "The corresponding temperature gradients at 0.2°C/min would be one-fifth of the value for the higher rate of heating and can be regarded as negligible." Regarding this

segment, John said, "*this part is very important. If my numerical simulation does not match with the results, my results is not correct*" (TBI, 20/02/2003).

Luckily for John, he found that his results matched those of both experimental and theoretical results mentioned in Khoury84. This finding meant a lot to him because, in a way, it acted as a confirmation that his understanding of the problem was "proper", or as he suggested in the following excerpt, that his simulations were "correct". He said, "*In comparison with this results, I found they have good agreement, so I am sure my simulation is correct*" (TBI, 20/02/2003).

John explained that making sure his simulations yielded reliable results was an important stage in his simulation studies. With respect to the particular simulation he had conducted before reading Khoury84, he said that he could not skip the stage of verification because it was a necessary requirement before he could move on to the next stage of his research. The next stage of his research was, in fact, his major research focus. It had to do with simulating and calculating the properties of the fracture process in heated concrete. Before simulating the fracture process and analyzing it, he needed to be sure that his simulation results for the temperature distributions and thermal stresses were consistent with the previous research. He said,

> **John:** *Before make the analysis of the fracture process, must finish the temperature distribution and thermal stress and also I should make verification.*
> **Researcher:** *And that's what you have been doing?*
> **John:** *Yeah... I think recently I just do this work.*
> **Researcher:** *Simulation and verification?*
> **John:** *Yeah right. Until now I think I am satisfied with the numerical simulation and also satisfied with verification.*
>
> TBI, 20/02/2003

When we were about to sum up the interview, John repeated that he was happy that his results were similar to those of the authors; he also insisted that the calculation of thermal gradients and stresses was not his end goal but rather a necessary stage in his move to the next stage—the analysis of the fracture process.

Interestingly, right after explaining that he needed to verify his results in order to be able to move to the next stage of his research, John introduced another factor which is important for understanding his reasons for verification. John engaged in the verification of his own results not only for his own sake and for his own personal comfort, but also, and probably more importantly, for the sake of communicating with others. The excerpt below is revealing of the wider social forces behind John's verification action:

> **John:** *So as you know, the temperature distribution and thermo stresses obtained by me is the same as theoretical. Now I put my heart. So as you know till now I think the reviewer cannot... to my model.*
> **Researcher:** *There'll be no criticism?*
> **John:** *Yeah right, because there is very good agreement.*
> **Researcher**: *You must be very happy?*
> **John**: *Yeah right. But because the fracture concrete fracture is a complicated problem, there is a few publication related to this problem. I think the reviewer must have to check my research. I should do verification and justification. Based on verification I think maybe the reviewers can accept the results of the fracture process.*
>
> <div align="right">TBI, 20/02/2003</div>

Some key phrases that highlight this excerpt are "the reviewer", "should do verification", and "accept the results". Though anonymous at the point of our discussions, for John the reviewer was a person (or persons) who would read one of the major final products of his PhD—his PhD thesis. For him, "the reviewer" was a key person that guarded his entry into the community of disciplinary researchers and could affect his acceptance by the others. Due to the stage of his PhD activity, John was highly aware of the presence of such "reviewers", and his interactions with Khoury84, though he was not immediately writing his thesis, were inevitably populated by his thoughts about "the reviewer".

To sum, John scanned through the pages of Khoury84 to verify the result of his simulations studies. He did so in order to move to the next stage of the research process and in order to meet the requirements of his future PhD thesis reviewers.

8.4.2.2. Developing a definition of settling time

Having ascertained that the numbers in Khoury84 were in agreement with his simulation results, John decided to read the text in more detail. While reading the text more carefully, John came across "*an interesting problem*" (TBI, 20/02/2003) and spent at least 3 days thinking and writing about it. The problem which captured his attention came from the results section of the numerical investigation. In the subsection of Khoury84 entitled "Development of temperature profile with time" under the section of "Results of numerical investigation", the authors use a phrase "settling time" in the last sentence of the section: "The settling time is consequently increased" (p. 150).

As I have mentioned before, John had marked this phrase during his first reading of the text a year ago, and on the 16th of February, was concerned with it again. As I have also shown in Section 7.3.1.1, John had a set of notes which he developed on the basis of this section of Khoury84. These notes span across three non-consecutive days and encompass abound five pages. On the 16th of February, his notes resemble closely the discussion in the section of Khoury84; on the 17th of February his notes are based on a Chinese text he read to enhance his understanding of the problem, and finally on the 20th of February, his notes end with a definition of settling time. John explains his concern with developing a definition of settling time in the following excerpt:

> **John:** *In this paper the author proposed a definition. I think it is very important for our research. The definition is the settling time. But they don't give detailed definition. So but so I want to make sure what is the settling time, so I write down something. It's just my viewpoint. So as you can see, the detail is settling time. Now in the future paper, in my future paper I want to make a clear definition of settling time. So I write down something. I think thoughts. And the next I will conduct another numerical simulation to confirm my definition.*
>
> <div align="right">TBI, 20/02/2003</div>

As we can see, John was unsatisfied with the fact that the authors of Khoury84 did not provide a well-developed definition of settling time. He took it as an opportunity to engage in his own development of the definition because he considered it would be a significant development for his research. He further planned to include his notes into a

future paper and to conduct another simulation study to confirm the definition he had developed.

To sum up, the role of Khoury84 in John's development of the definition of settling time was central since it provided him with the basis for his own definition. The role of the action itself in John's activity system is also central, and during our interpretative interview on the 7th of November 2003, John retrospectively suggested that in the long run this action of developing the definition was more important than the action of verifying his research results because it was a new contribution to the work of others in the disciplinary activity system.

8.4.2.3. Preparing for writing

As the previous section shows, John was already thinking of writing when reading Khoury84. As he explained to me, the notes he took when developing his definition of settling time comprised a stage of preparing for writing a paper in the future. He said,

> **John:** *I think writing a paper is simple process include prepare and then reading then taking note then write down paper. And if all this ok then I can make numerical simulation. So if the numerical results is what I want, so write up the full paper.*
>
> <div align="right">TBI, 20/02/2003</div>

This excerpt shows how reading Khoury84, writing the notes, simulating in the future, and writing a paper in the future are interrelated activities for John. In a way, both reading and writing notes are stages in the process of preparing for writing up a simulation study. Khoury84 in a way is a contributor to the content of John's future paper; the text, however, is also used as a source of specific language that can be reused in John's own paper.

When explaining his highlights, John said that he highlighted some sentences for the language used in them. Highlight 7 (H7) is part of the sentence, "Such temperature- and time-dependent transformations are indicated by an apparent transient increase in the specific heat of the material (13) and can be conveniently followed by techniques such as

differential thermal analysis (DTA)". Regarding this highlight, John and I had the following exchange:

> **John:** *I think the statement of the problem is very good, so I think I can use this statement, because this is not the author's view point, just objective factor.*
> **Researcher:** *Will you use the same words?*
> **John:** *Sometimes I also mark some sentences because I like the English. Maybe I can use English, just use other words instead.*
>
> <div align="right">20/02/2003</div>

The sentence is a description of the relationship observed between temperature- and time-dependent transformations of concrete and the heat level. To John, it is an "objective" observation rather than the authors' argument. This is the justification he provided for the possible use of the sentence in his own writing. If it were specific to the authors' argument and reflective of their point of view, he seems to suggest, it would not be as appropriate to use it in his writing. When I asked whether he would use the same words as the authors, John suggested that he would use the English but may change the words. Knowing that he is particularly concerned with the organization of writing rather than the vocabulary, I suspect that he meant he would change some words but would use the same sentence structure in his own writing.

The last highlight, H8, came from the concluding section of Khoury84 summarizing the results of the experimental investigation. It is the sentence "The ΔT curves were, however, significantly influenced by variations in thermal properties during first-time heating which are caused by transient thermally activated physical and chemical transformations". The phrase "physical and chemical transformations" shows that the sentence is related to the nature of concrete. John explained this highlight by saying that,

> **John:** *we are not expert of concrete technology, if I want to make a good discussion in my paper, I should know about the concrete not just related to temperature problem. … So I must get some good statement from the other people's publications.*
>
> <div align="right">TBI, 20/02/2003</div>

John suggests that because his knowledge is limited when it comes to physical properties of concrete, it will be good for him to use statements from other people's writing to enhance his own discussion. Both of the textual segments highlighted in pink relate to the experimental investigations. We should remember that John's work focuses on simulation research, yet he employs experiments as a validation tool for his simulations. Therefore, he will have to write about experiments as well in his PhD thesis. His focus on "good statements" about the nature of concrete (which is usually analyzed through experiments) can therefore be explained in terms of his future writing.

To sum up this section, the analysis of such textual operations performed by John as highlighting, underlining, and note-taking coupled with the interview data suggested that John's primary goal in reading Khoury84 was to verify his own research results with those of the authors. We see that reading did not stop with finding the satisfactory matches of the results; John continued to read and reread one section of the text with a purpose of developing the author's definition of the concept of settling time. Both of the actions of verification and developing a definition were situated in John's ongoing action of preparing for writing a paper, which would itself become a part of his PhD thesis. We see that his goals determined the kinds of textual interactions that John engaged in: to locate the numbers for verification, John had scanned for the underlined numbers, and left them highlighted. To develop a definition, John focused on a particular segment and wrote a set of notes over an extended period of time incorporating parts of the text as well as part of the visuals. His constant thought of writing led him to highlight sentences which he found potentially transferable to his own writing.

8.4.3. Social others in reading

At the level of operations, I focused on the analysis of reading as an individual event. When I moved from operations to actions, I began discussing social factors involved in reading. Thus, I highlighted the role of the authors and the future examiners in John's interactions with and around the text. In this section, I will revisit the issue of the social

others and draw a richer picture of John as a socially situated reader. I will show that John is conscious of both the more immediate members of the disciplinary activity system—the specific authors of the text, and of the more amorphous and less immediate community of the disciplinary activity system—other researchers in the discipline in general.

8.4.3.1. The authors of Khoury84

The most immediate others that can be traced in John's reading are the authors of Khoury84. As has been mentioned in Section 6.4.4, Khoury84 is authored by three researchers; two of them are affiliated with the Imperial College of Science and Technology and the other is affiliated with Central Electricity Research Laboratory. As has been shown in Section 7.3.1, John had underlined the last names of the first two authors and the word "Imperial" in the name of their institution upon his first reading of the text, before the reading episode described in this chapter. During the discussion of Khoury84, John displayed his awareness of the authors by constantly referring to them and by attributing the text to them.

John mentioned the authors without me having to steer the discussion into this direction, and he often used the single third person pronoun "he" to refer to the three authors. As it turned out, however, this was more of a mistake rather than an intention on John's part; later he used both "he" and the plural "they" when referring to the authors of the text. The authors emerged at various points in our interview.

In the following excerpt, for example, John started by evaluating the text in terms of its presentation and its content and moved to the evaluation of its authors. Thus, he said,

> **John:** *I think it's a good article because he gave a detailed and clear statement of heat transfer. I think it's very good article because the author they are maybe Britain they are from Imperial College. Imperial college is very strong in Civil Engineering. Actually, I like, what I like about this paper I think the author can give a very clear review, very clear and correct. Clear and correct review. So but at the same time, the author can use a simple model to explain a complex problem. So I think the author is very good.*
>
> TBI, 20/02/2003

In this excerpt, as we can see, John used the following criteria to describe the authors: their affiliation with the Imperial College, their ability to present a "clear and correct review" of heat transfer, and their ability to "use a simple model to explain a complex problem". During another text-based interview (27/02/2003), John and I discussed his reading of another text authored by the same researchers. It was then that John told me he liked reading articles written by these writers because they were "Big Professors", i.e., researchers who have established their names in the disciplinary activity system and are affiliated with famous institutions.

Thus, John appeared to be aware of the authors' research, their style of writing, and assigns them a particular status with the discipline. As I have shown in the previous sections, John will draw on these authors and their text to argue for the reliability of his research results, to develop a better definition of settling time, and to improve his writing in terms of English and content.

8.4.3.2. Authors of other texts

As the analysis of manifest intertextuality (see Section 8.3.2 above) shows, Khoury84 contains sixteen references within the text, and the most intertextual sections in the article are Introduction and Experimental Investigation. John did not mention any of the references used in Khoury84 and did not mark any of them on the References page. Interestingly, some of the sections he did mark on the text by highlighting them contain references to other sources. For example, as displayed in Table 8.7, highlights 4 and 5 contain specific numbers used by John to verify his research results. The authors of Khoury84 attribute these numbers to other sources, namely, to Anderberg and Thelandersson (1976) and to Thelandersson (1974). However, for John this fact did not appear to be of particular importance at this stage of his activities. There was no mention of the authors of intertextual references in our interview and there were no signs on the pages of Khoury84 that John that these references were important to John.

8.4.3.3. Reviewers

As has been discussed in Section 8.4.2, one major action John accomplished by reading Khoury84 was verification of his simulation results. It is with respect to this action that he brought in another social actor into our discussion—the "reviewer" of his writing. John explained that the reviewer of his work might need to check how well his results would agree with the results from previous studies. In a way, John engaged in verification to show to the reviewer that his results did agree with previous research, and John was satisfied because, as he said, "*Based on verification I think the reviewers can accept the results of the fracture process*" (TBI, 20/02/2003).

During our later discussions, John explained that he needed to persuade his reviewers (partly through verification of his results) because he was a postgraduate student. Interestingly, he compared himself to the established others who would not need to justify their research as much as he does. The following conversation took place between us:

> **John:** *I pay more attention to persuade someone, such as examiners, reviewers and to trust my results.*
> **Researcher:** *So that they can trust your results?*
> **John:** *yeah, yeah. But I think what is my purpose? What is my purpose? My purpose is to finish my research project. I think I trust myself. So I think what I do is right and proper. So it seems I needn't to persuade others, but actually everything I do in my thesis is try to persuade others.*
> **Researcher:** *Why?*
> **John:** *Because I want to get my PhD degree.*
>
> <div align="right">InterI, 07/11/2003</div>

Here John shows that he was particularly aware of his status within the disciplinary activity system and explained his need to be persuasive primarily because of the status he held. He further gave an example of a specific researcher with a particularly high status in the discipline whose presentation he once attended. He suggested that this researcher made a mistake about some specific issue during his presentation; however, nobody raised an objection to him because he was a "Big Professor". John continued to say, "*So he needn't persuade anybody because he is a Big Professor. I am not a Big Professor; I am just a*

PhD student. I need to get my degree, so with clear with clear tactic or aim I write my thesis" (InterI, 07/11/2003).

One role of Khoury84 in John's activity system then is that of a proof in his argument, an argument that he needed to present to his future reviewers. He felt he needed to engage in this argument particularly because he was a PhD student seeking to get a PhD degree.

8.4.3.4. Other members of the disciplinary activity system

As I mention in Section 6.5.2.2, John explains the significance of developing the definition of settling time in terms of contributing to the disciplinary community. He says,

> **John:** *As you know, there is not only me, the others also do same work...I know many people tried the same problem. So sometimes I should mention others' work. Actually, on the other hand, I should respect others' work, on the other hand, I think my research can get more new findings, I think.*
>
> TBI, 31/03/2003

From this excerpt, it appears that John is conscious of the other researchers who are working on problems similar to his. His aim, therefore, is to acknowledge that he is aware of them and also to suggest that his research may be better than theirs in certain aspects.

8.5. Conclusion

In this chapter, I first analyzed John's reading of Khoury84 in terms of the textual segments he attended to and in terms of the actions he accomplished. Here I demonstrated that John read the text for the most immediate goal of verifying his research results and therefore focused on specific numbers used in Khoury84. I also demonstrated that John's actions were not limited to the verification of his simulation results. He attended to both the content and the language of Khoury84 as part of developing his definition of settling time and preparing for writing his future paper.

Second, I analyzed John's reading specifically in terms of the social others. Here, I showed that John was particularly aware of two groups of social others: the authors of the text and the future readers of his own writing. I further highlighted that John was highly

conscious of his status as well as the status of the authors in the disciplinary activity

system and that his reading of the text was situated in a persuasive argument with the

future reviewers of his PhD thesis. I suggested that John's strong desire to meet the

perceived requirements of his future reviewers/examiners fostered and ran as a red thread

through his interactions with Khoury84.

This was the last in the series of detailed case studies of individual students' reading

academic texts. In the next chapter, I will present some major themes which emerged to be

important across these as well as the remaining seven cases (Chapter 9).

CHAPTER NINE: Overall findings and discussion

Figure 9.1 introduces the three major common themes that arise from the data: intertextuality, multimodality, and interactional networks in postgraduate reading. It further highlights some of the issues that will be raised as a result of the findings and their interpretations.

- Pg reading as unbounded to one text
- Pg reading as reading intergenerically
- Pg reading as linking texts of others' to self-authored texts

- Pg reading as unbounded to linguistic modes of semiosis
- Multiple modes as interacting in Pg reading

9.3 Multimodality

9.2. Intertextuality

Interactional networks 9.4.

- Pg reading as situated in social interactions with
  - Supervisors
  - Authors of texts
  - And multiple activity systems

Figure 9.1. Preview of Chapter 9

9.1. Introduction

In the preceding chapters, I laid out the methodological foundations of this study, the analytical framework employed for the analyses of the data, and 4 case studies. The first thing that stands out from the four cases presented in the previous chapters is the diversity in the ways in which students approached their reading and accomplished their goals. Activity theory provided a useful framework for examining these differences. The concepts of operations, actions, and activities which form the basis of this framework allowed me to capture different levels at which reading in context can be defined and to understand the differences between seemingly similar reading settings.

In addition to highlighting the diversity which is bound to arise from naturalistic case study research, this PhD study additionally aims to understand whether there are features which would be characteristic to postgraduate reading across cases. This chapter brings together the observations from the eleven case studies in a discussion of three aspects of postgraduate reading. Three themes that seem to be the common thread across the cases are intertextuality, multimodality, and impact of social others. The chapter relates the findings to the ongoing discussions in the fields of advanced academic literacy and reading research. It further highlights the need for more contextualized studies of reading which, it is hoped, would investigate the issues presented here in more detail. As in the previous chapters, the discussion in this chapter relies on the activity theoretical concepts detailed in Chapter 3 of this thesis.

9.2. Intertextuality in reading

Intertextual reading, defined as bringing in other texts into the reading of one, was a major finding derived from the case studies described in this thesis, as summarized in Table 9.1 below. In this section, I will draw on the remaining cases to show that intertextuality was not limited to the four cases and that intertextual reading should be considered a major characteristic of postgraduate reading in general. Several studies have recently conceptualized reading as an intertextual activity in which readers rely on and

bring in multiple texts authored by others into their meaning making interactions with one text (Hartman, 1995; Chi, 1995; Penningroth, 1997; Strømsø and Bråten, 2002). The findings of this study contribute to the previous discussions of intertextual reading and additionally suggest the need to extend the parameters of intertextuality to include students' own texts.

Table 9.1. Intertextual reading across the four cases

Student	Text	Other texts
Joanna	A general textbook	• comparison of textbook to research articles in terms of critical reading
Hugo	a famous research article	• frequent reference to the bibliography page • reading the bibliography page at the end of the reading episode • bringing in other texts into reading • motivated to read based on other texts
Dewey	a review article by a co-supervisor	• reading the bibliography page after the reading episode • mention of the author's other texts during the episode
John	a research article	• constant references to his own texts

As a starting point for the analysis of intertextuality across the remaining cases, I traced the origin of the texts the students brought into the reading of their primary text. Two categories similar to Hartman's (1995) endogenous and exogenous sources emerged: (1) texts which were mentioned in the primary text through references and citations and (2) texts which were not mentioned in the primary text but which were still brought into the actions of meaning making. Within the last category, the students' own written texts emerged as especially crucial.

With respect to the first category, the main conclusion is that while in some cases, references and in-text citations afforded students' abilities to extend their engagement with disciplinary activities through further reading, in other cases, references and in-text citations constrained students' interactions with a single text and led to significant frustration. With respect to the second category, two major findings emerge: (1) the importance of different genres in reading and (2) interactions between reading and writing.

These major findings will be discussed in this section of the chapter and Figure 9.2 presents a summative overview of the core themes which were identified.
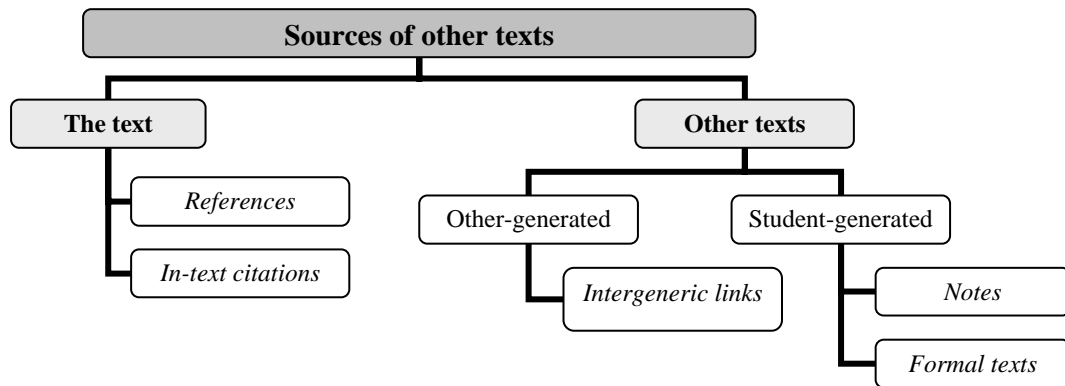
Figure 9.2. Aspects of intertextuality in the students' reading

9.2.1. Interacting with references and in-text citations

Lists of references (also called Bibliography, Works Cited, etc.) and in-text citations present the most manifest form of intertextuality in academic writing of various genres and especially in research articles. Here, I will start by looking at the students' interactions with lists of references. As expected, reading lists of references when reading research articles was a common operation across the cases in this study; however, the timing of this operation was different across the cases, and the operation contributed to different actions for the different students.

9.2.1.1. Reading references before the main text

Two students, Mike and June, engaged in reading the lists of references at the initial stages of encountering their texts. The analysis of the data reveals that the two students shared the following:

(1)   both of them considered themselves to be relatively experienced researchers, and while Mike had worked as an experimenter within mechanical engineering for 3 years, June had been involved with research in applied biology for more than a decade;

(2)   due to their previous interactions with the respective research activity systems, they displayed knowledge of certain researchers in the disciplines and recognized names of various authors; and finally,

(3)   both of them expressed a concern with efficiency in reading and the need to save time by carefully selecting what to read.

Both Mike and June relied on these lists when deciding whether they should proceed with the reading, and the operation of reading the references thus contributed to the similar actions of decision making for the two students. The lists, in conjunction with other factors such as the title and headings, the names of the authors, the figures presented in the text, allowed these two readers to predict how interesting and useful the text might be for their immediate goals, a finding previously observed by Bazerman (1985; 1988) in his study of expert physicists' reading.

June and Mike differed with respect to the kind of information textual references afforded them. Mike was concerned with expanding his knowledge of disciplinary developments which he could further utilize in his own research; therefore, he preferred to read texts which contained information new to him. In his pursuit of novelty, he did not see it useful to read texts which contained primarily references which were already familiar to him. June, on the other hand, was concerned with incorporating other researchers' findings, research methodologies and experimental set-ups in her own experiments. Like Mike, she recognized names of individual researchers and research groups, but unlike Mike, her maps of disciplinary researchers (her intertext, in Perfetti et al.'s (1999) terms), in addition to names and basic information about their research, contained another important piece of information—research validity and trustworthiness. Thus, she consulted the lists of references before reading a text in order to check whether the text incorporated findings from studies with questionable reputation (those of Mainland Chinese research groups, in particular). While studies of academic writing show that academic writers often utilize references to other texts to establish their credibility within disciplinary communities

(Latour, 1987; Hyland, 2000; Myers, 1990), this case shows that the postgraduate reader is able to use the references in order to judge the credibility of the text.

What the two cases together show is that at the very outset of reading, students may base their decisions to read or not read a text, to trust or not trust its methods, results, and conclusions on the basis of the references which the text relies on. Though, according to the order of placement within the research article, references come at the end, for the reader the references may be as important as the title, the names of the authors, and the abstract, which are given in the beginning.

9.2.1.2. Reading references after the main text

Though only two students engaged in reading lists of references before reading the main texts, almost all the students engaged in reading references after reading the main text. This was an operation which contributed to the same action in the cases where it was observed—to the action of planning future readings, which, in turn, related to the students' goals of extending the knowledge of the disciplinary activity systems they interacted with. Lists of references were always consulted when the text was deemed to be interesting and relevant to the student's engagement with ongoing activities. Interestingly, even when a text being read was found to be irrelevant and uninteresting, some students still read the list of reference explaining that they did not want to miss a text which might be useful. Amy, Jim, Lora, and Mike were particularly adamant about this issue.

There were two students, John and Fred, who did not read lists of references. To explain this lack of interest in references, I analyzed what actions comprised their reading and what activities those actions were part of. The two were engaged in similar activities: John at this stage of his PhD activity system was busy with writing up his papers (for a future inclusion into the thesis) and Fred was extremely busy with writing up his confirmation report. Both of the students did some reading, but they read the texts which they had read before and which they had noted previously for incorporating into their own texts. Unlike the other students, they were not concerned with extending their maps of

other disciplinary texts; instead they were concerned with integrating the texts they were already familiar with into their own writing.

9.2.1.3. Interacting with in-text citations

For Mike, Amy, and Sam, interacting with in-text citations was characteristic of reading research articles. Mike displayed kinds of interactions which were very similar to those of Hugo (see Chapter 5) in that he utilized in-text citations as tools for locating useful readings. Amy and Sam also saw citations as potentially leading to future readings; however, they were different from both Mike and Hugo in that they reacted to these citations negatively.

Mike was reading an abstract of a research article which justified the research on the basis of health concerns triggered by diesel particles. He noticed that there was no reference to justify these concerns and raised this issue as being important. He immediately switched to the list of references to check whether there was any relevant publication and found that the list was structured so that the information about the texts included: author/s, name of the publication, year, issue, and pages. The title of the actual text was left unspecified. His comments displayed his dissatisfaction especially obvious in his final remark: *"deprived of the name"* (TA, 10/03/2003). Afterwards, Mike referred to the list of references two times more, after coming across two in-text citations which he thought important for his own work as well. He marked these two texts on the page containing the list of references and said he would read them later.

Unlike Mike, Sam and Amy found the intertextual nature of academic writing difficult for meaning making. Since I consider it an important finding for our understanding of postgraduate reading and enculturation, I will present these students in more detail. For them, the heteroglossic nature of the research articles they read was a visible obstacle on the road of learning which led to double-bind situations. On the one hand, the students perceived a strong need to understand the full details of the texts they

read, and, on the other, they knew they could not understand everything no matter how hard they tried.

Amy and Sam were first-year PhD students of the Department of Land Surveying and Geo-Informatics. Amy was in the middle of her preparations for the guided course on image processing in remote sensing. According to the rules of the activity system of the course, she engaged in independent learning about various computational indices in remote sensing through such tools as texts and software manuals and had to display the knowledge of the material she learned by presenting an analysis of several indices in a paper. Reading research articles comprised a major action in her engagement with the assignment. It did not take her long to realize, however, that she was having major problems with her readings. She voiced these problems several times in multiple interviews, during one of which she explained:

> **Amy:** *The reason why it's not easy, I am reading from the top. The recent journals, not the back copies. The recent ones are built on the back copies. Assumptions of what has been done before. This paper refers to this paper, that's why I got this paper. This is another index. Much simpler than this one. You have to read all these if you want to get a whole picture.*
>
> <div align="right">TBI, 02/03/2003</div>

Concerned with getting the "whole picture," Amy attempted to read up as many articles as she possibly could. However, constrained by deadlines and her lack of familiarity with effective search skills, she was not able to read as much as she had hoped to and had to submit the assignment, feeling that she had not prepared well for it. In his feedback, the instructor of the course suggested that Amy go back to some indices and analyze them in detail rather than provide a description of them. At that stage, Amy decided to go back to some earlier articles, saying the following:

> **Amy:** *The older issues will tell you, for example, the beginnings of those indexes, or the development, which one developed after another. Or why, what was. Because usually they give you a reason why they have developed another one…it's much easier to understand because the mathematics, the development hasn't reached a complex level. Because really now it's so complex, that what they do is just sort of rush over it, a lot of things they brush over. You get a lot of formulas, a lot of whatever, you know. And they just sort of tell you, instead of going step by step, they just assume you know everything. And they assume that maybe because somebody has written back issues,*

somebody has done something on it. Or they just refer you to it. They give you the name of the authors of the articles. In Hafa 96, or Hafa whatever, definitions of etc. etc. They don't even tell you what it is.

<div align="right">TBI, 07/040/2003</div>

Eventually, Amy managed to complete her assignment satisfactorily; however, she engaged in the task with feelings of desperation and often helplessness. What her case highlights is that, though she was aware of the socially constructed nature of scientific knowledge and of the corresponding academic writing practices which often allude to previous developments instead of explicating them, as a novice to the activity system, she found the allusions to common knowledge and references to previous work extremely frustrating. She felt the need to uncover what was left unsaid in the research articles by tracing the references and going back to the earlier issues of disciplinary journals. Along the way, she found the process rather exhausting and time-consuming. Sam, her fellow PhD student, was experiencing similar problems.

Sam's supervisor suggested (or "ordered", in Sam's terms) that he should read a research report which could be potentially useful to his development of his own PhD object—a method for modeling atmospheric behavior. Sam's interpretation of the suggestion was that he was to read the text and report to the supervisor (1) what he had learned about the method presented in that text and (2) how this method could be adapted to his own PhD research. With these goals in mind, Sam read the same text three times and felt very dissatisfied with it. In our interviews, he was bitter about the whole endeavor, said that the text was too difficult, and at the end did not know what to report to the supervisor. The problem lay in the following:

> **Sam:** *The paper is so difficult because the method is ignored. Because just many many summary about the method. No detail. So I must search the method from different. Because some this method is just mentioned. Many many like this* (**pointing to references**). *If you want to understand the whole condensed actually in details, you must read some of the references mentioned here. I just researched it but can't obtain from the library. So this journal can't be gotten from PolyU library. I have booked it in interlibrary. Maybe in one month I think.*

<div align="right">TBI, 01/03/2003</div>

As this excerpt reveals, Sam could not understand the method presented in the research report because the author often referred to external references and presented brief summaries, rather than detailed explanations, of other texts. Sam felt he needed one particular reference (a previous publication by the same author) in order to understand the research report given to him by the supervisor. In his attempts to get a hold of the text, he submitted an interlibrary request; however, three weeks later he still had not obtained it and decided to give up on the idea of modifying the method for his own PhD.

What the two cases of Sam and Amy collectively show is that references to other texts do not always act as part of centripetal forces within disciplinary activity systems for the postgraduate students who aim to learn about and contribute to these systems in the future. For some students, especially those at the initial stages of their interactions with disciplinary activity systems, these references to other sources may be perceived as stumbling blocks and therefore act as part of centrifugal forces pushing these readers away from disciplinary communication and preventing them access to intertextual conversations. Even if the postgraduate students were able to recognize the intertextual links, they were not always able to draw on them for their own purposes because they did not have the knowledge of these texts, and as in the case of Sam, did not have even an access to some of them.

If we go back to the cases of Hugo and Mike and compare their interactions with the multiple references in the texts they read to the interactions of Amy and Sam, the construct of affordances (Gibson, 1979; van Lier, 2000) becomes important. We see that the same textual elements such as references to other texts may be perceived differently by different readers and therefore may lead to different actions. Hugo and Mike saw these references as affordances which allowed them to extend their repertoires of disciplinary texts and plan their future readings. Sam and Amy, in the contexts of their activities, could not think of references in their texts as affordances and instead reacted to them as to obstacles which constrained rather than enhanced their meaning making processes and interactions.

9.2.1.4. Summary

Studies interested in how academic writers engaged in "the rhetorical construction of readers" (Hyland, 2001, p. 551) have tended to discuss intertextual references in terms of the author aligning himself with the reader, and accordingly, references to other texts have been viewed as constructions of solidarity (Thompson, 2000; Thompson and Tribble, 2001; Hyland, 1999; 2001). However, what this study shows is that the intertextual nature of the genre of research articles may not culminate in feelings of solidarity for the reader who is a novice postgraduate student. In terms of advanced academic literacy needs of postgraduate students, the study suggest that there is a need to turn the tables and ask not only whether an ability of making appropriate references to the literature should be considered a feature of successful writing (Thompson and Tribble, 2001) but also (1) whether an ability to recognize and utilize the heteroglossic nature of academic texts should be considered a feature of successful reading and (2) whether this ability needs to be taught explicitly.

As Turner (2003) convincingly argues, advanced academic literacy today is no longer limited to an ability of an individual student to rely on her own powers of reason. The analysis of intertextuality in postgraduate reading supports Turner's (2003) argument and shows that the students engaged in such meaning making actions through reading which were both uniquely individual and social. The meanings they created depended on other meanings created by others in other times and places (Lemke, 2002) and meanings which became apparent to the students through the traces of other texts and their ability to bring in their own experiences with yet other texts into the reading of individual texts. On the basis of the study, I would argue that advanced academic literacy entails awareness of the communal nature of knowledge creation and an ability on a student's part to develop a textual map of the community within which academic texts are circulated. An availability of such a textual map could be crucial in the students' ability to deal with textual products of research communication and to participate in disciplinary knowledge creation.

9.2.2. Reading intergenerically

In several cases, reading one text was inseparable from reading other texts, which were not mentioned in the primary text. A major theme which emerged through these cases is the issue of relying on different genres in reading. Four students, Amy, Sam, Lora, and June, for whom reading involved mixing and interacting with multiple genres rather than one, will be presented in this section. Throughout the section, I present two tentative findings (1) that intergeneric reading is an essential feature of postgraduate reading and (2) the importance of various genres in reading may increase with the advanced in Internet technology. I will additionally suggest that being able to access and rely on genres such as textbooks, manuals, and theses may provide students with the zone of proximal development in which they can better interact with such primary texts of their disciplinary activity systems as research articles and reports.

9.2.2.1. Student cases

Amy was engaged in two parallel activity systems: a guided course (as described in the previous sections) and a task assigned by her supervisor. As part of engaging with the two activity systems, Amy read various texts, one of which, a textbook on image processing in remote sensing, became important for both of the systems and beyond them. The textbook was first used by Amy as part of her guided course on image processing. Then, she selectively read chapters from the textbook which were most relevant for her engagement with the written assignment of the course which required that she analyze various types of computational indices used in remote sensing. Only after reading those chapters did she feel ready to read research articles which dealt with specific computational indices.

The task assigned to Amy by her supervisor required that she learn certain software. The first stage of engaging with the task involved reading the software manual. To our interview, Amy brought a printout page from the manual and began her description of reading it by pointing to the sentence: "Please refer to an appropriate reference text for

complete information on classification." Her reaction to this sentence in the manual was that of disappointment, and her major comment was: "*If you decide to do anything with this software, just by doing it, you really won't get much out of it, you won't understand much of what you are doing unless you know the textbooks*" (TBI, 7/04/2003). Amy read the relevant sections from the same textbook mentioned above before attempting to read the manual again. Eventually, the textbook became part of Amy's learning beyond the course and the task, and she decided to read every chapter of it. She even borrowed two copies of the textbook from the library, and while she kept one of them in the office, she kept the other at her home.

The importance of the textbook in Amy's reading and her constant reference to it can be explained by the fact that Amy was a novice to the discipline of image processing. As a novice, she felt the need to "*get the principles*" (TBI, 02/03/2003) of the field, and the textbook provided a repository of these basic principles. Without knowing these principles, Amy felt disadvantaged and uncomfortable, and her reading of other genres was preceded by reading this text.

Sam was engaged in learning about and evaluating some of the models used in ground point determination in GIS, as part of which he read software manual to understand the model forming the base of this software. In his reading, he realized that the manual was missing one piece of information which was very important to him—it did not explain the associate Legendre function which was crucial to the model. Only by combining information from the manual, the Internet, a PhD thesis, and a textbook was Sam able to understand the function and eventually program it. In a somewhat linear fashion, I present his intergeneric reading in Figure 9.3 below. Here, I show that after reading each text, Sam managed to understand a certain aspect of it (indicated as "Known" in the figure) and formed a question which triggered his next steps ("Question" in the figure). The main texts read are presented in boxes with numbers indicating the stage in the process. Thick grey arrows contain the tools Sam used to locate texts for next reading. The whole process was

concerned with understanding issues related to the associate Legendre function, shown as ALF in the figure.

1.
Manual

Google

2.
www pages

List of references in the manual + Google

Known: missing information
Question: What is ALF?

Known: many kinds of ALF
Question: Which kind is meant in the manual?

3.
PhD thesis by one of the authors of manual

4.
Help pages

Metlab software

Known: the kind of ALF
Question: How to program this function?

Textbook in Chinese

Known: different coefficients used
Question: Which coefficient should be used?

5.
Section of the textbook chapter

Figure 9.3. Sam's intergeneric reading

As the diagram clearly indicates, Sam read several texts of various genres to explore various questions. His reading of these texts was very specific because, unlike Amy, Sam was interested in finding specific information and had specific questions which guided his interactions with these texts. Through the integrative reading of these texts, Sam was able to understand the function used in the model and finally knew how to program it.

Like Sam, Lora used a variety of sources including Internet texts to study for her course on mathematical modeling. This course was an important part of her PhD activity system because she had to rely on mathematical models in her development of a model for controlling manufacturing processes. Like Amy, Lora felt she was a novice to the field of mathematical modeling and therefore did not understand everything in her lecture notes, the primary texts for the course. In addition to directly approaching her class instructor, she engaged in constant and active search for more information on the Internet. Through integration of her class notes and Internet texts she was able to understand the course materials and prepare for her homework. Unlike Amy, Lora did not use textbooks but

instead relied on Internet because, as she explained, it provided a direct access to very specific information.

While Amy, Sam, and Lora were concerned with extending their knowledge of the activity systems of disciplines which were directly relevant to their PhD studies, June was reading up about genetic research, the disciplinary activity system which (1) was not focal to her PhD activity system at the time and (2) was new to her. She read in preparation for her future and only possible engagement with this activity system. She began by reading research articles assigned in the course on genetic research she was taking; however, since she did not understand the chemical aspects of genetic research, she had to rely on various textbooks. Her interactions with the textbooks were somewhat different from those of Amy. If Amy felt a very strong need to read the textbook and was somewhat stressed, June was more relaxed and did not report spending too much time on it.

9.2.2.2. Summary

What tentative conclusions can be drawn from the four cases described above about postgraduate reading? Overall, we can say that meaning making through reading is multi-faceted in that it is not limited to one text and to texts of the same genre. Rather, we see that relying on multiple genres may be crucial for postgraduate students in certain contexts. In this study, novice students' reliance on textbooks was particularly obvious. Within advanced academic literacy research, it has long been suggested that textbooks act as mediators of novice scientists' development and initiation into disciplinary communities (Myers, 1992; Swales, 1995). It appears that Internet is used by some students as a tool for accomplishing the same goal. In addition to containing enormous amounts of information, it also provides the students with tools for locating very specific information which can be especially important in certain contexts.

Activity theoretical discussions of tools may lead to further insights into postgraduate students' reliance on texts of multiple genres. Lantolf (2000) in his argument that mental activities do not have to remain as exclusively internal mental operations, gives

examples of individuals who, working on a difficult task and perceiving it important to persist in completing it, may refer for some external help to either people or artifacts made available to them by society (p. 15). What we see in these examples are the students referring to the symbolic artifacts available to them in order to successfully attain their reading goals. They need external help or mediation in order to successfully engage with the tasks they have, and this mediation can be provided by the textbooks and other genres made available to them by disciplinary activity systems.

If we think of the same issue from the perspective of the zone of proximal development (see Chapter 3, section 3.8), we see that there is a difference between what the student can accomplish when reading the text without external references to other mediational means and what the same reader can accomplish when reading with support from other texts.

9.2.3. Students' own texts

Another aspect of intertextuality, student-generated texts, will be discussed in this section. The data show two categories of such texts: textual notes and formal writing. The findings suggest that being able to situate own texts within the texts of others might be crucial for advanced academic literacy and disciplinary enculturation.

9.2.3.1. *Self-generated text-based notes*

Students' reliance on their own reading notes has been discussed in some detail by Strømsø and Bråten (2002) who observe that students used notes to reconstruct their previous understanding of texts and modified their notes upon their further reading. Similar to Strømsø and Bråten (2002), this study reveals that self-generated notes were very important to the postgraduate students and the notes were often left for future re-readings. The study provided additional insights about student-authored textual notes and these will be discussed in more detail below. As was expected from the analyses presented in Chapters 4-7, the notes across the remaining seven cases also differed along such

parameters as the content they chose to note on, the amount and kind of information they included into their notes, the structure of their notes, as well as the function the notes performed.

9.2.3.1.1. Student cases

For Amy, taking notes was a way of getting involved and interested in the reading. While preparing for writing an analysis paper about computational indices mentioned above, Amy concurrently engaged in the action of reflecting on her reading habits and looking for more effective ways of reading. She discussed her notes with respect to her search for effective strategies, as is evident in the excerpt below:

> **Amy:** *My reading behavior is not very good. I've read this paper once, but to read it I have to sit down, read it, put it down, read it again the same place. Just to settle in. It just won't happen the first time. Then I tried making highlighting and notes. Just read and make notes at the same time, just on a piece of paper. Separate piece. What I've read, how I understood it, and write it. The most effective method for me.*

<div align="right">

TBI, 02/03/2003

</div>

At this stage of her studies, Amy's notes were taken off the pages of the texts she was reading (similar to John's notes), and the notes included primarily summative information regarding the indices she was reading about. Though an evaluative aspect was seemingly absent from these notes, they still stimulated a deeper engagement for the student with her reading and her larger task.

Unlike Amy, June had already developed a rather complicated system of note-taking when reading research articles as part of preparing for her meetings with students in China. The process of note-taking overall involved several stages. First, during the initial reading of the research article, June used a pencil to underline segments and make notes. Here she relied on shorthand, signs such as a star or an asterisk, and occasional English words. Second, after the initial reading, she looked through the notes and evaluated which ones were important and which ones were not. She explained: *"The first reading too many new information for me. But when I finish all the paper, only 3 or 4 points is necessary for me.*

Then maybe I will go back and clean it up. Next time when I read the paper, it is only the really important points for me" (InterI, 15/03/2003). Thus, after reviewing her notes and erasing those which were not as important, June left a few notes on the pages of the text, which were meant for future readings.

The second stage of note-taking could evolve into the third stage which involved writing longer notes. These notes were left only on those articles which June found important for a discussion with her students and included particular issues she wanted to raise at the meeting with them. They were left on the most visible parts of the articles: the top left corner of the front page. To sum, June kept notes (1) for herself and for her meetings with students; (2) to note important information concurrently with reading and to note information for future rereading.

Though Lora's texts contained marks and notes of different kinds (i.e., keywords containing short phrases, Chinese translations of specific words, numbers to point to issues discussed in an order) just like in June's case, these were left for the purpose of future reading. Similar to June as well, upon completing reading, Lora noted the most important points by writing them in the top right corner of the first page of research articles. This operation was part of two actions for her: (1) preparations for meeting her supervisor who often asked her what she had learned from her readings and (2) preparations for writing a literature review.

Sam's and Mike's notes had one aspect in common: both of them engaged in extensive calculations on the pages of the texts they were reading and thus, their texts displayed a site of intense mathematical reasoning. Sam's notes are also interesting because they contain very few words but numerous question marks (and even the few words present questions). For Sam the notes appear to be a place of recording issues stemming from his reading. His focus on questions has been highlighted above as well when I discussed his intergeneric reading. His notes further highlight that his reading was accompanied with intensive questioning.

Mike's textual notes stand out from the others' not only because they contain numerous calculations but also because of their abundance. Mike maintained that for him texts were "tools" (his usage of the word) and as such they provided him with a space to think and record his thoughts about the text being read and its relevance to his own research. His notes, consequently, contain (1) points summarizing the contents of the article, and (2) issues of significance to his PhD experiments. Mike explained that he often started thinking of his own experiments based on the text he was reading and when the issues were too pressing, he would continue to think about his experiments by thus almost forgetting about the text. His concerns with his experiments and his work found their way into his extensive notes on the pages of the texts he read. One set of these notes is particularly important and is presented in Table 9.2 verbatim.

Table 9.2. Mike's notes

Line	Note
1.	Objective: what needs to be tested
2.	→how must the experimental set-up be prepared?
3.	NOT: we could do this, we could do that….
4.	→setup must be planned, parameters to test must be determined before!!
5.	Responsibility: do I have to do everything on my own?
6.	Just particle coagulation is not enough (not real)
7.	Software, air condition, CAD stations, copied software

As Mike explained to me, this particular text was read close to the time of the meeting with the supervisor and Mike had urgent issues to discuss with him. These issues emerged as notes which were recorded on the back of the first page of the article. The points he prepared to raise with his supervisor contain arguments (1-4 and 6), a question (5) and complaints about certain issues he observed in the research students' office (line 7).

Jim's notes were not as numerous and contained short keywords for main points. An interesting aspect of his note-taking practices, however, is a drawing he constructed on one of the articles. This was an article he was going to utilize in his own writing and the model needed to be modified to account for a more complex electric structure. Hence, Jim used

the graphic presentation of the model from the text to extend it into a new graph representing a more complex structure which he was going to utilize in his own article.

9.2.3.1.2. Summary

The study of the 6 students' note taking practices presented above reveals the following functions of textual notes and note-taking:

- as signposts for future re-reading and writing;

- as sites of intense thinking, including mathematical reasoning;

- as a tool of engagement with the text; and

- as operations involved in preparing for meetings with supervisors and others.

Though more research needs to be conducted for more definitive conclusions to emerge, I can tentatively suggest writing notes while reading is a major aspect of advanced academic reading, a finding which supports previous observations by Strømsø and Bråten (2002) and which is strengthened by studies of reading and writing connections (Grabe, 2001; Johns; 1997; Carson, 2001).

Vygotsky's (1978) notion of inner speech may provide an additional insight into the importance of notes in the cases presented above. In brief, the notion of inner speech implies that speech, in addition to its communicative function, carries private uses as well (Vygotsky, 1978; Appel and Lantolf, 1994; Wertsch, 1998). Academic writing has often been analyzed as a social activity carrying interpersonal communicative functions. It appears from this study that writing in academic contexts can also be highly private and that textual notes are one kind of private writing. This kind of private writing regulates the students' current engagement with reading as well as their future engagement with future reading, writing, and interpersonal meetings.

With respect to advanced academic literacy research and practice, the findings suggest that textual notes might be an important area of analysis for future studies in that they might provide a missing link between texts students read and knowledge they gain on

the basis of reading. In terms of practice, they suggest that there might be a need for more instructional emphasis on notes as means of stimulating deeper engagement with texts and reading.

9.2.3.2. Students' formal texts

Another aspect of intertextuality in postgraduate reading which emerged from this study is making links between texts being read and formal texts being written. As Chapter 2 shows, research into reading and writing connections has long been interested in how reading and writing impact each other (see, for example, Leki, 1993; Johns, 1993, 1997; Carson, 2001; and Grabe, 2001, 2003).Though this study did not aim to research reading and writing connections per se, due to the naturalistic nature of its design and due to its focus on postgraduate students, it is unsurprising that writing emerged to be linked in important ways with reading.

The cases of this study show that reading was an input that was important for the students' engagement with writing (Krashen, 1984), and as such it provided them with tools for organizing their own writing and with content to be included into their texts. On the other hand, writing tasks and goals affected the students' choice of reading and their setting of reading goals.

9.2.3.2.1. Student cases

Jim, Lora, Fred, Mike, and John were all engaged in writing their own academic texts. Jim was revising his PhD proposal. Lora and Mike were writing their literature reviews. Fred was frantically trying to finish his PhD confirmation report. Finally, June was reading to construct her experimental protocols. Different aspects of reading-writing connections emerged as a result of these different activities.

Jim's writing experiences in English were rather limited. His initial proposal which he had to write when applying for the program had to be re-written by his supervisor who he had known previously. At the moment of our interviews, he was in the process of

writing and revising a more detailed PhD proposal. This time, he was writing on his own though his supervisor continued to play a major role. The first draft of the proposal was disqualified by the supervisor for many reasons, one of which was the organization employed. In order to assist his student, the supervisor gave him a model proposal which he himself had written for another project. In his reading of this model proposal, Jim narrowly focused on the format of writing and imitated the style used by his supervisor. He said that he spent less than an hour reading it and based on the model, revised his own proposal to include subheadings, more explicit introductory sentences and links between sections.

Whenever Lora discussed her reading of research articles, she often brought up the issue of writing a literature review. She said that after reading about 30 texts she always tried to synthesize them into a section of her literature review. Eventually, she said, she hoped to combine these sections into one chapter. As I describe in the section on note-taking, she kept notes as a stage between reading and writing. As these notes suggest and as she explained, in her reading she focused on understanding what models were used in the texts she read, locating main aspects of these models, and reflecting on whether she could utilize them in her own research. As I will also show below, in the section on multimodality, she was also interested in how to construct her own visuals for presenting them in her own writing.

Mike had just finished that part of his literature review which dealt with the health aspects of the problem he was investigating. When he read about health problems in his further readings, he commented on this issue and related it to his literature review. On several occasions, he said he would need to revise a section and add more information based on what he had read.

Unlike the previous students, for Fred, writing presented a part of his most immediate concerns. His PhD was at the stage where he had to pass through a confirmation exam, which involved both oral and written components. At the time of our interactions, he was so concerned with writing his PhD confirmation report that he said he did not read

anything. Upon further questioning, however, it became apparent that he did read others'
texts, but, instead of reading new texts, he was re-reading the research articles he had read
before. In his reading, he focused on both the language and the content so that to
effectively incorporate both into his own writing.

Finally, June was preparing for a series of experiments to be conducted under her
supervision by several Master's students in Mainland China. As part of her preparations,
she read and scanned through numerous research articles (more than 80 per experiment)
and synthesized across them to prepare the following: materials and costs of the
experiment, stages to be involved, and results to be expected. She was particularly
interested in the expected results because she wanted to know how well her results would
match those of others'.

9.2.3.2.1. Summary

What do the cases presented above tell us about postgraduate reading? This study
probably raises more questions than it answers with respect to reading-writing connections.
However, one conclusion which can be drawn from these cases is that taking into account
students' writing tasks, needs, and purposes is important for understanding their reading
goals, operations, and accomplishments. Writing provided the students with the contexts
within which reading was framed and engaged in. It provided the students with the need
for reading and affected the aspects of texts they focused on. Reading, on the other hand,
provided the students with the content to draw on in their texts, with models showing how
to organizing content and what language to use in presenting it.

It has increasingly been shown in literacy research that an ability to integrate writing
and reading comprise a major aspect of advanced academic literacy (Jiang, 2003; Johns,
1993; Carson, 2001). This study further extends this argument to suggest that there are
different kinds of writing that draw on reading. Such genres as literature reviews,
experimental protocols, PhD proposals and confirmation reports emerged to be important

258

in this study. However, more research needs to be conducted to get a richer understanding of issues related to reading for writing these diverse genres.

In this chapter, the discussion of reading-writing connections is subsumed under intertextuality because (1) the students relied on multiple texts in constructing their own texts; (2) the pieces they wrote presented intertexts which carried traces of the texts they read; and (3) their interactions with the texts they read were affected by their perceptions of their own texts, future and current.

9.2.4. Conclusion: Intertextuality in postgraduate reading

In this thesis, I grouped my analysis of the students' interactions with lists of references, in-text citations, texts of various genres, their own textual notes, and their formal academic texts under the same category of "intertextuality in reading". By doing so, I attempted to show that:

(1)   academic texts that postgraduate students read, and especially research articles, may both scaffold and constrain the students' expanding engagement with the disciplinary activity systems into which they are socializing;

(2)   linking texts of various genres may often be involved in postgraduate reading, which can be especially important at the initial stages of developing expertise in disciplinary content;

(3)   students' textual notes may act as links between their current reading and future actions of writing, re-reading, and discussing texts with others; and finally

(4)   postgraduate reading involves making connections of different kinds between others' texts and students' own texts.

These four points extend and complexify our understanding of what "interactive" may mean in reading research (Grabe, 1988). In the section that follows, I will add another dimension into the discussion of postgraduate reading by showing how verbal messages and other modes of representation interacted in the students' meaning making processes.

9.3. Multimodality in reading

As has been detailed in Chapter 2, Literature Review, current views of texts acknowledge the multimodal nature of meaning making or semiosis (Kress and van Leeuwen, 1996, 1998; Thomas, 2004, Stenglin and Idema, 2001), and current research into disciplinary communication suggests that multimodality is a defining feature of scientific writing (Lynch and Woolgar, 1990; Myers, 1990, 1992; Latour, 1985, 1987; Johns, 1998; Rowley-Jolivet, 2002). The role of modes other than language emerged to be important in two out of the four case studies presented in Chapters 5-8. These are summarized in Table 9.3 below.

Table 9.3. Multimodality across four cases

Student	Text	Multimodality in reading
Joanna	A general textbook: 4 tables	• tables were scanned through but contain no additional marks
Hugo	a famous research article: 6 figures and 1 table	• Figure 2 is referred to once; contains a highlighted word • Table 1 and Figure 3 are referred to multiple times and used together to interpret the algorithm explained in the article • Figure 3 contains numerous lines drawn by Hugo
Dewey	a review article by a co-supervisor: 2 figures and 1 table	• None of the visuals is in the sections read by John during the think aloud session • Visuals appear in later sections, no marks are left around them
John	a research article: highly visual (23 figures) and mathematical (17 equations)	• Figure 2 is partially replicated in John's notes about settling time • It is further developed along with his own definition of settling time • Numbers representing experimental results are marked and noted for comparison with own results

Out of the four cases, it is in John's and Hugo's readings that we observe visuals being extremely important. Hugo made use of a table and a graph to visualize the procedures and the outcomes of the algorithm he was reading about. The ultimate understanding he achieved of the algorithm was co-mediated by various tools representing various semiotic modes and would not have been possible without them. John was

consciously searching for specific numbers and appropriated one of the visuals into his own visual in an effort to develop a definition of a scientific concept. Both of the students displayed an ability to interpret visuals in the contexts of their activities. The role of non-linguistic modes of communication in the readings of the other students will be analyzed in the sections that follow.

9.3.1. Visuals

Visuals of diverse types appeared in the texts that the students read. The ones which emerged as important in their meaning-making actions were: graphs, diagrams, and tables presenting data and correlations between various variables; graphic representations of certain processes; and graphic presentations of models underlying research studies. As expected, referring to visuals was a common operation among the students, but it contributed to the accomplishment of diverse actions.

9.3.1.1. Student cases

Just like the scientists of Bazerman's (1985; 1988) studies, two students in this study used visuals, in orchestration with other elements of texts and information about their authors, in deciding which texts they wanted to read in detail. Mike and June were reading extensively across research reports and articles presenting various experiments. For Mike, reading was part of reviewing literature with the focus on experimental set-ups; while for June, reading was part of preparing for her future experiments and writing up experimental protocols containing details of experimental set-ups and procedures.

Both June and Mike had been involved in extensive experimenting, and as a consequence, they had formed certain expectations of what kinds of results and correlations between various variables they could expect to see in others' texts. When first previewing research articles, Mike scanned the text for the graphs displaying results, and if they were similar to his own results and in some cases, similar to his own graphs, he would read the text in more detail. His goal was to analyze the experimental set-ups of studies

which led to results similar to his. June scanned for the graphs displaying correlations between variables used in various experimental studies. She was interested in what kinds of correlations she could expect in her own future studies. Those studies which presented correlations between variables she was planning to involve in her own experiments were read in more detail. In these two cases, visuals afforded a quick access to the information which was crucial to the students and as such mediated their decision making actions.

With respect to his focus on visuals, it should be pointed out that Mike often marked certain numbers in those visuals. These numbers included two groups: (1) experimental findings and (2) values of certain factors used in experimental set-ups. The first group of numbers were important because they afforded reference points for comparison to Mike. Mike either compared his own existing findings to the findings reported by others or noted them down for future comparisons with his future research findings. The second set of values were important because they gave Mike an idea of what kinds of experimental set ups with specific values he could use in his future experiments. Mike's use of both sets of numbers suggests that he connected his experimental efforts and findings to experiments conducted by others in the disciplinary activity system and evaluated his own results with respect to others'.

Like Mike and June, Lora and Amy, were engaged in reading research reports and articles and paid a significant amount of attention to visuals displaying data. Unlike the previous two students, Lora and Amy were not previewing but rather reading texts in detail with goals broader than those of Hugo and June. Amy read across multiple studies of various computational indices, while Lora read across studies of existing models of manufacturing control. Unlike Hugo and Amy, they were comparative novices to the fields of their research, and visuals played a crucial role in their attempts to understand verbal discussions of the data they encountered.

Amy relied on graphic presentations of data to understand the purpose, significance, and accuracy of the indices she was reading about. The texts she read contained numerous visuals, including pictures, tables, and graphic presentations of the data. Amy particularly

benefited from tables and graphs and referred to them constantly "*to see what they* [authors] *are talking about*" (TBI, 02/03/2003). Though she felt the visuals were complicated to understand as well, they made papers *"more sensible"* (TBI, 02/03/2003).

Lora's texts were filled with visuals. One of the research articles she read, for example, was 7 pages long and contained 4 pictures, 6 schematic presentations of processes, 2 data tables, and 16 diagrams displaying relationships between various variables in the experimental study. The data diagrams were important because they allowed Lora to quickly assess the variables involved in the study and the relationships between them: *"Some figure is more important than word to engineering. Sometimes easier to understand. Like this figure. I know clearly that it's positive direction. I think it's more clearly than the paragraph"* (TBI, 24/02/2003).

Schematic presentations of processes were also important, but for a different reason. Lora consciously analyzed these visuals in order to learn how to create her own visual presentation of processes. She said, *"I must know clearly how to, what dimensions, why he put this diagram here. How does he come to the manufacturing process. How to express its meaning in a diagram"* (TBI, 24/02/2003). By analyzing the diagrams and the authorial intentions behind constructing and using them, Lora learned disciplinarily appropriate ways of utilizing visuals in research papers. Both verbal and visual modes interacted in her learning actions.

Fred, another engineering student, was asked to review a research article submitted for publication to the journal edited by his supervisor. In his reading, he noticed that the author presented a model which was a modification of a previously established model which, to his surprise, was not acknowledged by the author. Fred was able to recognize that one of the graphs used by the author was taken from another publication and said he would recommend that the author acknowledge others' work in his paper before resubmitting it for publication. In his review of the author's study, he observed that the graphs presented good results of the modified model. His interpretation follows:

Fred: *This is the model result. You see solid point is the test result and the line is the simulation result. Agreement is so good. Only one not good here. Others, this is volume, this is strength. I think this is correct. In my experience, model strength is very good.*

TBI, 01/03/2003

His interpretation of the author's results had direct traces of his previous experiences and expectations. Like John and Hugo, Jim added his own drawings to a visual representing a model of electric units in one building. He read the text because his supervisor told him that he had to consider how many units to use in his own PhD research. He read this article which presented two units and was concerned with whether he could expand this model to incorporate more units. While reading and thinking about the model, he expanded the visual and hence the visual stimulated his thinking. Though he did not know yet whether he would use the model proposed by the authors, he suggested that drawing the expanded model was useful to his thinking about his research.

9.3.1.2. Summary

In this section, I presented several cases in which reading involved interacting with both verbal and visual modes of communication. I was able to show the students using visuals in the following actions:

1.   to preview research articles and reports and decide whether they were worth reading;

2.   to enhance their understanding of the verbal explanations;

3.   to understand how and for what purposes visuals were created;

4.   to evaluate texts and research findings; and

5.   to stimulate thinking about own research in terms of others' studies.

In some cases, visuals were used in orchestration with other modes and elements of texts they read, while in others visuals played considerably more important roles than verbal messages. What this analysis suggests overall is that visual modes may be especially important for engineering and other disciplines which rely on visual displays of data (Lynch and Woolgar, 1990; Shea, 2000). It also suggests that some students may find

it easier to understand visual rather than verbal modes of communication, especially when it comes to descriptions of results in research studies (Johns, 1998; Rowley-Jolivet, 2002).

With respect to advanced academic literacy development, it appears that postgraduate students may benefit greatly in their learning if they were able to understand and integrate visual modes of representation into their meaning making actions.

8.3.2. Equations

Just like visuals, the mathematical language presented another semiotic mode that some students had to understand and rely on in their reading. Lemke (1998) reports that scientific texts rely on graphs when presenting experimental results and on equations when presenting theoretical underpinnings of studies. As expected, the students focused on mathematical equations when reading theoretical parts of experimental and simulation reports or when reading theoretical studies of disciplinary activity systems which relied on mathematical modeling and reasoning as a tool of researching. In this section, I will present several cases to highlight the importance of equations in reading and to show how students made meaning of them.

9.3.2.1. Student cases

Two aspects characterize Mike's interactions with equations: a constant comparison between the equations he was reading and those he had seen and read about before and reconstruction of certain equations. One particular text worth mentioning here is a research article presenting "the first analytical solution to the Brownian aerosol coagulation problem that addresses the entire particle size range" (Park et al., 1999). Its presentation of the analytical solution contains the total of 55 equations (on 14 pages): 32 in the main text, and 9 and 14 in Appendices A and B, respectively. More than half of these equations are literally surrounded by Mike's notes.

This is the article that Mike said he was "working with" and the article he called his "tool" (TBI, 19/02/2003). He carried it around with him for several weeks and worked on

it in diverse places, including various coffee shops and ferries. For Mike, the significance of the analytical solution was in the potential of using it as part of his own PhD research. Therefore, he needed to reconstruct the solution and the stages in the development of the equations. The equations were so important that Mike spent several days working on the appendices of the text. Here, he said, there was more information about the solution and he was trying to understand what the authors were *"doing with equations"* (TBI, 19/02/2003).

In addition to reconstructing the equations individually, Mike also enlisted some support from one of the authors of the text. Thanks to the address provided in the research article, he had sent an e-mail request to the author for a complete solution (with all the stages in the calculations outlined) and indeed got an answer soon afterwards.

Similar to Mike, Sam engaged in extensive reconstructions of certain equations. Unlike Mike, who did not refer to external sources other than the author, Sam additionally relied on textbooks, websites, software manuals, PhD theses, and other materials of various genres (see the section on intertextuality above). Like Sam, Lora also relied on multiple sources; but unlike Sam, she calculated for a class and not immediately for her PhD research and was new to the field of mathematical modeling. Therefore, it took her considerably more time and effort to finish calculations and more effort went into memorizing some of them.

Unlike the other three students, Jim and Amy did not engage in calculations though they were attentive to the equations used in research articles they were reading. Instead, they reported relying on verbal explanations accompanying equations in order to make some sense of them. Having little background in mathematics, they considered a text which contained many equations "difficult". For Amy, in particular, equations presented a problem area in reading. As she explained her negative reactions to more current research articles about computational indices, she referred to the complexified mathematical reasoning used in them and the more complex equations mentioned. She related this issue to the intertextual nature of texts and suggested that to understand all formulae and equations she may need to read all the references mentioned in the article because they

would be simpler in maths and would present a progression in which the mathematical reasoning developed.

9.3.2.2. Summary

Bazerman (1988) described the processes that scientists engaged in order to understand the calculations used in the texts they read as "opening up black boxes" (p. 245). The students who worked on the equations as part of their reading were in fact opening up new boxes to themselves as well. Like Bazerman's scientists, these students calculated and verified equations, spent time on them, used additional sources, and by doing so engaged in expanding their knowledge of disciplinary activity systems.

Overall, the following points emerged from the data presented above:

1. mathematical equations and calculations comprised a major part of research articles read by the students of those disciplines which relied on mathematical reasoning;

2. while some students engaged in detailed reconstructions of equations and further calculations, others skipped equations altogether. Irrespective of whether they worked on equations or not, most students perceived them to be difficult to understand;

3. those who spent a considerable amount of time and made an effort to understand equations relied on multiple texts of various genres in their calculations; and

4. more detailed information about mathematical equations and calculations could be obtained directly from the authors of research articles.

In the section that follows, I attempt to bring together the findings which emerged in the study regarding the importance of visuals and equations in a discussion of multimodal nature of postgraduate reading.

9.3.3. Conclusion: Multimodality in postgraduate reading

There have been multiple calls in TESOL and Applied Linguistics communities for more research into modes other than verbal language. It has been argued that verbal and

non-verbal means of communication interact in readers' and writers' meaning making processes (Johns, 1998; Lemke, 2000; Kress, 2000; Kress and van Leeuwen, 1996, 1998). This study supports this call and adds to the existing research by showing in which ways visuals and equations interact with verbal language in postgraduate students' reading. Due to its nature, the study does not provide generalizable results and does not argue for the overwhelming importance of non-verbal modes in reading. However, we can draw tentative conclusions regarding several issues.

One of the conclusions which seems to be particularly important here is the understanding that relying on and interpreting non-verbal modes is an integral part of reading scientific texts. Research into teachers' perceptions of visual modes in reading and writing classes suggests that some teachers view the ability to use and rely on visuals as a technical skill, as opposed to a reading or writing skill (Petrie, 2003). Bazerman (1988), on the contrary, in his analysis of experimental reports in physics over 1893-1980 suggests that when authors use non-verbal means to communicate their ideas, they may be shifting their arguments into different semiotic means, but "the decision of when and where to employ them, how they should be designed and what information to include, are as much writing decisions as are word selection and organization" (p. 172). To follow Bazerman's (1988) argument, it can be suggested that by focusing on the visuals the students may be turning to non-verbal means of semiosis, however, when to focus on visuals, where and how to use them are as much part of the reading processes and decisions as deciphering letters, understanding individual words, making sense of sentences, etc.

I believe that language professionals working in contexts of postgraduate education may do a disservice to their students by continuing to ignore visual and other modes of representation and consider using these modes as skills unrelated to reading and writing (Petrie, 2003; Lemke, 2000). A model of advanced academic literacy which is concerned solely with comprehension of graphic letters will no longer be able to explain how readers derive meanings from texts (Kress, 2000; Lemke, 2000, 2002).

The analysis presented here of what semiotic modes are in use when postgraduate students read academic texts further points to the capacities and limitations of the various modes, or in activity theoretical terms, of the affordances presented by the various modes. Since these various semiotic modes get integrated in academic texts, it is most appropriate to start asking the question of how these semiotic modes get used and whether they present affordances or challenges to postgraduate students. Finally, if we think in terms of the metaphor of "language games" which has become increasingly popular with advanced academic literacy specialists (see Casanave, 2002; Canagarajah, 2002), there seems to be a reason to extend the metaphor into "semiotic games" which would include both linguistic and non-linguistic modes of communication.

9.4. Interactional networks of postgraduate reading

In the sections above, where I engaged in the analysis of intertextuality and multimodality, I began highlighting the social nature of postgraduate reading. With respect to intertextuality, I showed that the students' meaning-making actions were often initiated by, situated within and mediated by the previous interpretations of the text within disciplinary community systems, and thus meaning making did not have to be a strictly individual endeavor. In fact, I showed that when the students were not able to utilize other texts in their attempts to understand a single text and use other texts as tools, they were disadvantaged and found themselves in double bind situations.

With respect to multimodality, I showed that genres of communication within and between disciplinary activity systems have evolved in such ways that multiple modes of communication are often involved in one and the same academic text. The postgraduate students, especially those of engineering and geo-informatic sciences, often relied on visual, verbal, numerical, and mathematical modes when working out the meanings of their texts. I suggested that since academic texts involve multiple modes of presentation, postgraduate students may need to be able to utilize these modes efficiently in order to enhance their extending interactions with disciplinary activity systems.

269

In this section of the chapter, I will engage in a focused discussion of the role of interacting with others in the students' reading. The discussion will be structured according to the main themes presenting social others which emerged through the data: (co)-supervisor-supervisee relationships, conversations with authors, interacting with multiple disciplinary and professional activity systems. Through the analysis of the roles of these socially significant others in the students' reading, I will illustrate how postgraduate students situate themselves with respect to these others, what rules and expectations regulate and mediate their interactions with them, and how these aspects interact with and shape their engagement with reading and vice versa.

9.4.1. Supervisor-supervisee relationships

Studies of supervisor-supervisee relationships have extensively documented various kinds of interactions postgraduate students engage in with their supervisors (Belcher, 1994; Dong, 1996; Angelova and Riazantseva, 1999; Ivanič, 1998; Cadman, 2000; Dysthe, 2002). Some of these studies have suggested that supervisors may positively affect students' successful disciplinary enculturation and scaffolding their academic writing abilities (Blakeslee, 1997; Angelova and Riazantseva, 1999; Belcher, 1994).

Out of the four detailed case studies presented in Chapters 5-8, Dewey's conveyed very clearly the role and mediational possibilities student-supervisory relationships may have with regards to postgraduate students' advanced academic reading. Dewey had to prepare for his weekly meeting with his supervisor who encouraged him to discuss his readings during their meetings (in addition to other tasks that characterized his PhD activity system at the time). On the one hand, Dewey's interactions with the supervisor had traces of the "teaching model" of supervision (Dysthe, 2002)—Dewey perceived a hierarchically structured power relationship and a strong need to prepare for the meetings, and often approached the supervisor for help and explanations of unknown disciplinary terms and methods he came across in the texts he read.

However, the relationship is best characterized as Dysthe's (2002) "apprenticeship model of supervision"—not only did his supervisor introduce him to the author of the text Dewey read, Dewey also observed his supervisor's approach to supervisory meetings and was planning to utilize a similar style with his own students. Overall, the relationship could be characterized as that of trust and respect, which when it came to reading, signified that Dewey could rely on his supervisor for help with his readings and co-constructed his understanding of the texts with his supervisor. In the remainder of the section, I will trace the role of supervisors across the other seven cases.

9.4.1.1. Student cases

Among the remaining students, Jim's case was most similar to Dewey's in terms of student-supervisor relationships. Like Dewey, Jim appropriated some of the practices his supervisor engaged in and encouraged him to develop. As reflective in the following excerpt, he particularly liked the idea of careful planning and engaging in several tasks at the same time: "*Supervisor has concept that someone do something in one time. You should have a plan. If I write this paper, for next paper can prepare during this time. I try my best to learn this way*" (TBI, 20/02/2003).

Unlike Dewey, Jim was more reliant on his supervisor and seemed to work under his direct instructions. This may have been due to the fact that, unlike Dewey, Jim was in his early 20s and had had little experience of independent research activities. The readings he engaged in were mostly used as tools for the achievement of his writing tasks, which were set up and directed by the supervisor; consequently, some of the texts Jim read were also suggested by the supervisor. Like Dewey, he had a considerable supervisory support and reported little if any problems with his readings.

Not all the students felt the same way towards their supervisors. Mike, a PhD student from Germany supervised by a local professor, often discussed his relationship with his supervisor in negative terms suggestive of the multiple tensions which must have existed between them. When we discussed his reading of a research article which eventually

turned out to be very useful for his PhD, Mike said that he read this text because his supervisor gave it to him and his attitude to the text was initially very skeptical just because it came from his supervisor: "*My supervisor gave it to me. (**mimicking his supervisor**) "oh, here is something about tobacco smoke. It's not very related but ah". (**continues**) As soon as he finds a few similar diagrams, like this one, he thinks, oh it must be useful for me*" (TBI, 19/02/2003). Though later, with considerable reluctance, he acknowledged the usefulness of the text to his study and the relevance of it to his literature review, his first reactions to the supervisor's suggestion were those of resistance and dismissal.

One more article we discussed was given to Mike by his supervisor and Mike did not think it was a right reading for the stage of his PhD activity system he was at:

> **Mike:** *It's one of these articles my supervisor showed me. And it's not good for a project. First you get a general idea and not equations, equations. So he wasn't very helpful to start the project. He gave me only theoretical articles…But this kind of articles are useful after one year, I think. After you have an idea about the experiments. You have a few results.*
>
> TBI, 19/02/2003

Mike struck me as a person who knew what he needed to successfully engage with his PhD research object. He seemed to believe that his supervisor's suggestions with regards to readings (and other activities) were often irrelevant. When I later asked him whether, considering that his supervisor often gave him articles to read, they discussed these articles together, Mike said that they didn't really discuss the articles "*because he [the supervisor] never reads the articles*" (TBI, 19/02/2003). Moreover, Mike was asked to send the references to the texts he read (especially research articles) to his supervisor, and his reaction to this practice was also negative: "*He wants to see them. I usually e-mail the articles to him. He's collecting literature. That's the point*" (TBI, 19/02/2003).

Though this picture of the student-supervisor relationship is based on somewhat limited data and involves only the perspectives of the student, it does suggest a major point—that not all students may appreciate their supervisors' explicit instructions and may perceive them as restricting and irrelevant. Their reactions to the texts recommended by

their supervisor may be affected by the nature of their relationship with their supervisor and they may be blinded to the usefulness of the texts due to their affective reactions.

If for Jim and Dewey, their supervisors emerged as role models and sources of support primarily, for Sam and Lora, their supervisors were a source of pressure, whose expectations they attempted to meet. Unlike Mike, they did not express direct opposition to their supervisors' instructions and instead considered it normal to accept their supervisors' suggestions and prepare extensively for their supervisory meetings. For Sam, his supervisor was the one who "ordered" him to read some articles expecting him to understand them and present them to him at their meetings. When he was experiencing problems with understanding a text because he could not locate references, Sam did not think of approaching his supervisor regarding the problem and instead anxiously awaited the meeting expecting to be reprimanded for a perceived failure. For Lora, who also had regular meetings with her supervisor, reading was one way of preparing for the meetings. She said: "*You must do a lot of things. Read something like that. Then you will have something new to tell him. The supervisor asks "anything new?" You must read, you must have some new idea*" (TBI, 09/04/2003).

Both students were in the very beginning of their PhD studies and their activities were structured around the need to learn about and compare the different methods which existed in the disciplinary activity systems to solve the problems which they aimed to solve in their PhDs. Both felt that they needed to learn from the texts they read and report their learning to their supervisors. They saw their supervisors as the authority whose primary job was to expect perfect outcomes from the students. The feedback was feared to be negative and corrective rather than supportive and constructive. Overall, the relationships with the supervisors were presented as highly assymetrical in terms of power and status and the interactions around texts were monologic rather than dialogic (Bakhtin, 1986) and the outcome was transmission of what was learned by the student individually rather than co-construction of knowledge. The transmission seems to have followed the path of "the text→the student→the supervisor".

A somewhat unique, in comparison to other cases, relationship with the supervisor emerged in June's case. Like Jim, she read several texts written by her supervisors. However, while Jim was told to read the text by his supervisor, she did it on her own accord. The texts were not interesting to June in terms of the research presented in them, but in terms of the kind of the author they reflected. June read "*to understand my boss*" (TBI, 10/02/2003) in terms of both his research interests and styles of writing. The easiest way to understand a supervisor, she said, was by reading his papers.

9.4.1.2. Summary

So what kind of conclusions can we draw from these cases? What consequences do they have for the ongoing discussions of advanced academic literacy and disciplinary enculturation? There seem to be two major findings: (1) not all students engaged in direct interactions with their supervisors about the texts they read; (2) among those who did interact with their supervisors specifically about the texts they read, some see the interactions as encouraging and motivating while others see them as a source of constraint, pressure, anxiety, or simply annoyance.

The existing research into advanced academic literacy needs of postgraduate students suggests that postgraduate students and supervisors may be bringing different expectations into the supervisory relationships and may not always be aware of the expectations of each other (Prior, 1998; Belcher, 1994). Moreover, writing research has begun to show that some supervisors often assume that postgraduate students have the knowledge they need to cope with the writing encountered at this level of socialization into a disciplinary activity system and may not realize students' problems unless the students raise them directly (Angelova and Riazantzeva, 1999). On the other hand, the same research shows that students may feel uneasy to approach their supervisors directly and would benefit from some welcoming signs from their supervisors (Angelova and Riazantzeva, 1999) or may not have the communication skills and find it difficult to ask for the information they need from their supervisors (Allison, et al., 1998).

Like Angelova and Riazantzeva (1999) and many others, this research seems to suggest that more regular "lines of communication" characterized by shared expectations and less hierarchical relationships could provide students with genuine opportunities to discuss their readings with their supervisors and learn through these discussions. To strengthen this point, we should return to Sam's struggles with references in the text he was reading. One could ask how much easier it could have been for Sam if he could approach his supervisor with his problems of locating outside sources he needed for understanding a text. He may have benefited if the supervisor provided some kind of scaffolding to mediate the student's interactions with highly intertextual academic articles. Instead, he was alone in battling the double binds he was experiencing and never managed to solve them.

9.4.2. The author/s

Research literature on expert reading and reading-writing connections (see sections 2.3.1 and 2.3.2 of Chapter 2) shows that reading, especially at the level of disciplinary expertise, involves readers engaging in "mental conversations" with the authors of the texts they read. All the four cases presented in Chapters 4-8 contain elements of conversing with authors, as overviewed in Table 9.4 below.

Table 9.4. Conversations with author/s across the cases

Student	Text	Reactions to author
Joanna	General textbook	• Minimal references • Pronoun 'he' • No evaluative comments
Hugo	Famous research article	• Very frequent references • Pronoun "he", name of the author • negative comments regarding author's algorithm and applications • confusion with author's algorithm and presentation
Dewey	A review article by a co-supervisor	• Very frequent references • "author", name of the author, "she" • positive comments on author's epistemological stance and style of writing • alignment with the author's views

John	A research article	• Frequent references to the author plus references to affiliations • "Authors", "famous authors", "big professors" • comments on author's status in the disciplinary activity system • drawing on their authority in presenting trustworthiness of own research results • extending author's work in own research

As the table shows, Hugo, Dewey, and John (1) were familiar with the names of the authors before reading the texts, (2) recognized the status of the authors in the disciplinary activity systems, and (3) considered status an important factor in their decision to read the texts. John was particularly aware of the status issues of the author of the text he was reading and relied on this status in his own work to show the credibility of his research results.

9.4.2.1. Student cases

The fact that Joanna did not refer to the author as much as the other students of the four case studies and the fact that she did not seem to engage in "conversing" with him was somewhat puzzling. Following Haswell et al.'s (1999) warning, however, I questioned whether the authors of the texts were always unimportant for Joanna. Upon the analysis of Joanna's reading of other texts, I find that there were texts in the reading of which Joanna displayed a considerable attention to the author/s. These texts were research articles written by researchers established in the field of second language acquisition, research articles authored by her course instructors and research articles on the basis of which she was refining her research questions and hypotheses. However, in the reading of the various chapters of the textbook, she continued to engage in minimal reactions to the author.

It appears that reading a textbook is different from reading research articles in terms of the level of engagement in a "conversation" (Geisler, 1991) with the author. One reason for neutrality of Joanna towards the author of the textbook could be the fact that she did not have enough background knowledge regarding the issues presented in the text was in

the position of "blind faith in the author" (Afflerbach, 1990, p. 36). Also, as it has been suggested by previous research, textbooks due to their purpose of summarizing research conducted by various people, may be disassociated from specific authors (Myers, 1992; Johns, 1997). Finally, from an activity theory perspective, it also appears that Joanna was not interested in extending her interactions with the activity system of language teachers for whom the text was intended and therefore did not engage deeply with reading the text.

In addition to Joanna, there were two more students, Amy and Lora, who did not engage in obvious interactions with authors. Amy, at the initial stage of her PhD study, was concerned about learning the contents of the texts she read. She had just begun her explorations of the general principles and specific studies of the activity system of remote sensing and had not accumulated enough knowledge of the specific people in it.

Similarly, Lora was also a novice to the activity system of the discipline she chose to study for her PhD. Unlike Amy, however, she was not concerned with the basic principles of the disciplinary activity system, but with specific methods of controlling manufacturing processes that were developed and used in the field. She hoped to combine two existing methods in her own development of a new method as the object of her PhD activity system. She read widely from various authors to gather as much information about the various methods as possible, and though she did refer to the authors on occasion, she was more concerned about their methods rather than their names, affiliations, or disciplinary status.

The status of the authors was an important criterion in the decision making processes for two students, John (as described above) and June, a finding which is supported by Bazerman's (1988) study of expert physicists' reading. Just like John, June displayed a high awareness of certain authors, their affiliations, and disciplinary status often expressed in terms of trustworthiness. Unlike John, she was in the very beginning of her PhD process; however, like Dewey, she was an established researcher and practitioner in the Mainland China and therefore cannot be considered "a true novice" (Gee, 2002) to the disciplinary activity system she expanding her participation with.

June followed certain research groups and their activities through years and knew which groups she trusted and which she didn't. During a think-aloud session, she read a research article written by a research group she was not aware of yet. She evaluated this text in terms of the journal in which it was published as well as the affiliations of the researchers. She said "*This journal is international journal of pharmaceutics. It's a third degree journal I think. This group is pharmaceutics (**reads the name**) Wow. Two or three levels in the world. At the top...*" (TA, 13/03/2003).

For June, knowing which research group the researchers belonged to was important because she had certain suspicions towards research groups in Mainland China. She could predict the subtext of certain texts (Wineburg, 1991a, 1994) if they were authored by Chinese research groups. In a way, she divided the disciplinary activity system into Chinese research groups and others. She saw the objects motivating research within the activity system of Chinese research groups as being different from the object of other groups, for example, European groups. She explained:

> **June:** *When I stayed in Europe, I found out great differences between Chinese research groups and European research groups. That institute continue to work in the same direction of same…For example liver. You can find paper related to liver more than 20 or 30 years ago. Maybe at the beginning it is simple, only liver, then deeper and deeper ...and newer and newer. But in China, because of you see, historical accidents had something, sometimes research is formal condition. So maybe this one is new this topic or this direction is good future or something. So do this.*

> ExplanI, 13/03/2003

Because June suspected that Chinese groups were primarily concerned with doing ad hoc research which was popular instead of doing detailed and systematic research in order to contribute to the understanding of a research object in depth, she did not always trust the results published in Chinese-authored papers. Knowing the researchers' affiliations and country affected June's decisions in choosing texts and consequently evaluating their trustworthiness. Trustworthiness was important partly because for June authors of the texts she read had the potential of becoming sources of further information and even research materials.

She contacted authors of several texts she read. One of the texts we discussed was a research article authored by a professor in Germany whose work involved a special plasmate which June wanted to have. She found the professor's e-mail on the Internet, sent him an e-mail asking if she could have some of the plasmate and received a very favorable quick response. She went back to the references on the Internet and found out the author was a famous scientists "*because he published paper in Nature magazine. In natural science field, there is a saying that if you publish one paper on Nature, then you are famous*" (TBI, 10/02/2003). The fact that she was able to receive such a good response from an established researcher made June excited and ready to work with the plasmate.

Like June, Mike was eager to contact the authors of the texts he read if he deemed their work useful for his own and if he had specific questions that he knew they could answer. For example, after reading a 1997 research article presenting an experimental set-up similar to his, Mike wanted to contact the authors of the text. However, the article contained only postal information for the contact author and no e-mail address, and Mike used the Internet in order to find the author's e-mail address.

On a different occasion, after reading a research article co-authored by a German professor, Mike contacted the professor to get the calculations used in the article. He explained that because he sent his request for this information, he did not have to engage in calculations himself. He said that it was "*thanks to reading the whole article, [that I came across the sentence] "at your request, the file is available at…"*" (TBI, 19/02/2003). When sending his e-mail request to the author, Mike introduced himself and explained why he was writing from Hong Kong. The professor replied almost the same day and encouraged Mike's attempts with his work. Later, Mike sent him "*a few results using these calculations. And…he gave me a few more tips*" (TBI, 19/02/2003). For Mike, the texts clearly acted as tools, which in combination with growing Internet capacities, connected him with researchers all over the world and enhanced his growing interactions with others. Additionally, he appeared to be aware of and to rely on the division of labor in the disciplinary activity system and did not see usefulness in conducting work which, he knew,

had been done well by others. Instead, he preferred to contact the authors directly and incorporate their work into his own.

Like Mike, Sam also contacted some authors when he needed more information. For example, when reading a research article that he thought could be useful for his project, he sent an e-mail to the author asking for more references. The author sent him not only a list of references but also a website which had a link to his complete PhD thesis. For Sam, this was exciting news and he was very happy to get such personal and quick response.

9.4.2.2. Summary

The postgraduate students of this study often read with the awareness of the author, as has been suggested before in studies of expert reading (Wineburg, 1991a, 1991b, 1994; Leinhardt and Young, 1996; Haas and Flower, 1988; Haswell et al., 1999; Bazerman, 1985; Geisler, 1991). The importance of the author and his prominence in the accounts of reading were not always the same and in some cases the authors did not emerge as important. It appears that the awareness the students have about other members of disciplinary research communities and their immediate concerns may affect how prominent the author emerges to be in their reading.

One particularly strong finding of this study is that some students engaged in conversations with the authors not only at the level of abstract internal conversations but at the level of interpersonal conversations involving real authors. These conversations provided the students with a chance to ask for materials, calculations, references and benefit from the division of labor and exchange of tools in disciplinary activity systems. This aspect of reading, to my knowledge, has not been examined or even suggested in the previous literature and more research may provide more interesting clues as to how reading leads to the establishment of personal contacts between postgraduate students and other participants of disciplinary activity systems.

9.4.3. Interacting with multiple activity systems

According to the principles of activity theory, activity systems are open systems which relate to and overlap with other activity systems. Every activity system is thus situated in a network of other activity systems and every member of any one activity system may be engaged with other activity systems as well (see Engeström, 1999). One finding of the study has been that students, while reading various texts as part of their PhD activity systems, engaged in various interactions with the disciplinary community systems to which they aimed to contribute as a result of their PhD activity systems.

In Chapter 6, while analyzing the reading of Dewey, I showed how patients and medical doctors, the members of his professional activity system, were irrevocably evoked almost throughout his reading of the text. I showed that his concern with understanding the epistemologies in reading were populated with the presence of these significant others. Joanna, in her reading of Brown00, was interpreting the text in the context of her course activity system, together with her classmates, most of whom were secondary school teachers. She herself, however, did not see her role as a future teacher and hence some sections of the text she did not even read. While Dewey was actively affiliating himself with his professional others, Joanna seemed to distance her needs from those of the professional teachers. There were several other cases, in which the students read texts of other disciplinary activity systems or interpreted texts in terms of professional activity systems.

9.4.3.1. Student cases

In the remaining cases, June and Mike were particularly interesting with respect to crossing the borders between disciplinary and professional activity systems. June read numerous research articles for her work with Master's students in the Mainland China. Supervising six of them, she was initiating them into the practices of experimenting. Much of their interactions involved discussing experimental protocols. June skimmed and scanned through mounts of research articles to prepare her experimental protocols. She

gave the students a chance to develop and present their own protocols; however, she also did her job and prepared a protocol herself, which she encouraged the students to critique and evaluate.

In addition to the activities June supervised in China, she was also preparing for her future activities and her future work in a new disciplinary area, that of protein research. At PolyU, June took a course on techniques of protein chemistry and read several research articles when preparing for the classes. Though this course was not relevant to her current PhD, she saw it as a chance to prepare for the future. She said protein research was a very popular area in today's science and she needed to stay on top of new experiments and discoveries so that to be ready to start working in the area at some point in the future.

Like the scientists in Bazerman's study (1985, 1988), June read with a clear distinction between core reading which was directly relevant to her work at PolyU and her students in the Mainland China and her peripheral reading. This peripheral reading included reading for future participation in new disciplinary activity systems. To use Bazerman's (1988) analogy, she read to both tutor herself in the new directions and "to window shop for potential problems to work on" (p. 238) in future activity systems.

During the think-aloud session, Mike read an article which presented chemical analyses of pollution particles. Aligning himself with researchers of mechanical engineering, Mike did not like this article and said, "*I don't like chemical experiments*" (TA, 10/03/2003). Being familiar with the styles used in mechanical engineering, he was particularly negative about the referencing conventions employed in this article and the style of writing which led him to suggest, *"Who is reading these articles? Housewives?"* (TA, 10/03/2003). Being an outsider to chemical research, he was particularly critical about it. He chose the text based on the keywords and, when reading it, skipped most of the sections, reading only the abstract, the introduction and the references, and scanning through the results and discussion. His concluding remark was:

> **Mike:** *I don't know how they write such papers. They just tell us these engines have this this this ingredients. But what for? …Everybody knows we need engines and we need the quality of the exhaust. Less pollutants. But*

they only measure what do we have. It's not common knowledge but what do they do with this knowledge? Too general.

<div align="right">TA, 10/03/2003</div>

What Mike seemed to be reacting to was the differences in the objects of two disciplinary activity systems. While as a mechanical engineer, he valued the practical solutions sought for and provided by his disciplinary activity system, he seemed to underplay the importance of researching the chemical properties of exhaust, the object of the disciplinary activity system of chemical research. In his case, we see a comparative newcomer interacting, somewhat by chance, with a text of a disciplinary activity system which partially shares an object with his activity system but differs from it in its foci and outcomes.

On another occasion, Mike commented on a reference used in one of the texts he read because he found it was a publication of the Society for Automotive Engineers, and he said:

> **Mike:** *Do they do anything useful? All their publications are about what do we measure and how do we measure. Only descriptive. We build a nice machine, we put this machine into…but it is not only about vehicles, it's also about industrial exhaust, processes, like painting, anything.*

<div align="right">TA, 10/03/2003</div>

Here Mike is pointing out the narrow focus (research object) of the activity system of automotive engineers. He finds limitations in their work and seems to suggest that the object of research should be broader, somewhat like in the disciplinary activity system of civil engineers. Research into the reading processes of expert readers has shown that a distinction needs to be made between the readers' interactions with texts of familiar and related but not as familiar disciplines (Leinhardt and Young, 1996). Mike's case indeed shows that his interactions with related but not familiar disciplines through reading were often discussed in negative terms and it appears that he brought expectations of reading texts of mechanical engineering into his reading of texts of less familiar disciplines.

9.4.3.2. Summary

One major conclusion arises from the cases in which interactions with multiple activity systems became prominent. It appears that as part of their PhD studies, some students may be engaged in learning about multiple related disciplines. Some of these disciplinary activity systems may be more foregrounded than others (Prior, 1998), and some of them may be important for the future engagements rather than the present. Students' interactions with multiple activity systems, however, implies that their readings might span across texts of various disciplinary activity systems, some of which might be more familiar than others to them. This finding bears relevance to advance academic literacy research in that it suggests that we may need to go beyond conceptualizations of disciplinary enculturation as involving only one discipline. Accordingly, we may need to be aware that postgraduate students may already be central participants in certain activity systems (both disciplinary and professional) and draw on this awareness for further practice.

9.4.4. Conclusion: postgraduate reading situated in networks of interactions

Today it has become somewhat of a truism to say that literacy is embedded in social-historical contexts, and Johns and Swales (2002), for example, summarize the previous findings in terms of what they call "several layers of shaping context" (p. 17). In this study, the "social" emerged at three levels of interactions: (1) student-author/s-text; (2) student-supervisor/s-text; and (3) student-other activity systems-text.

The social nature of reading, in the sense that meaning making from texts is mediated by immediate social others, has been somewhat discussed in critical reading research (Wallace, 1992, 2003; Luke and Freebody, 1997) and in relatively few activity theory analytical approaches to reading (e.g., Smagorinsky, 2001). Both strands, focusing primarily on younger readers, emphasize the dialogic relationship between the communal and individual meaning making processes. This study provides evidence to reinforce this finding: while the social forces had the potential for enhancing the students' interactions

with texts, the meanings the students derived from texts had the potential to mediate the students' expanding involvement with various activity systems and their achievement of goals subordinated to the major object of their PhD activity system.

Smagorinsky (2001) argues that cultural mediation is "often invisible" yet unavoidable (p. 24). While this study does not and has not aimed to provide an exclusive evidence for this assertion, it does show that in some cases the students' social relations did mediate their meaning making processes and supports the view of reading which would suggest the importance of creating environments in which the students would be enabled by social others to engage in complexly rich and meaningful interactions with texts. Such environments may provide opportunities to scaffold (Vygotsky, 1978) the students' achievement of a variety of outcomes as a result of interacting with academic texts.

9.5. Overall chapter conclusion

In this chapter, I explored the third research question of this study: "What common themes emerge across cases and in what ways are these themes similar and different?" Three major themes were identified across the cases: the role of intertextuality, multimodality, and social others in reading. Through the analysis and interpretation of intertextuality in the students' reading, I highlighted that reading one text involves making complex connections between multiple texts, including texts authored by the students. I showed that while the intertextual nature of academic texts presents an affordance for extending interactions with disciplinary activity systems, it might also present constraints in meaning making actions which focus on propositions of individual texts.

In the section on multimodality in reading, I pointed out that multiple modes of meaning making are often involved in postgraduate reading, especially in disciplines relying on visual modes of representing data and on mathematical reasoning. Finally, in the discussion of social interactions, I turned to the analysis of the students' relationships with their supervisors, authors of texts, and multiple activity systems. I argued that interactions

with others may provide the students with the support and scaffolding they often need in dealing with issues of understanding aspects of texts they read. I showed that the students often engaged in real as well as mental conversations with authors and interact with multiple rather than single activity systems through their reading practices and choices.

Chapter 10 provides a summary of the study's overall approach and findings which will lead to the discussion of significant conclusions and implications for both research and pedagogy.

CHAPTER TEN: Conclusions and implications

In this last chapter, I briefly revisit the main objectives of this study and restate the research questions which guided it. Then, I summarize the findings for the three research questions and relate them to key discussions in L2 reading and advanced academic literacy research. In light of these findings, I further discuss the theoretical significance of the current study and its pedagogical implications. I conclude the chapter by critically evaluating some of its major limitations and suggesting directions for further research.

10.1. Summary of study approach

As I argue in Chapter 2 of this thesis, L2 reading research has been somewhat reluctant to acknowledge and build on the current developments in socially-oriented L1 literacy research. Unlike its sister discipline, L2 writing, L2 reading research has remained largely at the level of analyzing reading as a mechanical skill involving cognitive processes of decoding and comprehension and its methodologies have been limited to experimental and quasi-experimental set-ups. Meanwhile, there have been numerous calls in recent literature for more naturalistic and socially-oriented studies of L2 reading (Grabe, 1997; Penningroth, 1997; Strømsø and Bråten, 2002), studies which would (1) turn to methodologies which go beyond experimental settings so that to observe naturally occurring reading processes and practices; (2) be based on clear conceptualizations of "context"; (3) account for social contextual factors in L2 reading; and (3) consider readers as socially, politically, and ideologically situated.

It is within these calls for more socially oriented L2 reading research employing naturalistic methodologies that this study of reading has been theorized and carried out. In addition to L2 reading research, it aims to contribute to the ongoing discussions within advanced academic literacy research which has been concerned with postgraduate students literacy needs and development (Sengupta, 2004; Casanave, 2002; Prior, 1992; 1998; Johns and Swales, 2002; Braine, 2002). Within this area, it has long been suggested that reading plays an important role in postgraduate students' education (Carson, 2001; Johns,

1997). However, apart from Benson (1991) and Jiang (2001), few other studies have focused on how and why postgraduate students read.

In light of the gaps identified in the current literature on L2 reading and advanced academic literacy development, this study has aimed to accomplish the following objectives:

(1)   to examine postgraduate reading in contexts of its natural occurrence;

(2)   to identify unique features of postgraduate reading within cases and to locate commonalities across cases;

(3)   to propose a framework for studying reading in context; and

(4)   to suggest areas of further research to enhance our understanding of postgraduate reading and its role in advanced academic literacy development.

In accord with its objectives, this PhD study is situated within the naturalistic inquiry (Owens, 1982) and employed a multiple case study design (Yin, 2003; Stake, 2000), with adaptive and evolving procedures for data collection (Denzin and Lincoln, 1998) and reiterative methods of data analysis (Miles and Huberman, 1994; Richards, 2003). The data were gathered from eleven postgraduate students through collecting texts, conducting interviews and think-aloud session, and observing some students' reading. The resulting textual, verbal, and observational data were analyzed with two research questions in mind:

RQ1: What is the nature of reading in context? What social forces are involved in reading? How do these forces interact with and shape reading?

RQ2: What common themes emerge across cases? In what ways are these themes similar and different?

In this thesis, Research Question 1 has been discussed through four detailed case studies presented in Chapters 5-8. The four students were chosen for a detailed analysis based my judgment of the quality, quantity, and theoretical interest of the data. The theoretical interest was envisioned to be in the line of progression represented by the four students who were at different stages of their postgraduate studies. Research Question 2

was answered by identifying major themes across all 11 cases and by analyzing similarities as well as differences between them. The focus of this study on both detailed interpretations of single cases and cross-case analysis was important because of its aim to understand both the idiosyncratic nature of reading in each case and to locate commonalities across cases.

Finally, the study drew on activity theory (Vygotsky, 1978; Leontev, 1978; Engeström, 1987, 1999) for its conceptualization of the notion of context. According to activity theory, context is a complex co-construction of the individual, the social, and the material. It is not a frame that surrounds a focal phenomenon (Goodwin and Duranti, 1992) but the focal phenomenon within which human processes are understood. To understand reading within particular contexts, three levels of analysis discussed in activity theory were adopted in this study: operations, actions, and activity systems.

Briefly, in this study, analyzing reading at the level of activity systems meant conceptualizing the reader as a social actor interacting with others through the texts he reads and analyzing the social origins of his reading motives. Analyzing reading at the level of actions meant tracing the goals the reader sets up to accomplish by reading and the actual accomplishment of these goals. Finally, analyzing reading at the level of operations means analyzing the conditions in which reading actions are realized, which meant analyzing spatio-temporal conditions and the reader's use of various mediational means such as computers and dictionaries. The activity theoretical analysis in this study resulted in several major findings, which are presented in the next section according to the research questions.

10.2. Summary of findings

10.2.1. Research Question 1

Table 10.1 summarizes the four cases presented in Chapters 5-8 in terms of the student's postgraduate backgrounds, texts read, and operations, actions, and activity systems (with important social others) identified.

Table 10.1. Four students' reading

	Joanna	Hugo	Dewey	John
Pg status	Second semester MPhil	Second semester 4 yr PhD	First semester 3 yr PhD	Last semester 3 yr PhD
Discipline of studies	Second Language Acquisition	Geographic Information Systems	Neuropsychology	Mechanical Engineering
Text	Brown00 Textbook chapter	Bowyer81 Research article	Wilson00 Theoretical review paper	Khoury84 research article
Primary reason for reading	Preparation for the course	A very famous article in the discipline, "everybody cites it"	Directly relevant to his future research study	To verify simulation results
Operations	Note-taking, highlighting, checking vocabulary	Note-taking, highlighting, evaluating, complaining, comparing, skipping, referring to the computer, using wooden objects	Note-taking, highlighting, evaluating, skipping, guessing, checking vocabulary electronically, reflecting, sub-vocalizing, gesturing	Note-taking, highlighting, drawing
Actions	Preparing for a class meeting Improving vocabulary Making sense of self	Making sense of the algorithm presented in the text Expanding the textual base (intertext)	Learning new treatment techniques Learning about epistemological debates	Verifying simulation results Developing definition of "settling time" Preparing for writing
Activity systems (AS)	Course LING 5XXX Professional AS of language teachers	Two stages of disciplinary AS of computational geometry: around 1980s and 2000	Supervision meetings Professional AS of rehabilitation practitioners, disciplinary AS of neuropsychology	Final examination Disciplinary AS of mechanical engineering
Social others	The author Classmate and course instructor Less defined others	The author Other authors	The author Other authors Supervisor Patient Other medical practitioners	The authors Future reviewers/examiners Other researchers in mechanical engineering

Overall, these case studies highlight that postgraduate reading is, at the same time, deeply individual yet socially situated and tool-mediated. It is conducted for specific purposes and as part of engaging with social formations such as courses and examinations, disciplines and professions. It is realized through diverse operations which include writing and highlighting, using computers and other objects of the material surroundings, and evaluating, reflecting, comparing, and other mental processes. These operations lead to the students' realizations of multiple goals which themselves are subordinated to their broader motives of doing postgraduate studies and their engagement with multiple activity systems.

With respect to the first research question, when analyzed in contexts of its natural occurrence, postgraduate reading emerged to be:

1. an individual's active engagement with texts. The individual nature of reading was apparent in the fact that the four students read the texts on their own, without immediately discussing it with others, and often in the confines of socially isolated rooms: either an individual cubicle in a research room or a room in the student hostel. The active nature of reading was apparent in the students' awareness of their reading goals and aspects of texts that needed focused attention, and in their operations of note-taking, highlighting, reflecting on the textual propositions and on their own research. Not all the four students engaged equally actively with the texts they read. Most notably, Joanna did not engage with the textbook chapter she was reading as actively as the other students. This was due to the peripherality of the course she was reading for in her PhD activity system and her lack of background knowledge in the topics covered in the chapter.

2. a purposeful engagement with texts. As highlighted above, the students had specific goals in mind. The goals were not fixed purposes for reading, but evolved as reading progressed and reflected the students' needs, fears, expectations, and awareness of socially constructed disciplinary knowledge. The latter was true especially of Hugo, John, and Dewey. For example Hugo's initial goal was to read the research article because it was highly cited in disciplinary publications. His further goals included

understanding of the algorithm presented in the text and making links between the text and texts of future reading.

3. <u>making links between multiple texts</u>. This finding was particularly obvious in Hugo's case, who used texts as means of locating future readings and as means of enhancing his understanding of the text being read.

4. <u>an interaction of multiple modes of meaning making</u>. The role of visuals was important in at least two of the four case studies. Hugo relied on multiple graphs and tables in order to understand the algorithm he was reading about. These visuals, especially graphs, provided him with the means for visualizing the stages in the algorithm and afforded his better understanding of the text. John went a step further than Hugo and appropriated the author's visual in the construction of his own definition of a concept which he recorded, together with the drawing, on a piece of paper for further incorporation into his thesis.

5. <u>closely connected with writing</u>. Reading in the four cases was inseparable from note-taking. All the four students left notes which were idiosyncratic and highly individual, yet point to the significance of writing in reading. In addition to these informal notes, John read as part of preparing for writing a research paper, which affected what he focused on in his reading and what he accomplished by reading.

6. <u>involving tools in addition to texts</u>. Within the studies, the role of computers emerged to be central for two students: Hugo and Dewey. Dewey used it to check words he did not know, while Hugo used his computer to check his program and thus verify the author's algorithm, and his EndNote files by thus checking whether he'd read texts mentioned in the text he was reading. Additionally, Dorothy relied on multiple dictionaries to check up the words she did not know, and John made an extensive use of the notepad he had to record his notes and develop a definition of the concept based on the text he read.

7. <u>a social engagement with others through texts</u>. The actions I identified in the students' reading were socially situated in the students' perceptions of their PhD

roles, of most valued disciplinary texts, shared practices and beliefs, as well as expectations. Thus, Joanna's action of learning new vocabulary is tied to her belief that, since she was a student of an English department, she was expected to know English well. Hugo's decision to read the text and his action of making sense of the algorithm presented in it is inseparable from the fact that he had noticed the high value attached to the text within the discipline and the fact that the algorithm was among the first developed in the discipline. Dewey's action of learning about the epistemological debates from reading the text is itself reflective of his awareness of the existence and importance of these debates. Finally, John's action of verifying his research results stems from his expectation that his reviewers/examiners would want to know how reliable his results were and his awareness that it was a common practice to argue for the reliability of research results by referring to others' results.

10.2.2. Research Question 2

In answering the second research question, three major themes were identified across the eleven cases of this study: the role of intertextuality, multimodality, and social others in reading. Through the analysis and interpretation of intertextuality in the students' reading, the following findings emerged: (1) reading one text involves making complex connections between multiple texts, including texts authored by the students; (2) in some cases reading one text leads to reading multiple texts of different genres, including internet websites; and (3) while the intertextual nature of academic texts presents an affordance for extending interactions with disciplinary activity systems to some students, it also presents constraints in meaning making actions for other students.

With respect to multimodality in reading, I identified instances of the students' reliance on visual and mathematical modes of representation when reading academic texts. Through the analysis of the visuals in reading, it became obvious that (1) for some students, visuals such as graphs, tables, and diagrams, present a more accessible

medium for meaning making than linguistic signs and verbal discussions; (2) some students utilized visuals displaying research results to preview texts; and (3) and one student engaged in a conscious analysis of how visuals are constructed in academic writing and what purposes they serve for writers. Additionally, through the analysis of the role of equations in the students' reading, I suggested that (1) texts with mathematical equations are viewed as difficult by several students and were skipped in reading; (2) only some of them engage in calculating and reconstructing the equations; and (3) those who did reconstruct equations, did so by relying on their prior experiences with equations but also multiple means such as other texts and authors of the original text.

Finally, in the analysis of social interactions in postgraduate reading, I identified several sub-themes: (1) the students' interactions with their supervisors, (2) authors of texts they read, and (3) multiple activity systems that go beyond tight disciplinary boundaries. Some of the major findings are: (1) not all the students interacted with their supervisors regarding the texts they read; (2) some of those who had to report to their supervisors about their reading felt pressured by their supervisors while others benefited greatly from those discussions; (3) the students often engaged in real as well as mental conversations with authors; and (4) some students read as part of interacting with multiple rather than single activity systems, which included both professional and disciplinary communities.

10.3. Significance of the study

By involving a systematic analysis of eleven postgraduate students' reading in naturally occurring contexts, this study contributes to at least two research areas: L2 reading and advanced academic literacy research. In the first sub-section that follows, I discuss some of these contributions. Because the study focused on a few students of one university and employed a case study design with interpretative methods of data analysis, it is inappropriate to suggest far-reaching generalizable recommendations for teaching. However, several issues which emerged from the study merit serious consideration by L2

educators and advanced academic literacy practitioners, and these will also be discussed
here.

10.3.1. Contribution to theory

10.3.1.1. L2 reading research

This study contributes to L2 reading research by studying reading in contexts of its
natural occurrence for which it utilized a naturalistic methodology and a unique framework
for understanding context. As a naturalistic study of L2 reading, it follows the tradition set
up by previous research in both L1 and L2 reading (Smagorinsky, 2001; Penningroth, 1997;
Strømsø and Bråten, 2002) and suggests that more naturalistic inquiries into the nature of
L2 reading may provide a better understanding of why students read, what texts they
choose to read, what problems they encounter, and what interactions they engage in.

More importantly, this study contributes to L2 reading research by developing and
applying a framework for understanding contexts, the notion which has been said to be ill-
defined in L2 reading research (Grabe and Stoller, 2002) and in applied linguistics research
in general (Parks and Maguire, 1999; Leki, 2000). The current study suggests the
importance of considering reading in relation to multiple layers of context in which it is
embedded: (1) the context of actual physical-temporal settings, (2) the immediate context of
reading (shifting and developing goals, operations/strategies employed, availability of
tools), and (3) the less immediate contexts of social others (authors, supervisors,
disciplinary and professional communities). The application of activity theory to reading
research appears to offer considerable promise and future studies may develop even
stronger and richer understandings of reading across various contexts by incorporating
activity theory as their analytical tools.

10.3.1.2. Advanced academic literacy research

Finally, the study contributes to the ongoing discussions of advanced academic
literacy research by acknowledging the importance of reading in postgraduate studies

(Johns, 1997; Carson, 2001) and suggesting that advanced academic reading involves: (1) an ability to recognize and rely on the intertextual nature of academic texts; (2) an ability to understand and utilize multiple modes of communication which comprise disciplinary texts; and (3) an ability to see reading as an opportunity to engage in furthering participation with disciplinary and professional activity systems as well as to rely on prior experiences with multiple activity systems in dealing with multiple texts.

10.3.2. Pedagogical implications

The main pedagogical applications of this study arise from the findings concerning the intertextual, multimodal, and social nature of postgraduate reading. First, the current study points to the potential limitations of single-text approaches in L2 reading pedagogy. The tendency of L2 teachers to focus on a single text may be justifiable in certain contexts; however, this study suggests the importance of constructing tasks which would require students to read more than one text. This way, L2 students can engage in more active reading (Simpson and Nist, 2002) and develop intertextual maps which will benefit them with their studies beyond ESL classroom settings.

The study reported here found that for some students the intertextual nature of academic texts presents considerable difficulties. L2 reading instructors, especially those dealing with academic reading, may greatly benefit their students if they discuss some strategies that students could use to solve their problems. These strategies may include: (1) referring to textbooks, Internet and other reference materials for more information which may be alluded to but not explained in primary texts, and (2) recording the texts they read for future references (i.e., through computerized tools such as EndNote).

Finally, note-taking as part of intertextual reading tasks should be given more consideration in L2 reading instruction. As research in L1 reading pedagogy has shown, teaching note-taking strategies and their importance can encourage students to think beyond one text and consider it as a product of an author (see Vaughan and Estes, 1986; Ogle and Blachowicz, 2002).

Considering the finding that postgraduate reading involves interactions with multiple modes of meaning making, another pedagogical implication from this study is the need to reconsider reading instruction to acknowledge the importance of modes other than language (Kress, 2000). It may be argued that L2 academic reading instructors, having been trained in language and linguistics, may not be able to help students develop strategies and techniques for interpreting discipline-specific graphs, statistics, and equations. However, language teachers can help their students realize that multiple modes of communication, when used academic research genres, act as complementary to each other rather than independent and autonomous from each other. Hence, students could rely on language to understand visuals, and on visuals to understand verbal messages.

Finally, the data suggest the importance of social others, especially supervisors, in the student's approaches to reading. Through interacting with their supervisors, students may learn from their supervisors in terms of how they read, how they manage large quantities of reading, how they combine reading with other research activities, what texts they consider important, etc.

10.4. Limitations and future line of research

As the discussion of its theoretical significance and potential pedagogical implications implies, this qualitative study of postgraduate students' reading presented here begins to open up "black boxes" (Latour, 1987) of an intriguing and complex area of L2 reading which has been previously left unexplored. As any research study, however, it has its numerous limitations, and future research will be required to fill the gaps. In this section, I will address some of the gaps of this study and suggest potential directions for future research.

As one of the first studies into postgraduate students' reading, this study is rather **exploratory** in nature and hence all the areas I have identified as characteristic of postgraduate reading deserve more focused attention in future research. Thus, the role of intertextual reading may be analyzed at different stages of postgraduate education, across

various textual genres, or even across specific disciplines. The role of visual and mathematical modes of communication in reading should be further analyzed across different disciplinary communities. Furthermore, the importance of reading in supervisor-supervisee meetings or any research-related meetings that postgraduate students engage in will be an exciting area to look at in the future. One issue to be considered here is whether students need social support of others with their readings and whether this support is provided to them.

Finally, another finding of this study has been the embeddedness of reading in student-supervisor relationships. Specifically, I have shown that some students benefited from discussing their texts with their supervisors because these discussions provided them with a chance to learn from the supervisors and develop their advanced reading abilities. However, as activity theorists caution (see Lantolf, 2000), not every student-supervisor relationship led to the opening up of zones of proximal development for the students, and some students felt constrained by the need to meet with their supervisors which may have hindered their abilities to deal with their readings. What future research may need to consider is the features of student-supervisor relationships which result in student development of advanced reading abilities. For this, future studies of postgraduate reading may need to consider extending their methodologies to include qualitative observations of supervisory meetings.

As a study which sought to understand reading in context, this PhD research relied on **activity theory** for its conceptual framework. As I point out in Chapter 3, activity theory has been under considerable criticism for the openness and "incompleteness" of its notions (see Bannon, 1997; Engeström, 1999). In this study, activity theory concepts have been used as guidelines to understanding the data rather than ready-made techniques and fixed conceptual determinants of meaning (Kramsch, 2000; Russell, 1997). Therefore, their openness to interpretation and applications has been considered a positive rather than a negative aspect. The process I went through in appropriating and concretizing the loosely-defined concepts of activity theory as my research analytical tools has helped me to stay

focused on the object of this research and, consequently, mediated my understanding of its complex nature. Nonetheless, other studies may need to combine this framework with other theories or modify it in order to gain an even deeper understanding of reading in context.

To understand the students' research, their interactions within respective communities, and their reading of specific texts, **the data collection** spanned across the average of three months. While this led to a great amount of information which was deemed more than adequate to answer the research questions of this study, it was not enough to understand the long-term impact of reading on disciplinary enculturation. Longer ethnographic studies of postgraduate reading might need to be conducted in order to address changes in students' reading practices and explore further relationships between reading and advanced academic literacy development. Such longitudinal studies might further contribute to exploring in-depth the social nature of postgraduate reading by analyzing student readers as social actors interacting with others through the texts they read. They may need to conduct interviews with supervisors and students' colleagues to gain wider perspectives.

In this research, I employed a multiple **case study design** (Yin, 2003), which allowed me to capture both the idiosyncrasies of reading in each case as well as commonalities across them. However, achieving the balance between the depth and the breadth proved to be difficult, both in the analysis and presentation of the data. As a result, it might appear to some readers that this thesis provides too much detail about the students and their reading. In the future, studies may need to carefully consider the limitations of employing multiple case studies and the difficulties associated with analyzing and presenting the data.

Employing **the think-aloud method** provided an invaluable opportunity to observe the physical-temporal settings in which the students read and their reliance on material and semiotic tools, as well as to record their immediate thoughts. Hugo's and Dewey's cases therefore revealed more information about their operations when compared to Joanna and John. However, not all students of this study agreed to or were able to think aloud while

reading. This is somewhat unfortunate considering that think aloud sessions can provide a window into the readers' minds (Smagorinsky, 1998) and can lead to detailed descriptions and analyses of their reading (Pressley and Afflerbach, 1995). Future studies may need to find other more effective ways of substituting for the think aloud data, and in particular, they might explore the possibility of regular reading logs to be collected from the readers.

Finally, it has been pointed out by more recent research in university students' reading that students approach academic texts with certain **theories of reading** (see Sengupta, 2002). In this study, I also observed that several students had conceptions of what it meant to be a good reader and, for example, reading every word was not characteristic of good reading for some of them. Future studies of postgraduate reading may lead to more interesting findings if they systematically analyze students' theories about reading in general and about "good" vs. "bad" reading, in particular.

Despite these limitations, the present study is nonetheless provocative in that it provides a systematic analysis of postgraduate students' reading in naturalistic contexts. By utilizing a comparatively "new" theoretical framework for research into the nature of postgraduate reading and presenting case studies as well as cross-case comparisons, it has identified some new venues for research that will expand our understanding about L2 reading and advanced academic literacy. It is hoped that other studies of reading will be encouraged by the findings from this study and generate more comprehensive and helpful insights.

References

Afflerbach, P. P. (1990). The influence of prior knowledge on expert readers' main idea construction strategies. Reading Research Quarterly, 25(1), 31-46.

Ahmed, M. K. (1994). Speaking as cognitive regulation: A Vygotskian perspective on dialogic communication. In J. P. Lantolf and G. Appel (Eds.), Vygotskian approaches to second language research (pp. 157-171). Norwood, NJ: Ablex.

Allen, G. (2000). Intertextuality. London: Routledge.

Allison, D., Cooley, L., Lewkowicz, J., and Nunan, D. (1998). Dissertation writing in action: The development of a dissertation writing support program for ESL graduate research students. English for Specific Purposes, 17(2), 199-217.

Amann, K., and Knorr Cetina, K. (1990). The fixation of (visual) evidence. In M. Lynch and S. Woolgar (Eds.), Representation in scientific practice (pp. 85-121). Cambridge: The MIT Press.

Angelova, M. and Riazantseva, A. (1999). "If you don't tell me, how can I know?" A case study of four international students learning to write the U.S. way. Written Communication, 16(4), 491-525.

Anonymous. (1996). Editorial. Journal of Literacy Research, 28(1), 1-8.

Arizpe, E. and Styles, M. (2003). Children reading pictures: Interpreting visual texts. London: Routledge Falmer Taylor and Francis Group.

Astorga, M. C. (1999). Text-image interaction and second language learning. Australian Journal of Language and Culture, 22, 212-233.

Atkinson, D. (1999). Scientific discourse in sociohistorical context: The Philosophical Transactions of the Royal Society, 1675-1975. Mahwah NJ: Lawrence Erlbaum Associates.

Atkinson, D. (2003). Writing and culture in the post-process era. Journal of Second Language Writing, 12(1), 49-63.

Atkinson, P. (1992). Understanding ethnographic texts. Newbury Park: Sage.

Aurenhammer, F. and Klein, R. (2000). Voronoi Diagrams. In J.-R. Sack and J. Urrutia (Eds.), Handbook of computational geometry (pp. 201-290). Amsterdam: Elsevier.

Bakhtin, M. (1981). The dialogic imagination. Austin: University of Texas Press.

Bakhtin, M. M. (1986). The problem of speech genres (V. W. McGee, Trans.). In C. Emerson and M. Holquist (Eds.), Speech Genre and Other Essays (pp. 60-102). Austin: University of Texas Press.

Bannon, L. (1997). Activity theory. Retrieved 4 February, 2003, from the World Wide Web: http://www-sv.cict.fr/cotcos/pjs/TheoreticalApproaches/Actvity/ActivitypaperBannon.htm

Barton, D. (1994). Literacy: An introduction to the ecology of written language. Oxford: Blackwell.

Barton, D., Hamilton, M., and Ivanič, R. (Eds.). (2000). Situated literacies: Reading and writing in context. London: Routledge.

Bastide, F. (1990). The iconography of scientific texts: Principles of analysis (G. Myers, Trans.). In M. Lynch and S. Woolgar (Eds.), Representation in scientific practice (pp. 187-229). Cambridge: The MIT Press.

Bateson, G. (1972). Steps to an ecology of mind. New York: Ballantine.

Bazerman, C. (1985). Physicists reading physics: Schema-laden purposes and purpose-laden schema. Written Communication, 2(1), 3-23.

Bazerman, C. (1988). Shaping written knowledge: The genre and activity of the experimental article in science. Madison: University of Wisconsin Press.

Bazerman, C. (1997). Discursively structured activities. Mind, Culture, and Activity, 4(4), 296-308.

Bazerman, C. (2004). Intertextuality: How texts rely on other texts. In C. Bazerman and P. Prior (Eds.), What writing does and how it does it: An introduction to analyzing texts and textual practices (pp. 83-96). Mahwah, NJ: Lawrence Erlbaum Associates.

Bean, T.W. (2001). An update on reading in the content areas: Social constructionist dimensions. Reading Online, 5(5). Retrieved 12 August, 2003, from the World Wide Web: http://www.readingonline.org/articles/art_index.asp?HREF=handbook/bean/index.html

Beck, I. L. and McKeown, M. G. (2001). Inviting students into the pursuit of meaning. Educational Psychology Review, 13(3), 225-241.

Belcher, D. (1994). The apprenticeship approach to advanced academic literacy: Graduate students and their mentors. English for Specific Purposes, 13, 23-34.

Benson, M. J. (1991). University ESL reading: A content analysis. English for Specific Purposes, 10, 75-88.

Berkenkotter, C. and Huckin, T. N. (1995). Genre knowledge in disciplinary communication. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Berkenkotter, C., Huckin, T. N., and Ackerman, J. (1991). Social context and socially constructed texts. In C. Bazerman (Ed.), Textual Dynamics of the Professions (pp. 191-215). Madison: University of Wisconsin Press.

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

Bishop, W. (1999). Ethnographic writing research: Writing it down, writing it up, and reading it. Portsmouth, NH: Boynton/Cook Publishers, Heinemann.

Biswas, G. (2003). Historical developments in computational fluid dynamics. Retrieved 12 August, 2003, from the World Wide Web: http://www.sali.freeservers.com/engineering/cfd/cfd_history.html

Blakeslee, A. M. (1997). Activity, context, interaction, and authority: Learning to write scientific papers in situ. Journal of Business and Technical Communication, 11, 125-169.

Boje, D. M. (2001). Narrative methods for organizational and communication research. Thousand Oaks, CA: Sage.

Boren, M. T. and Ramey, J. (2000). Thinking aloud: Reconciling theory and practice. IEEE Transactions on Professional Communication, 43(3), 261-278.

Bossers, B. (1992). Reading in two languages: A study of reading comprehension in Dutch as a second language and in Turkish as a first language. Rotterdam, The Netherlands: Drukkerij Van Driel.

Braine, G. (2002). Academic literacy and the nonnative speaker graduate student. Journal of English for Academic Purposes, 1, 59-68.

Burniske, R. W. and Monke, L. (2001). <u>Breaking down the digital walls: Learning to teach in a post-modern world</u>. Albany: State University of New York Press.

Cadman, K. (2000). 'Voices in the air': Evaluations of the learning experiences of international postgraduates and their supervisors. <u>Teaching in Higher Education, 5</u>(4), 475-491.

Campbell, C. (1990). Writing with others' words: Using background reading text in academic compositions. In B. Kroll (Ed.), <u>Second language writing: Research insights for the classroom</u> (pp. 211-230). New York: Cambridge University Press.

Canagarajah, S. (2002). Multilingual writers and the academic community: Towards a critical relationship. <u>Journal of English for Academic Purposes, 1</u>, 29-44.

Candlin, C. N. and Maley, Y. (1997). Intertextuality and interdiscursivity in the discourse of alternative dispute resolution. In B. Gunnarsson, P. Linell, and B. Nordberg (Eds.), <u>The construction of professional discourse</u> (pp. 201-222). Harlow, Essex: Addison Wesley Longman.

Canning-Wilson, C. (2001). <u>Choosing EFL/ESL visual assessment: Image and picture selection on foreign and second language exams</u> (FL026679). East Lansing, MI: National Center for Research in Teacher Learning.

Carpenter, P. A. and Shah, P. (1998). A model of the perceptual and conceptual processes in graph comprehension. <u>Journal of Experimental Psychology: Applied, 4</u>(2), 75-100.

Carrell, P. (1991). Second language reading: Reading ability or language proficiency. <u>Applied Linguistics, 12</u>(2), 159-179.

Carrell, P. and Connor, U. (1991). Reading and writing descriptive and persuasive texts. *The Modern Language Journal 7*(3), 314- 328.

Carson, J. G. (2000). Reading and writing for academic purposes. In M. Pally (Ed.), <u>Sustained content teaching in academic ESL/EFL: A practical approach</u> (pp. 19-34). Boston: Houghton Mifflin.

Carson, J. G. (2001). A task analysis of reading and writing in academic contexts. In D. D. Belcher and A. R. Hirvela (Eds.), <u>Linking literacies: Perspectives on L2 reading-writing connections</u> (pp. 48-83). Ann Arbor: The University of Michigan Press.

Carson, J. E., Carrell, P.L., Silberstein, S., Kroll, B., and: Kuehn, P.A. (1990). Reading-writing relationships in first and second language. <u>TESOL Quarterly, 24</u>(2), 245-266.

Casanave, C. P. (1992). Cultural diversity and socialization: A case study of a Hispanic woman in a doctoral program in sociology. In D. E. Murray (Ed.), <u>Diversity as resource: Redefining cultural literacy</u> (pp. 148-182). Alexandria, VA: Teachers of English to Speakers of Other Languages.

Casanave, C. P. (2002). <u>Writing games: Multicultural case studies of academic literacy practices in higher education</u>. Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.

Casanave, C. P. (2003). Looking ahead to more sociopolitically-oriented case study research in L2 writing scholarship: (But should it be called "post-process"?). <u>Journal of Second Language Writing, 12</u>(1), 85-102.

Casanave, C. P. and Hubbard, P. (1992). The writing assignments and writing problems of doctoral students: Faculty perceptions, pedagogical issues, and needed research. <u>English for Specific Purposes, 11</u>, 33-49.

Cavalcanti, M. C. (1987). Investigating FL reading performance through pause protocols. In C. Faerch and G. Kasper (Eds.), <u>Introspection in second language research</u> (Vol. 30, pp. 230-250). Clevedon, PA: Multilingual Matters.

Chapman, A. (1995). Intertextuality in school mathematics. <u>Linguistics and Education, 7</u>, 243-262.

Chi, F.-M. (1995). EFL readers and a focus on intertextuality. <u>Journal of Reading, 38</u>(8), 638-644.

Cohen, A. D. (1998). <u>Strategies in learning and using a second language</u>. London: Longman.

Cohen, L., Manion, L., and Morrison, K. (2000). <u>Research methods in education</u> (5 ed.). London: RoutledgeFalmer.

Cole, M. (1996). <u>Cultural psychology: A once and future discipline</u>. Cambridge, MA: Harvard University Press.

Colombi, M. C. and Schleppegrell, M. J. (2002). Theory and practice in the development of advanced literacy. In M. J. Schleppegrell and M. C. Colombi (Eds.), <u>developing advanced literacy in first and second languages: Meaning with power</u> (pp. 1-19). Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.

Creswell, J. W. (2003). <u>Research design: Qualitative, quantitative, and mixed methods approaches</u>. Thousand Oaks, CA: Sage Publications.

Cronbach, L. J. (1975). Beyond the two disciplines of scientific psychology. <u>American Psychologist, 30</u>, 116-127.

Davydov, V. V. (1988). Problems of the child's mental development. <u>Soviet Education, 30</u>(8), 44-97.

Davydov, V. V. and Radzikovskii, L. A. (1985). Vygotsky's theory and the activity-oriented approach in psychology. In J. V. Wertsch (Ed.), <u>Culture, communication, and cognition: Vygotskian perspectives</u> (pp. 35-65). Cambridge: Cambridge University Press.

de Floriani, L., Magillo, P., and Puppo, E. (2000). Applications of computational geometry to Geographic Information Systems. In J.-R. Sack and J. Urrutia (Eds.), <u>Handbook of computational geometry</u> (pp. 333-388). Amsterdam: Elsevier.

Denzin, M. K. and Lincoln, Y. S. (Eds.). (1998). <u>Collecting <i>and</i> interpreting qualitative materials</u>. Thousand Oaks: Sage Publications.

Denzin, N. K. (1978). <u>The research act: A theoretical introduction to sociological methods</u>. New York: McGraw-Hill Book Company.

Denzin, N. K. and Lincoln, Y. S. (2000). The discipline and practice of qualitative research. In N. K. Denzin and Y. S. Lincoln (Eds.), <u>Handbook of qualitative research</u> (pp. 1-29). London: Sage Publications.

Denzin, N. K. and Lincoln, Y. S. (2003). Introduction: The discipline and practice of qualitative research. In N. K. Denzin and Y. S. Lincoln (Eds.), <u>The landscape of qualitative research: Theories and issues</u> (pp. 1-45). Thousand Oaks, CA: Sage Publications.

Dexter, S. L., Anderson, R. E., and Becker, H. J. (1999). Teachers' views of computers as catalysts for change in their teaching practice. <u>Journal of Research on Computing in Education, 31</u>(3), 221-239.

Dias, P. (2000). Writing classrooms as activity systems. In P. Dias and A. Pare (Eds.), <u>Transitions: Writing in academic and workplace settings</u> (pp. 11-29). Cresskill, NJ: Hampton Press, Inc.

Dickey, R. J. (2004). ELT book review: Principles of language learning and teaching (4th Ed.). Retrieved 15 January, 2004, from the World Wide Web: http://www.eltnews.com/features/eltbooks/003.shtml

Donato, R. (2000). Sociocultural contributions to understanding the foreign and second language classroom. In J. P. Lantolf (Ed.), Sociocultural theory and second language learning (pp. 27-50). Oxford: Oxford University Press.

Dong, Y. R. (1998). Non-native graduate students' thesis/dissertation writing in science: Self-reports by students and their advisors from two U.S. institutions. English for Specific Purposes, 17(4), 369-390.

Donmoyer, R. (2000). Generalizability and the single-case study. In R. Gomm, M. Hammersley, and P. Foster (Eds.), Case study method: Key issues, key texts (pp. 45-68). London: Sage Publications.

Douglas, D. (2000). Assessing language for specific purposes. Cambridge: Cambridge University Press.

Duff, P. A. (2002). Research approaches in Applied Linguistics. In R. Kaplan (Ed.), The Oxford handbook of Applied Linguistics (pp. 13-23). New York: Oxford University Press.

Duff, P. A. (2004). Intertextuality and hybrid discourses: The infusion of pop culture in educational discourse. Linguistics and Education, 14, 231-276.

Durgunoglu, A. Y. and Verhoeven, L. T. W. (Eds.) (1998). Literacy development in a multilingual context: Cross-cultural perspectives. Mahwah, NJ: Erlbaum.

Dysthe, O. (2002). Professors as mediators of academic text cultures. Written Communication, 19(4), 493-544.

Egan-Robertson, A. (1998). Learning about culture, language, and power: Understanding relationships among personhood, literacy practices, and intertextuality. Journal of Literacy Research, 30(4), 449-487.

Eisner, E. W. (2001). Concerns and aspirations for qualitative research in the new millennium. Qualitative research, 1(2), 135-145.

Eisterhold, J. C. (1990). Reading-writing connections: Toward a description for second language learners. In B. Kroll (Ed.), Second language writing: Research insights for the classroom (pp. 88-107). New York: Cambridge University Press.

Elley, W. (1991). Acquiring literacy in a second language: The effect of book-based programs. Portsmouth, NH: Heineman.

Elley, W. (1996). Using book floods to raise literacy levels in developing countries. In V. Greaney (Ed.), Promoting reading in developing countries: Views on making reading materials accessible to increase literacy levels (pp. 148-163). Newark, DE: International Reading Association

Engeström, Y. (1987). Learning by expanding: An activity-theoretical approach to developmental research. Helsinki: Orienta-Konsultit Oy.

Engeström, Y. (1993). Developmental studies of work as a testbench of activity theory: The case of primary care medical practice. In S. Chaiklin and J. Lave (Eds.), Understanding practice: Perspectives on activity and context (pp. 64-103). Cambridge: Cambridge University Press.

Engeström, Y. (1999). Activity theory and individual and social transformation. In Y. Engestrom, R. Miettinen, and R.-L. Punamaki (Eds.), Perspectives on activity theory (pp. 19-38). Cambridge: Cambridge University Press.

Engeström, Y. (2001). <u>Activity theory and social capital</u>. Helsinki: Center for Activity theory and Developmental Work Research, University of Helsinki.

Ericsson, K. A. and Simon, H. A. (1984). <u>Protocol analysis: Verbal reports as data</u>. Cambridge: MIT Press.

Ericsson, K. A. and Simon, H. A. (1993). <u>Protocol analysis: Verbal reports as data</u> (Revised ed.). Cambridge, MA: MIT Press.

Ericsson, K. A. and Simon, H. A. (1998). How to study thinking in everyday life: Contrasting think-aloud protocols with descriptions and explanations of thinking. <u>Mind, Culture, and Activity, 5</u>(3), 178-186.

Fairclough, N. (1992). Intertextuality in Critical Discourse Analysis. <u>Linguistics and Education, 4</u>, 269-293.

Forrest, D. (1998). Canada today. In T. W. Foresman (Ed.), <u>The history of geographic information systems: Perspectives from the pioneers</u> (pp. 331-347). Upper Saddle River, NJ: Prentice Hall.

Frankel, R. and Beckman, H. (1982). IMPACT: An interaction based method for preserving and analyzing clinical transactions. In L. Pettigrew (Ed.), <u>Explorations in provider and patient transactions</u>. Memphis, TN: Humana.

Freedman, S. (1995). Crossing the bridge to practice: Rethinking the theories of Vygotsky and Bakhtin. <u>Written Communication, 12</u>, 74-92.

Freire, P. (1970). <u>Pedagogy of the oppressed</u>. New York: Herder and Herder.

Fretchling, J. and Sharp, L. (1997). <u>User-friendly handbook for mixed method evaluations</u>. Retrieved 23 May, 2004, from the World Wide Web: <u>http://www.ehr.nsf.gov/EHR/REC/pubs/NSF97-153/start.htm</u>

Galperin, P. Y. (1969). Stages in the development of mental acts. In M. Cole and I. Maltzman (Eds.), <u>A handbook of contemporary Soviet psychology</u> (pp. 249-273). New York: Basic Books.

Garrett, P. and Bell, A. (1998). Media and discourse: A critical overview. In A. Bell and P. Garrett (Eds.), <u>Approaches to media discourse</u> (pp. 1-20). Oxford: Blackwell Publishers.

Gass, S. M. and Mackey, A. (2000). <u>Stimulated recall methodology in second language research</u>. Mahwah, NJ: Lawrence Erlbaum.

Gee, J. P. (1992). Socio-cultural approaches to literacy (literacies). <u>Annual Review of Applied Linguistics, 12</u>, 31-48.

Gee, J. P. (1996). <u>Social linguistics and literacies: Ideology in Discourses</u>. London: Taylor & Francis.

Gee, J. P. (1999). <u>An introduction to discourse analysis: Theory and method</u>. London: Routledge.

Gee, J. P. (2002). Literacies, identities, and discourses. In M. J. Schleppegrell and M. C. Colombi (Eds.), <u>Developing advanced literacy in first and second languages: Meaning with power</u> (pp. 159-175). Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.

Geertz, C. (1983). <u>Local knowledge: Further essays in interpretive anthropology</u>. New York: Basic Books.

Geisler, C. (1991). Toward a cognitive model of literacy: Constructing mental models in a philosophical conversation. In C. Bazerman and J. Paradis (Eds.), <u>Textual</u>

dynamics and the professions: Historical and contemporary studies of writing in professional communities (pp. 171-190). Madison: University of Wisconsin Press.

Giacshi, P. (2000). Gender positioning in education: A critical image analysis of ESL texts. TESL Canada Journal, 18(1), 32-47.

Gibson, J. J. (1979). The ecological approach to visual perception. Boston: Houghton Mifflin.

Ginther, A. (2001). Effects of the presence and absence of visuals on performance on TOEFL CBT listening-comprehensive stimuli (66). Princeton, NJ: ETS.

Glanville, R., Sengupta, S., and Forey, G. (1998). A (cybernetic) musing: Language and science in the language of science. Cybernetics and Human Knowing, 5(4), 61-70.

Glaser, B. G. (1978). Theoretical sensitivity. Mill Valley, CA: Sociology Press.

Glaser, B. G. and Strauss, A. L. (1967). The discovery of grounded theory: Strategies for qualitative research. New York: Aldine Publishing.

Glesne, C. (1999). Becoming qualitative researchers: An introduction. New York: Longman.

Goetz, J. and LeCompte, M. (1984). Ethnography and qualitative design in educational research. Orlando, Fl: Academic Press.

Goffman, E. (1981). Forms of talk. Philadelphia: University of Pennsylvania Press.

Goldman, S. R. (1997). Learning from text: Reflections on the past and suggestions for the future. Discourse Processes, 23, 357-398.

Goodwin, C. and Duranti, A. (1992). Rethinking context: An introduction. In A. Duranti and C. Goodwin (Eds.), Rethinking context: Language as an interactive phenomenon (pp. 1-42). Cambridge: Cambridge University Press.

Gosden, H. (1995). Success in research article writing and revision: A social constructionist perspective. English for Specific Purposes, 14(1), 37-57.

Gosden, H. (1996). Verbal reports of Japanese novices' research writing practices in English. Journal of Second Language Writing, 5, 109-128.

Grabe, W. (1988). Reassessing the term 'interactive'. In P. L. Carrell, J. Devine, and D. E. Eskey (Eds.), Interactive approaches to second language reading (pp. 56-70). Cambridge: Cambridge University Press.

Grabe, W. (1997). Reading research and its implications for reading assessment. In A. J. Kunnan (Ed.), Fairness and validation in language assessment: Selected papers from the 19th Language Testing Research Colloquium, Orlando, Florida (pp. 226-262). Cambridge: Cambridge University Press.

Grabe, W. (2001). Reading-writing relations: Theoretical perspectives and instructional practices. In D. Belcher and A. R. Hirvela (Eds.), Linking literacies: Perspectives on L2 reading-writing connections (pp. 15-47). Ann Arbor: The University of Michigan Press.

Grabe, W. (2003). Reading and writing relations: Second language perspectives on research and practice. In B. Kroll (Ed.), Exploring the dynamics of second language writing (pp. 242-262). Cambridge: Cambridge University Press.

Grabe, W. and Stoller, F. L. (2002). Teaching and researching reading. Harlow: Longman.

Gradwohl-Nash, J., Schumacher, G., and Calrson, B. (1993). Writing from sources: A structure mapping model. Journal of Educational Psychology, 85, 159-170.

Gross, A. G., Harmon, J. E., and Reidy, M. (2002). Communicating Science: The scientific article from the 17th century to the present. Oxford: Oxford University Press.

Grotjahn, R. (1987). On the methodological basis of introspective methods. In C. Faerch and G. Kasper (Eds.), Introspection in second language research (pp. 54-81). Clevedon, PA: Multilingual Matters LTD.

Guba, E. G. and Lincoln, Y. S. (1989). Fourth generation evaluation. Newbury Park, CA: Sage Publications.

Haas, C. (1994). Learning to read biology: One student's rhetorical development in college. Written Communication, 11(1), 43-84.

Haas, C. and Flower, L. (1988). Rhetorical reading strategies and the construction of meaning. College Composition and Communication, 39, 167-183.

Hacker, D. J. (1998). Self-regulated comprehension during normal reading. In D. J. Hacker, J. Dunlosky, and A. C. Graesser (Eds.), Metacognition in educational theory and practice (pp. 165-191). Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.

Halliday, M. A. K. (1973). Explorations in the function of language. London: Edward Arnold.

Haneda, M. (2000). Negotiating meaning in writing conferences: An investigation of a university Japanese-as-a-foreign -language class. Unpublished PhD dissertation, University of Toronto, Toronto.

Harms, P. L. C. (2003). Writing-across-the-curriculum in a linked course method for first-year students: An activity theory analysis. Unpublished PhD, Iowa State University, Ames, IA.

Hartman, D. K. (1992). Intertextuality and reading: The text, the reader, the author, and the context. Linguistics and Education, 4, 295-311.

Hartman, D. K. (1995). Eight readers reading: The intertextual links of proficient readers using multiple passages. Reading Research Quarterly, 30(3), 520-561.

Haswell, R., Briggs, T. L., Fay, J. A., Gillen, N. K., Harrill, R., Shupala, A. M., and Trevino, S. S. (1999). Context and rhetorical reading strategies: Haas and Flower (1988) revisited. Written Communication, 16, 3-27.

Hickman, L. A. (1990). John Dewey's pragmatic technology. Bloomington, IN: Indiana University Press.

Holliday, A. (2002). Doing and writing qualitative research. London: Sage Publications.

Hong Kong Polytechnic University. (2003). Research student handbook for 2003-2004. Hong Kong: The Hong Kong Polytechnic University.

Huberman, A. M. and Miles, M. B. (2002). The qualitative researcher's companion. Thousand Oaks: Sage Publications.

Hyland, K. (1998). Persuasion and context: The pragmatics of academic metadiscourse. Journal of Pragmatics, 30(437-455).

Hyland, K. (1999). Academic attribution: Citation and the construction of disciplinary knowledge. Applied Linguistics, 20(3), 341-367.

Hyland, K. (2000). Disciplinary discourses: Social interactions in academic writing. Harlow: Longman.

Hyland, K. (2001). Bringing in the reader: Addressee features in academic articles. Written Communication, 18(4), 549-574.

Hyland, K. (2003). Genre-based pedagogies: A social response to process. <u>Journal of Second Language Writing, 12</u>(1), 17-29.

Hyland, K. and Hamp-Lyons, L. (2002). EAP: Issues and directions. <u>Journal of English for Academic Purposes, 1</u>(1), 1-12.

Jenkins, S., Jordan, M. K., and Weiland, P. O. (1993). The role of writing in graduate engineering education: A survey of faulty beliefs and practices. <u>English for Specific Purposes, 12</u>, 51-67.

Jewitt, C. and Oyama, R. (2001). Visual meaning: A social semiotic approach. In T. van Leeuwen and C. Jewitt (Eds.), <u>Handbook of visual analysis</u> (pp. 134-156). London: Sage Publications.

Jiang, S. (2001). <u>English academic writing and reading: Case studies of Taiwanese graduate students' second language research paper composing in an American university.</u> Unpublished PhD, Indiana University, USA.

Johns, A. M. (1991). Interpreting an English competency examination: The frustrations of an ESL science student. <u>Written Communication, 8</u>, 379-401.

Johns, A. M. (1993). Written argumentation for real audiences: Suggestions for teacher research and classroom practice. <u>TESOL Quarterly, 27</u>(1), 75-90.

Johns, A. M. (1997). <u>Text, role, and context</u>. Cambridge: Cambridge University Press.

Johns, A. M. (1998). The visual and the verbal: A case study in microeconomics. <u>English for Specific Purposes, 17</u>(2), 183-197.

Johns, A. and Mayes, P. (1990). An analysis of summary protocols of university ESL students. <u>Applied Linguistics, 11</u>, 253-271.

Johns, A. M. and Swales, J. M. (2002). Literacy and disciplinary practices: opening and closing perspectives. <u>Journal of English for Academic Purposes, 1</u>, 13-28.

John-Steiner, V. (1995). Cognitive pluralism: A sociocultural approach. <u>Mind, Culture and Activity, 2</u>, 2-10.

Johnston, P. H. and Afflerbach, P. P. (1985). The process of constructing main ideas from text. <u>Cognition and Instruction, 2</u>, 207-232.

Kaiser, D. (2001). <u>Pain and somatic disorders alert</u>. Retrieved 6 February, 2004, from the World Wide Web: <u>http://health.groups.yahoo.com/group/painalert/message/101</u>

Kaptelinin, V. (1996). Computer-mediated activity: Functional organs in social and developmental contexts. In B. A. Nardi (Ed.), <u>Context and consciousness: Activity theory and human-computer interaction</u> (pp. 45-68). Cambridge: The MIT Press.

Katz, I. R., Xi, X., Kim, H. J., and Cheng, P. C. H. (2004). <u>Elicited speech from graph items on the Test of Spoken English</u> (TOEFL Report 74). Princeton, NJ: ETS.

Kluwer Academic Publishers. (2004). <u>Neuropsychology Review: Aims and scope</u>. Retrieved 6 February, 2004, from the World Wide Web: <u>http://www.kluweronline.com/issn/1040-7308/contents</u>

Ko, P. K. (1997). <u>Postgraduate education in Hong Kong—Past, present, and future.</u> Paper presented at the conference "The role of postgraduate education in the 21st century", Hong Kong.

Koutsantoni, D. (2004). Attitude, certainty, and allusion to common knowledge in scientific research articles. <u>Journal of English for Academic Purposes, 3</u>, 163-182.

Kozulin, A. (1986). The concept of activity in Soviet psychology. <u>American Psychologist, 41</u>, 264-274.

Kramsch, C. (2000). Social discursive constructions of self in L2 learning. In J. P. Lantolf (Ed.), <u>Sociocultural theory and second language learning</u> (pp. 133-153). Oxford: Oxford University Press.

Krashen, S. (1984). <u>Writing: Research, theory, and applications</u>. Oxford: Pergamon Institute of English.

Kress, G. (2000). Multimodality: Challenges to thinking about language. <u>TESOL Quarterly, 34</u>, 337-340.

Kress, G. and van Leeuwen, T. (1996). <u>Reading images: The grammar of visual design</u>. London: Routledge.

Kress, G. and van Leeuwen, T. (1998). Front pages: (The critical) analysis of newspaper layout. In A. Bell and P. Garrett (Eds.), <u>Approaches to media discourse</u> (pp. 186-219). Oxford: Blackwell Publishers.

Kristeva, J. (1980). Word, dialogue, and novel (L. S. Roudiez, Trans.). In T. Gora et al. (Eds.), <u>Desire and language</u> (pp. 64-91). New York: Columbia University Press.

Kristeva, J. (1986). Word, dialogue and novel. In T. Moi (Ed.), <u>The Kristeva reader</u>. Oxford, England: Basil Blackwell.

Kucan, L. and Beck, I. L. (1997). Thinking aloud and reading comprehension research: Inquiry, instruction, and social interaction. <u>Review of Educational Research, 67</u>(3), 271-299.

Kucer, S. L. (1985). The making of meaning: Reading and writing as parallel processes. <u>Written Communication, 2</u>(3), 317-336.

Kuhn, T. (1962). <u>The structure of scientific revolutions</u>. Chicago: University of Chicago Press.

Kuutti, K. (1996). Activity theory as a potential framework for human-computer interaction research. In B. A. Nardi (Ed.), <u>Context and consciousness: Activity theory and human-computer interaction</u> (pp. 17-44). Cambridge: The MIT Press.

Kvale, S. (1995). The social construction of validity. <u>Qualitative inquiry, 1</u>(1), 19-40.

Langer, J. and Flihan, S. (2000). Writing and reading relationships: Constructive tasks. In R. Indrisano and J. R. Squire (Eds.), <u>Perspectives on writing: Research, theory, and practice</u>. Newark, Del.: International Reading Association.

Lantolf, J. P. (2000). Introducing sociocultural theory. In J. P. Lantolf (Ed.), <u>Sociocultural theory and second language learning</u> (pp. 1-26). Oxford: Oxford University Press.

Lantolf, J. P. and Appel, G. (Eds.). (1994). <u>Vygotskian approaches to second language research</u>. Norwood, NJ: Ablex.

Latour, B. (1987). <u>Science in action: How to follow scientists and engineers through society</u>. Milton Keynes, England: Open University Press.

Latour, B. (1990). Drawing things together. In M. Lynch and S. Woolgar (Eds.), <u>Representation in scientific practice</u> (pp. 19-68). Cambridge: The MIT Press.

Lave, J. and Wenger, E. (1991). <u>Situated learning: Legitimate peripheral participation</u>. Cambridge: Cambridge University Press.

Law, J. and Lynch, M. (1990). Lists, field notes, and descriptive organization of seeing: Birdwatching as an exemplary observational activity. In M. Lynch and S. Woolgar (Eds.), <u>Representation in scientific practice</u> (pp. 267-299). Cambridge: The MIT Press.

Leinhardt, G. and Young, K. M. (1996). Two texts, three readers: Distance and expertise in reading history. <u>Cognition and Instruction, 14</u>(4), 441-486.

Leki, I. (1993). Reciprocal themes in ESL reading and writing. In J. G. Carson and I. Leki (Eds.), <u>Reading in the composition classroom: Second language perspectives</u> (pp. 9-32). Boston: Heinle and Heinle Publishers.

Leki, I. (1998). <u>Academic writing: Exploring processes and strategies</u>. Cambridge: Cambridge University Press.

Leki, I. (2000). Writing, literacy, and applied linguistics. <u>Annual Review of Applied Linguistics, 20</u>, 99-115.

Leki, I. (2003). Coda: Pushing L2 writing research. <u>Journal of Second Language Writing, 12</u>(1), 103-105.

Leki, I. and Carson, J. (1994). Students' perceptions of EAP writing instruction and writing needs across the disciplines. <u>TESOL Quarterly, 28</u>, 81-101.

Leki, I. and Carson, J. (1997). "Completely different worlds": EAP and the writing experiences of ESL students in university courses. <u>TESOL Quarterly, 31</u>, 39-69.

Lektorsky, V. A. (Ed.). (1991). <u>Activity: Theories, methodology and problems</u>. Orlando: Paul M. Deutsch Press.

Lemke, J. L. (1998). Multiplying meaning: Visual and verbal semiotics in scientific text. In J. R. Martin and R. Veel (Eds.), <u>Reading science</u> (pp. 87-113). London: Routledge.

Lemke, J. L. (2000). Multimedia demands of the scientific curriculum. <u>Linguistics and Education, 10</u>(3), 1-25.

Lemke, J. L. (2002). Multimedia semiotics: Genres for science education and scientific literacy. In M. J. Schleppegrell and M. C. Colombi (Eds.), <u>Developing advanced literacy in first and second languages: Meaning with power</u> (pp. 21-44). Mahwah, NJ: Lawrence Erlbaum Associates.

Leontev, A. N. (1978). <u>Activity, consciousness, and personality</u> (M. J. Hall, Trans.). Englewood Cliffs, NJ: Prentice-Hall.

Levin, J. R., Anglin, G. J., and Carney, R. N. (1987). On empirically validating functions of pictures in prose. In D. A. Willows and H. A. Houghton (Eds.), <u>The psychology of illustration</u> (pp. 51-85). New York: Springer-Verlag.

Lincoln, Y. S. and Guba, E. G. (1985). <u>Naturalistic inquiry</u>. Newbury Parks, CA: Sage Publications.

Lincoln, Y. S. and Guba, E. G. (2000). The only generalization is: There is no generalization. In R. Gomm, M. Hammersley, and P. Foster (Eds.), <u>Case study method: Key issues, key texts</u> (pp. 27-44). London: Sage Publications.

Lincoln, Y. S. and Guba, E. G. (2003). Paradigmatic controversies, contradictions, and emerging confluences. In N. K. Denzin and Y. S. Lincoln (Eds.), <u>The landscape of qualitative research: theories and issues</u> (pp. 253-291). Thousand Oaks, CA: Sage Publications.

Lister, M. and Wells, L. (2001). Seeing beyond belief: Cultural Studies as an approach to analyzing the visual. In T. van Leeuwen and C. Jewitt (Eds.), <u>Handbook of visual analysis</u> (pp. 61-91). London: Sage Publications.

Luke, A. and Freebody, P. (1997). Shaping the social practices of reading. In S. Muspratt, A. Luke, and P. Freebody (Eds.), <u>Constructing critical literacies: Teaching and learning textual practice</u> (pp. 185-225). Sydney: Allen and Unwin.

Lundeberg, M. A. (1987). Metacognitive aspects of reading comprehension: Studying understanding in legal case analysis. <u>Reading Research Quarterly, 22</u>, 407-432.

Lynch, M. (1985). Discipline and the material form of images: An analysis of scientific visibility. Social Studies of Science, 15(1), 37-66.

Lynch, M. and Woolgar, S. (Eds.). (1990). Representation in scientific practice. Cambridge: The MIT Press.

Marshall, C. and Rossman, G. B. (1989). Designing qualitative research. Newbury Park, CA: Sage Publications.

Mason, J. (2002). Qualitative researching. London: Sage Publications.

Matsuda, P. K. (2001). Reexamining audiolingualism: On the genesis of reading and writing in L2 studies. In D. D. Belcher and A. R. Hirvela (Eds.), Linking Literacies: Perspectives on L2 reading-writing connections (pp. 84-105). Ann Arbor: University of Michigan Press.

Matsuda, P. K. (2003). Process and post-process: A discursive history. Journal of Second Language Writing, 12(1), 65-83.

Matsuda, P. K., Canagarajah, A. S., Harklau, L., Hyland, K., and Warschauer, M. (2003). Changing currents in second language writing research: A colloquium. Journal of Second Language Writing, 12, 151-179.

Mayer, R. E. (1984). Aids to prose comprehension. Educational Psychologist, 19, 30-42.

Mayer, R. E. (1989). Models for understanding. Review of Educational Research, 59, 43-64.

Mayer, R. E. (1993). Comprehension of graphics in text: An overview. Learning and Instruction, 3, 239-246.

Mayer, R. E., Bove, W., Bryman, A., Mars, R., and Tapangco, L. (1996). When less is more: Meaningful learning from visual and verbal summaries of science textbook lessons. Journal of Educational Psychology, 82, 64-73.

Mayer, R. E., Steinhoff, K., Bower, G., and 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), 31-44.

McKeown, M. G. and Beck, I. L. (1998). Talking to an author: Readers taking charge of the reading process. In N. Nelson and R. C. Calfee (Eds.), The reading-writing connection: Ninety-seventh yearbook of the National Society for the Study of Education (pp. 112-130). Chicago: The University of Chicago Press.

Medical Research Council. (2000). Press release. Retrieved 4 February, 2004, from the World Wide Web: http://www.mrc.ac.uk/index/public-interest/public-press_office/public-press_releases_2000/public-19_october_2000.htm

Miettinen, R. (2001). Artifact Mediation in Dewey and in cultural-historical activity theory. Mind, Culture, and Activity, 8, 297-308.

Miles, M. B. and Huberman, A. M. (1994). Qualitative data analysis. London: Sage Publications.

Miller, T. (1998). Visual persuasion: A comparison of visuals in academic texts and the popular press. English for Specific Purposes, 17(1), 29-46.

Minichiello, V., Aroni, R., Timewell, E., and Alexander, L. (1990). In-depth interviewing: Researching people. Melbourne: Longman Cheshire.

Morrison, B. J. (2003). A study of the extent to which existing models of evaluation in education and language learning can be applied to a self-access language learning environment. Unpublished PhD, Hong Kong Polytechnic University, Hong Kong.

Myers, G. (1990). Every picture tells a story: Illustrations in E.O. Wilson's *Sociobiology*. In M. Lynch and S. Woolgar (Eds.), Representation in scientific practice (pp. 231-265). Cambridge: The MIT Press.

Myers, G. (1990). Writing biology: Texts in the social construction of scientific knowledge. Madison, WI: The University of Wisconsin Press.

Myers, G. A. (1992). Textbooks and the sociology of scientific knowledge. English for Specific Purposes, 11, 3-17.

Nardi, B. A. (1996). Activity theory and human-computer interaction. In B. A. Nardi (Ed.), Context and consciousness: Activity theory and human-computer interaction (pp. 7-16). Cambridge: The MIT Press.

Nelson, N. and Calfee, R. C. (1998). The reading-writing connection viewed historically. In N. Nelson and R. C. Calfee (Eds.), The reading-writing connection: Ninety-seventh yearbook of the National Society for the Study of Education (pp. 1-52). Chicago: The University of Chicago Press.

New London Group. (1996). A pedagogy of multiliteracies: Designing social futures. Harvard Educational Review, 66, 60-92.

Nunan, D. (1999). Research methods in language learning. Cambridge: Cambridge University Press.

Ogle, D. and Blachowicz, C. L. Z. (2002). Beyond literature circles: Helping students comprehend informational texts. In C. C. Block and M. Pressley (Eds.), Comprehension instruction: Research-based best practices (pp. 259-274). New York: The Guilford Press.

Okabe, A., Boots, B., Sugihara, K., and Chiu, S. N. (2000). Spatial tessellations: Concepts and applications of Voronoi diagrams. New York: John Wiley & Sons.

Oppenheim, A. N. (1992). Questionnaire design, interviewing and attitude development. London: Sage Publications.

Ostler, S. E. (1995). Book review: Principles of language learning and teaching, 3rd edition. TESL-EJ. Retrieved 15 January, 2004, from the World Wide Web: http://www-writing.berkeley.edu/TESL-EJ/ej03/r15.html

Owens, R. G. (1982). Methodological rigor in naturalistic inquiry: Some issues and answers. Educational Administration Quarterly, 18(2), 1-21.

Parks, S. and Maguire, M. (1999). Coping with on-the-job writing in ESL: A constructivist-semiotic perspective. Language Learning, 29, 143-175.

Peeck, J. (1987). The role of illustrations in processing and remembering illustrated text. In D. A. Willows and H. A. Houghton (Eds.), The psychology of illustration (pp. 115-151). New York: Springer-Verlag.

Penningroth, A. P. (1997). Making meaning in second language reading: The case of an advanced learner of German in the foreign language classroom. Unpublished PhD, Georgetown University, Washington, DC.

Pennycook, A. (1996). Borrowing others' words: Text, ownership, memory, and plagiarism. TESOL Quarterly, 30(2), 201-230.

Penrose, A. M. and Geisler, C. (1994). Reading and writing without authority. College Composition and Communication, 45, 505-520.

Perfetti, C. A., Britt, M. A., and Georgi, M. C. (1995). Text-based learning and reasoning: Studies in history. Hillsdale, NJ: Erlbaum.

Perfetti, C. A., Rouet, J. F., and Britt, M. A. (1999). Toward a theory of documents representation. In H. van Oostendorp and S. R. Goldman (Eds.), <u>The construction of mental representations during reading</u> (pp. 99-122). Mahwah, NJ: Erlbaum.

Petrie, G. M. (2003). ESL teachers' views on visual language: A grounded theory. <u>The Reading Matrix, 3</u>(3), 137-168.

Pickard, V. (1995). Citing previous writers: What can we say instead of "say"? <u>Hong Kong Papers in Linguistics and Language Teaching, 18</u>, 89-102.

Plett, H. F. (Ed.). (1991). <u>Intertextuality</u>. Berlin: Walter de Gruyter.

Pressley, M. (1998). <u>Reading instruction that works: The case for balanced teaching</u>. New York: Guilford.

Pressley, M. and Afflerbach, P. (1995). <u>Verbal protocols of reading: The nature of constructively responsive reading</u>. Hillsdale, NJ: Lawrence Erlbaum.

Pressley, M. and Miller, G. E. (1987). Effects of illustrations on children's listening comprehension and oral prose memory. In D. A. Willows and H. A. Houghton (Eds.), <u>The psychology of illustration</u> (pp. 87-114). New York: Springer-Verlag.

Pressley, M. and Woloshyn, V. (Eds.). (1995). <u>Cognitive strategy instruction that really improves children's academic performance</u>. Cambridge, MA: Brookline.

Pressley, M., El-Dinary, P. B., Gaskins, I., Schuder, T., Bergman, J., Almasi, L., and Brown, R. (1992). Beyond direct explanation: Transactional instruction of reading comprehension strategies. <u>Elementary School Journal, 92</u>, 511-554.

Prior, P. A. (1992). <u>Contextualizing writing and response in graduate seminars: A sociohistoric perspective on academic literacies.</u> Unpublished PhD, University of Minnesota, Minneapolis.

Prior, P. A. (1994). Response, revision, disciplinarity: A microhistory of a dissertation prospectus in sociology. <u>Written Communication, 11</u>, 483-533.

Prior, P. A. (1995). Tracing authoritative and internally persuasive discourses: A case study of response, revision, and disciplinary enculturation. <u>Research in the Teaching of English, 29</u>, 288-325.

Prior, P. A. (1997). Literate activity and disciplinarity: The heterogeneous (re)production of American Studies around a graduate seminar. <u>Mind, Culture, and Activity, 4</u>, 275-295.

Prior, P. A. (1998). <u>Writing/Disciplinarity: A sociohistoric account of literate activity in the academy</u>. Mahwah, NJ: Lawrence Erlbaum Associates.

Prior, P. (2004). Tracing processes: How texts come into being. In C. Bazerman and P. Prior (Eds.), <u>What writing does and how it does it: An introduction to analyzing texts and textual practices</u> (pp. 167-200). Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.

Raithel, A. and Velichkovsky, B. M. (1996). Joint attention and co-construction of tasks. In B. A. Nardi (Ed.), <u>Context and consciousness: Activity theory and human-computer interaction</u> (pp. 199-233). Cambridge: The MIT Press.

Raney, K. (1998). A matter of survival on being visually literate. <u>English and Media Magazine, 39</u>, 37-42.

Richards, K. (2003). <u>Qualitative inquiry in TESOL</u>. Basingstoke: Palgrave Macmillan.

Ricoeur, P. (1983). <u>Time and narrative</u> (K. McLaughlin and D. Pellauer, Trans.) (Vol. 1). Chicago: University of Chicago Press.

Rowley-Jolivet, E. (2002). Visual discourse in scientific conference papers: A genre-based study. English for Specific Purposes, 21, 19-40.

Russell, D. and Yanez, A. (2003). 'Big picture people rarely become historians': Genre systems and the contradictions of general education. In C. Bazerman and D. Russell (Eds.), Writing selves/Writing societies: Research from Activity Perspective (pp. 331-362). Fort Collins, Colorado: The WAC Clearinghouse and Mind, Culture, and Activity.

Russell, D. R. (1997). Rethinking genre in school and society: An activity theory analysis. Written Communication, 14, 504-554.

Russell, D. R. (March 1998). The limits of the apprenticeship models in WAC/WID research. Paper presented at the Conference of College Composition and Communication.

Sack, J.-R. and Urrutia, J. (1991). Editorial. Computational geometry: Theory and applications, 1(1), vii-viii.

Sack, J.-R. and Urrutia, J. (Eds.). (1999). Handbook of computational geometry. Amsterdam,: Elsevier Science.

Samuels, S. J. (1970). Effects of pictures on learning to read, comprehension and attitudes. Review of Educational Research, 40, 397-407.

Sarangi, S. and Candlin, C. N. (2003). Introduction trading between reflexivity and relevance: New challenges for applied linguistics. Applied Linguistics, 24(3), 271-285.

Scollon, R., Tsang, W. K., Li, D., Yung, V., and Jones, R. (1998). Voice, appropriation and discourse representation in a student writing task. Linguistics and Education, 9, 227-250.

Scribner, S. and Cole, M. (1981). The psychology of literacy. Cambridge, MA: Harvard University Press.

Sengupta, S. (2002). Developing academic reading at tertiary level: A longitudinal study tracing conceptual change. The Reading Matrix, 2(1).

Sengupta, S. (2004). Advanced academic literacy in the world. Symposium presented at the AAAL Annual Conference, Portland, Oregon.

Shea, W. R. (Ed.). (2000). Science and the visual image in the Enlightenment. Canton, MA: Science History Publications/USA.

Schneider, M. L. and Fujishima, N. K. (1995). When practice doesn't make perfect: The case of a graduate ESL student. In D. Belcher and G. Braine (Eds.), Academic writing in a second language: Essays on research and pedagogy (pp. 3-22). Norwood, NJ: Ablex Publishing Corporation.

Silva, T., Leki, I., and Carson, J. (1997). Broadening the perspective of mainstream composition studies: Some thoughts from the disciplinary margins. Written Communication, 14(3), 398-428.

Simpson, M. L. and Nist, S. L. (2002). Encouraging active reading at the college level. In C. C. Block and M. Pressley (Eds.), Comprehension instruction: Research-based best practices (pp. 365-379). New York: The Guilford Press.

Slotte, C. and Lanka, K. (1999). Review of process effects of spontaneous note-taking on text comprehension. Contemporary Educational Psychology, 24, 1-20.

Smagorinsky, P. (1998). Thinking and speech and protocol analysis. Mind, Culture, and Activity, 5(3), 157-177.

Smagorinsky, P. (2001). If meaning is constructed, what is it made from? Toward a cultural theory of reading. Review of Educational Research, 71, 133-169.

Smith, L. D., Best, L. A., Stubbs, D. A., Johnston, J., and Archibald, A. B. (2000). Scientific graphs and the hierarchy of the sciences: A Latourian survey of inscription practices. Social Studies of Science, 30(1), 73-94.

Spack, R. (1997). The acquisition of academic literacy in a second language: A longitudinal case study. Written Communication, 14(1), 3-62.

Spence-Brown, R. (2003). Authentic assessment? The implementation of an 'authentic' teaching and assessment task. Unpublished PhD, the University of Melbourne, Melbourne.

Stahl, S. A., Hynd, C. R., Britton, B. K., McNish, M. M., and Bosquet, D. (1996). What happens when students read multiple source documents in history? Reading Research Quarterly, 31(4), 430-456.

Stake, R. E. (2000). The case study method in social inquiry. In R. Gomm, M. Hammersley, and P. Foster (Eds.), Case study method: Key issues, key texts (pp. 19-26). London: Sage Publications.

Stenbacka, C. (2001). Qualitative research requires quality concepts of its own. Management Decision, 39(7), 551-555.

Stenglin, M. and Iedema, R. (2001). How to analyze visual images: A guide for TESOL teachers. In A. Burns and C. Coffin (Eds.), Analyzing English in a global context: A readers (pp. 194-208). London: Routledge.

Stewart, A. (1998). The ethnographer's method. Thousand Oaks, CA: Sage Publications.

Stratman, J. F. and Hamp-Lyons, L. (1994). Reactivity in concurrent think-aloud protocols: Issues for research. In P. Smagorinsky (Ed.), Speaking about writing: Reflections on research methodology. London: Sage publications.

Street, B. (1984). Literacy in theory and practice. Cambridge: Cambridge University Press.

Street, B. (1995). Social literacies: Critical perspectives on literacy in development, ethnography and education. London: Longman.

Strømsø, H. I. and Bråten, I. (2002). Norwegian law students' use of multiple sources while reading expository texts. Reading Research Quarterly, 37(2), 208-227.

Stroupe, C. (2000). Visualizing English: Recognizing the hybrid literacy of visual and verbal authorship on the Web. College English, 62(5), 607-632.

Swales, J. M. (1981). Aspects of article introductions. Birmingham, UK: Aston University Languages Study Unit.

Swales, J. M. (1986). Citation analysis and discourse analysis. Applied Linguistics, 7(1), 39-56.

Swales, J. M. (1990). Genre analysis: English in academic and research settings. Cambridge: Cambridge University Press.

Swales, J. M. (1995). The role of the textbook in EAP writing research. English for Specific Purposes, 14(1), 3-18.

Tang, G. (1991). The role and value of graphic representation of knowledge structures in ESL student learning: An ethnographic study. TESL Canada Journal, 9(1), 29-41.

Tang, G. (1992). The effect of graphic representation of knowledge structures on ESL reading comprehension. SSLA, 14, 177-195.

Thomas, S. (2004). Reading through the basics: Towards a visual analysis of a newspaper advertisement on education. Language and Education, 18(1), 53-68.

Thompson, P. (2000). Citation practices in PhD theses. In L. Burnard and T. McEnery (Eds.), Rethinking language pedagogy from a corpus perspective (pp. 91-101). Frankfurt: Peter Lang.

Thompson, P. and Tribble, C. (2001). Looking at citations: Using corpora in English for Academic Purposes. Language Learning and Technology, 5(3), 91-105.

Thorne, S. L. (2000). Second language acquisition theory and the truth(s) about relativity. In J. P. Lantolf (Ed.), Sociocultural theory and second language learning (pp. 219-243). Oxford: Oxford University Press.

Trimbur, J. (1994). Taking the social turn: Teaching writing post-process. College Composition and Communication, 45, 108-118.

Tsang, W. K. (1996). Comparing the effects of reading and writing on writing performance. Applied Linguistics, 17(2), 210-223.

Tsang, W. K. (2001). Intersection of school writing and public discourse. Linguistics and Education, 12, 51-83.

Turner, J. (2003). Writing a PhD in the contemporary humanities. Hong Kong Journal of Applied Linguistics, 8(2), 34-53.

United Kingdom Literacy Association. (2004). Our name change. Retrieved 10 August, 2004, from the World Wide Web: http://www.ukla.org/site/about/namechange.html

Urquhart, S. and Weir, C. (1998). Reading in a second language: Process, product and practice. London: Longman.

van Leeuwen, T. and Jewitt, C. (2001). Handbook of visual analysis. London: Sage Publications.

van Lier, L. (1996). Interaction in the language curriculum: Awareness, autonomy, and authenticity. London: Longman.

van Lier, L. (2000). From input to affordance: Social-interactive learning from an ecological perspective. In J. P. Lantolf (Ed.), Sociocultural theory and second language learning (pp. 245-259). Oxford: Oxford University Press.

van Lier, L. (2002). An ecological-semiotic perspective on language and linguistics. In C. Kramsch (Ed.), Language acquisition and language socialization: Ecological perspectives (pp. 140-164). London: Continuum.

van Lier, L. and Matsuo, N. (2000). Varieties of conversational experience: Looking for learning opportunities. Applied Language Learning, 11(2), 265-287.

Vaughan, J. L. and Estes, T. H. (1986). Reading and reasoning beyond the primary grades. Boston: Allyn & Bacon.

Verhoeven, L. T. W. and Aarts, R. (1998). Attaining functional biliteracy in the Netherlands. In A. Y. Durgunoglu and L. T. W. Verhoeven (Eds.), Literacy development in a multilingual context: Cross-cultural perspectives (pp. 111-134). Mahwah, NJ: Erlbaum.

Vygotsky, L. (1978). Mind in society: The development of higher psychological processes. Cambridge, MA: Harvard University Press.

Vygotsky, L. (1981). The instrumental method in psychology. In J. V. Wertsch (Ed.), The concept of activity in Soviet psychology (pp. 134-143). Armonk, NY: M. E. Sharpe.

Wallace, C. (1992). Reading. Oxford: Oxford University Press.

Wallace, C. (2003). Critical reading in language education. New York: Palgrave Macmillan.

Wells, G. (1996). Using the tool-kit of discourse in the activity of learning and teaching. Mind, Culture and Activity, 3(2), 74-101.

Wells, G. (1999). Dialogic inquiry: Towards a sociocultural practice and theory of education. Cambridge: Cambridge University Press.

Wertsch, J. V. (1994). The primacy of mediated action: A sociocultural approach in psychology. Mind, Culture, and Activity, 1, 202-208.

Wertsch, S. (1998). Mind as action. Oxford: Oxford University Press.

Wikipedia. (2004). Geographic information system. Retrieved 17 January, 2004, from the World Wide Web: http://en.wikipedia.org/wiki/Gis?%20--wikipedia

Wilson, B. A. (2002). Towards a comprehensive model of cognitive rehabilitation. Neuropsychological Rehabilitation, 12, 97-110.

Wineburg, S. S. (1991). Historical problem solving: A study of the cognitive processes used in the evaluation of documentary and pictorial evidence. Journal of Educational Psychology, 83, 73-87.

Wineburg, S. S. (1991). On the reading of historical texts: Notes on the breach between the school and academy. American Educational Research Journal, 28, 495-519.

Wineburg, S. S. (1994). The cognitive representation of historical texts. In G. Leinhardt, I. L. Beck, and C. Stainton (Eds.), Teaching and learning in history (pp. 85-135). Hillsdale, NJ: Lawrence Erlbaum.

Wineburg, S. S. (1996). The psychology of learning and teaching history. In D. C. Berliner and R. C. Calfee (Eds.), Handbook of educational psychology (pp. 423-437). New York: Simon & Schuster Macmillan.

Winn, B. (1987). Charts, graphs, and diagrams in educational materials. In D. A. Willows and H. A. Houghton (Eds.), The psychology of illustration (pp. 152-198). New York: Springer-Verlag.

Winsor, D. A. (2003). Writing power : Communication in an engineering center. Albany: State University of New York Press.

Wolcott, H. F. (1994). Transforming qualitative data: Description, analysis, and interpretation. Thousand Oaks: Sage.

Wu, F. (1997). Social role of postgraduate education and its implications to Hong Kong. Paper presented at the conference "The role of postgraduate education in the 21st century", Hong Kong.

Yin, R. K. (2003). Case study research: Design and methods. Thousand Oaks, CA: Sage Publications.

Zamel, V. (1992). Writing one's way onto reading. TESOL Quarterly, 26(3), 463-484.

researcher: Svetlana Tchigaeva
e-mail: XXXX@polyu.edi.hk
phone: xxxx xxxx

Informed Consent Form

Thank you for agreeing to participate in this PhD research. This form outlines the purposes of the study and provides a description of your involvement and rights as a participant. You are encouraged to ask any questions at any time about the nature of the study and the methods that I am using. Your suggestions and concerns are important to me; please contact me at any time at the phone number and the e-mail address listed above.

The main purposes of this project are:
1) to fulfill a requirement towards a PhD degree with the Department of English, the Hong Kong Polytechnic University and
2) to gain insight in the topic of postgraduate students' reading of academic texts in a second/foreign language.

As a participant, for about six months you will be involved in:
1) an-hour-long interview on a weekly or biweekly basis (depending on your availability and/or interest) and
2) reading sessions on a monthly basis observed by me.

As a researcher, I guarantee that the following conditions will be met:
1) Your real name will not be used at any point of information collection, or in any written report; instead, you and any other person and place names involved in the study will be given pseudonyms that will be used in all verbal and written records and reports.
2) Your participation in this research is voluntary; you have the right to withdraw at any point of the study, for any reason, and without any prejudice.
3) You will be given an opportunity to review my comments on the data that is directly relevant to you. Your suggestions for the revision of comments will be taken seriously.
4) If you grant permission for audio and video taping, no tapes will be used for any purpose other than the ones you agreed to.

Do you grant permission to be audio and video taped?   Yes _____ No _____

Do you grant permission to use the tapes:
             a.   for any educational and research purposes   ☐
             b.   only for research purposes   ☐
             c.   do not grant any permission   ☐

Do you grant permission to be quoted directly?   Yes _____ No _____

I agree to the terms: Respondent _____ Date _____

I agree to the terms: Researcher _____ Date _____

<u>**Appendix 4.2. Structure of think aloud training sessions**</u>

Purpose: to prepare students for thinking aloud
Tine of conducting: no more than a week before the think-aloud session
Materials: authentic and student-specific (depending on research study, previous interviews, and research proposal)

Stage 1: Make the participant comfortable.

Use a simple ordinary question as a conversation starter. Use a question that would be easy for Participant to answer. In the context of my study, an easy question could be directed at travelling. (e.g., ask Participant to explain how to get to Stanley Market)

Main processes: Thinking   +   Verbalizing

Stage 2: Engage the participant in problem-solving.

Use a scrambled abstract exercise. Make sure the abstract comes from an article of direct interest to Participant.

Main processes: reading*thinking + verbalizing
Relation of thinking to reading: sentence-bound
Relation of verbalizing to reading*thinking: retrospective
Motivation: researcher-oriented
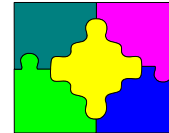
Stage 3: Provide the participant with a meaningful task.

Prepare several abstracts of potential interest to Participant and ask him to choose the most relevant abstract (relevant to his work, current research, etc.).

Main processes: reading*thinking + verbalizing
Relation of thinking to reading: sentence-bound → paragraph-bound → random
Relation of verbalizing to reading*thinking: retrospective → more concurrent
Motivation: researcher-oriented → intrinsic to student

Stage 4: Engage the participant in meaningful reading.

Make printouts of the papers whose abstracts were used in Stage 3. Ask the student to read the paper whose abstract was deemed most relevant in Stage 3.

Main processes: reading*thinking + verbalizing
Relation of thinking to reading: random
Relation of verbalizing to reading*thinking: more concurrent
Motivation: intrinsic to student

Appendix 4.3. Transcript conventions

The following symbols are used in the transcriptions:

(1) **( )** = a note about the student's physical movements and emotional expressions (e.g., **(Hugo uses his hands to show a particular configuration of points)**

(2) [ ] = uncertain transcription

(3) … = a pause

Participants' speech has not been edited to correct errors or to standardize style. Capitalization and punctuation are included into transcripts to aid in analyzing and reading them. More information is provided with specific transcripts included in Appendices 5.2, 6.2, 7.2, and 8.2.

Within the thesis, the following abbreviations are used to refer to specific data collection methods (for more information, please refer to Chapter 4, section 4.6)

IntroI	Introductory interview
TBI	Text-based interview
ExplanI	Explanatory interview
InterI	Interpretative interview
TA	Think-aloud session
RL	Reading log

Appendix 4.4. A sample narrative—The case of Lora

The main purpose of reading for Linda is to develop her own method for controlling a manufacturing process. She says she hopes that after reading a certain amount of papers describing various methods she will be able to devise her own method that would be worth of a PhD. In reality, reading is not the only mediator in Linda's process of designing the method. Along with reading, Linda is involved in experimenting as well as taking courses. However, the fact remains that reading is consciously geared towards finding the best method for controlling the process of manufacturing and it remains a main component of her work. Reading is especially significant when one looks at Linda's interactions with her supervisor. In order to report on her developments, Linda feels she needs to read literature, and reading becomes instrumental for her preparation for those meetings.

It is not surprising then, that Linda is consciously analyzing texts she reads for the pros and cons of the methods described in them. The role of experimenting in reading is also interesting: because she has done and is doing experiments, Linda has expectations for certain numbers that get reported in papers, and she compares these numbers to her expectations. When there is a mismatch, she tries to identify why this mismatch occurs and what it means for her PhD. Since the method is likely to be mathematical, Linda is aware of the math involved in texts and pays a conscious attention to how formulas are derived and which variables are used in the models.

Taking notes after reading has a specific significance for writing the literature review. After reading 20-30 papers, Linda writes up her review of these papers, and hopes that after some time, she will combine these mini-reviews and have a complete PhD literature review. Taking notes is therefore significant when reading for future writing (though not only for writing but also for reminding self about the main points of the article). Reading, though primarily geared towards learning methods used in the area, becomes indirectly geared towards writing a literature review.

The role of models in her work is especially highlighted by her decision to take a course on mathematical modeling at PolyU. This course requires that she take an exam, and though models are important for Linda's PhD, her motivation to read course notes and understand certain models changes from reading for her own PhD to reading for exams. This is also due to the fact that not all models are relevant to her PhD. The course notes she has are worked on. They are no more mere containers of information but are also tools to deciphering this information. Reading the words on these pages becomes less important than reading and working on the problems, formulas, derivations, etc. Reading these materials becomes studying them.

An interesting aspect of Linda's reading is her frequent reliance on internet materials for additional information. Thus, for example, she downloads and prints out some websites to get more information about the concepts explained in the course (including specific words used in marketing), to get information on certain professional seminars and products, etc. When it comes to writing, however, Linda is hesitant to include www materials due to the issues of credibility that she feels are important when it comes to www.

Main themes:
Reading to develop method
Reading to write literature review (indirectly)
Reading for meetings with Supervisor
Reading and experimenting
Reading for the course--Studying texts
Reading www materials

Supervisor

Internet community

Learning various methods

Focus on "total" understan...

Quoting later in paper

RA from Sup

Difficulti es: b/c electri... system inside buildings

Focus on numbers/ calculatio

NA standards

Working on math

Getting RA from Sup

Checking references

UK standards

Ordering references

Reporting to Sup

Software manual: ionosphere

Comparin g models

Calculatin g math

Program ming

MATLAB help: L function

Comparin g L functions

Chinese textbook

Finding coefficien t for L function

www cite L functions

Comparing functions

PhD pages: L function

Searching Google

Checking references in manual

CHAPTER 6

PERSONALITY

FACTORS

THE PREVIOUS two chapters dealt with two facets of the cognitive domain of language learning: human learning processes in general, and cognitive variations in learning—styles and strategies. Similarly, this chapter and Chapter 7 deal with two facets of the affective domain of second language acquisition. The first of these is the intrinsic side of affectivity: personality factors within a person that contribute in some way to the success of language learning. The second facet, treated in Chapter 7, encompasses extrinsic factors—sociocultural variables that emerge as the second language learner brings not just two languages into contact but two cultures, and in some sense must learn a second culture along with a second language.

If we were to devise theories of second language acquisition or teaching methodologies that were based only on cognitive considerations, we would be omitting the most fundamental side of human behavior. Ernest Hilgard, well known for his study of human learning and cognition, once noted that "purely cognitive theories of learning will be rejected unless a role is assigned to affectivity" (1963: 267). In recent thinking (Arnold 1999), there is no doubt at all about the importance of examining personality factors in building a theory of second language acquisition.

The affective domain is difficult to describe scientifically. A large number of variables are implied in considering the emotional side of human behavior in the second language learning process. One problem in

---

striving for affective explanations of language success is presented by the task of subdividing and categorizing the factors of the affective domain. We are often tempted to use rather sweeping terms as if they were carefully defined.

For example, it is easy enough to say that "culture conflict" accounts for many language learning problems, or that "motivation" is the key to success in a foreign language; but it is quite another matter to define such terms with precision. Psychologists also experience a difficulty in defining terms. Abstract concepts such as empathy, aggression, extroversion, and other common labels are difficult to define empirically. Standardized psychological tests often form an operational definition of such concepts, but constant revisions are evidence of an ongoing struggle for validity. Nevertheless, the elusive nature of affective and cognitive concepts need not deter us from seeking answers to questions. Careful, systematic study of the role of personality in second language acquisition has already led to a greater understanding of the language learning process and to improved language teaching designs.

THE AFFECTIVE DOMAIN

Affect refers to emotion or feeling. The affective domain is the emotional side of human behavior, and it may be juxtaposed to the cognitive side. The development of affective states or feelings involves a variety of personality factors, feelings both about ourselves and about others with whom we come into contact.

Benjamin Bloom and his colleagues (Krathwohl, Bloom, & Masia 1964) provided a useful extended definition of the affective domain that is still widely used today.

1. At the first and fundamental level, the development of affectivity begins with receiving. Persons must be aware of the environment surrounding them and be conscious of situations, phenomena, people, objects; be willing to receive—to tolerate a stimulus, not avoid it—and give a stimulus their controlled or selected attention.

2. Next, persons must go beyond receiving to responding, committing themselves in at least some small measure to a phenomenon or a person. Such responding in one dimension may be in acquiescence, but in another, higher dimension the person is willing to respond voluntarily without coercion, and then to receive satisfaction from that response.

3. The third level of affectivity involves valuing: placing worth on a thing, a behavior, or a person. Valuing takes on the characteristics of beliefs or attitudes as values are internalized. Individuals do not

Researcher (R)	Texts and textual segments that mediated the discussion	Joanna (P)
	Notation: N=note H=highlight	
R1: What did you discuss last week?		**P1:** Last week discussed styles and strategies. This week Sociocultural factors. It's interesting that when I first read the book for the first two chapters about language learning and teaching, about those kind of theories, approaches, I do have a lot of questions to ask during lectures. If I don't ask I still have questions in my mind to think about. And I think it is from last 2 weeks…
R2: From Styles and Strategies?	P pauses to look through the textbook	**P2:** Yeah, from styles and strategies and I don't have a lot of things to ask.
R3: Why? Is it because it's very simple or you are not interested?		**P3:** I think most of the things here are interesting but it seems like most of the content some kind of descriptive. Describing how your left brain or right brain work. You don't have questions to ask because you don't know anything about it. You just absorb what the author wants to say. And for example for last week lecture talking about personality factors. About affective domain, about Myer-Briggs.
R4: About what?		**P4:** About Myer-Briggs. There are two types. It's quite interesting. It's about some kind of characteristics list. I will not say test those types, but there are some expensive tests in business center to try to test which characters their staff possess. What sector, which department they can work in. for example if you are introverted, these persons can have quite a number of tasks and [pause]
R5: To make it easy, let's just go through the chapters. To see what you did with them and what kind of notes you wrote. I see you wrote a lot of notes on some of them. This is Chapter 6.		**P5:** Chapter 6.
R6: Personality factors. You read it on the 12th of February. That's very cute. Do you always write this?	P looks at the notes on the text and adds	

R7: Just for me?	p. 142, the starting page of the chapter	**P6:** No
		P7: No. At that time, I just wanted to write down. Later on, you find it out I start to read it on 12th, but I finished it maybe on 15th .
	[we laugh]	
R8: So what are you writing here?	p. 142, **N1:** "an aspect of sth" above "facets"	**P8:** Now here, I, that is what I have tried to do. I think I know the word facet but not in a very solid explicit way. So I tried to write it down. Some explanation.
R9: Where did you get this explanation? From a dictionary? Or?		
		P9: From MSN.
R10: I see.		**R10:** And here. I think I just summarized something in the paragraph. And here the affective domain, they've got 6 domains. This is the definition of affective domain. They've got six domains. Self-esteem…
	p. 142, **N2:** "learning second cultures along with L2"	
	p. 143, **N5:** "1. self-esteem	
R11: Oh, those are the domains?	2. inhibition	**P11:** Something like that. I read several pages and after I've read it I can, I will totally forget the names because quite long. So I put them here. And the first few paragraphs, they try to define and explain what affective domain is. So I highlight something.
	3. risk-taking	
	4. anxiety	
	5. empathy	
R12: Something like keywords?	6. extroversion"	**P12:** Yes, and then go through the chapter. And what I really want to tell you as I have told you before, I found I have got no questions. When I read. But when. When… During the lecture, we have some kind of presentation. They quote some of the sentence from the book and then and then at that time professor asks about, questions, about quoting what they mean. What I am saying or something like that. This kind of thing. And I realize that when I read the book, I don't have why, the reason why I don't have any questions I am already in the side of the book.
		P13: I am following the views of the book. So when he concludes something, I am already like thinking in that way. But when you quote something, that means you are not reading the whole book, then you will see some problem.
R13: Aha…		
R14: I see. That's very interesting.		**P14:** Yeah, and I feel this is worth to, to have another presentation even though

R15: Aha, aha. That's very interesting.

R16: You'll just have to believe, don't you? Very interesting…

R17: I see. The most important revelation? Like an understanding?

R18: This is very exciting.

R19: Did you do it for me or did you just come across this?

R20: There is an argument?

R21: Do you think methodology is the easiest thing to critique?

R22: Is it too introductory then?

they are extracting from the book and they , and they expect you to read the book first before you go to the lecture.

P15: And that's why I think you, you, ah. It is very difficult to be critical because when you read a book. When you go through the chapters you, you are already in the same flow. Except some exceptional case, you've got some kind of example. And you stop and think. If you don't have any experience about it, you will just like in here, accept right or wrong, is the sample correct, and then will go. Go.

P16: Yeah…That's, I think that's the most, I mean…I mean that's the most important thing I've got from this.

P17: Yeah…

P18: Really?

P19: Not for you, of course. Just for me only. And I am willing to share with you. Because I think this is very important. We am always. I mean I am always on the track. That's why I don't have much questions to ask, even if I am reading journals. I mean journals really different because…

P20: Yes. And methodology. And if you don't, if you yourself have no questions, somebody will have questions about methodology.

P21: There are always pros and cons. And even, and because when they present the methodology, they try to…They try to tell you what's the pros and what's the cons of their method. But, ah. For this, for this kind of book, I mean if you really want to be critical you need much more information than what is presented here.

P22: It's really good to read something introductory. I told you I don't' have

		experience before. It's really good to have somebody to talk to, especially we have 20 students in the class and from different backgrounds. They will, they will keep an eye on it. And then most of them are from secondary school English teachers, I think one or two of them are teaching Chinese. Some of them even not from a linguistic background.
R23:. So do you get a lot of discussions at those lectures?		
		P23: Yes, because of different background. They will have different focus and then they ask different questions. But if you yourself read, you wouldn't have such a lot of questions because... and if one question, for example, then triggers other questions.
R24: I see, this is a very useful discussion.		
	We look through the pages again	**P24:** Yeah.
R25: What about these? Why did you circle 'context' and 'orientation'?		
	p. 163, **C1 and C2:** "context" and "orientation"	**P25:** Oh. this is circled during the lesson.
R26: Oh.		**P26:** Because ah… When they talking about instrumental integrators, they are first they are talking about motivation. And then later on, the researchers changed the word from motivation to context orientation.
R27: Did you write this during the lesson or when you read?	p. 162, **N48:** "motivation→orientation"	**P27:** Lesson, lesson.
R28: Just for the tape. That was motivation to orientation. Here you are using Chinese, ah?		
	p. 164, Chinese **N52** and **N53** above "stockpile" and "incongruity"	**P28:** Yeah, because this kind of 'incongruity' is very abstract. And this 'autonomy', I think, it's just like, ah, I know… in a sense that what it means. But if you ask me to define autonomy, I cannot. Even if you ask me the same questions in Chinese…It's better to put it there. It's just like asking what is. Just like I can ask the children what ice-cream is… They know this is ice-cream and that is not ice-cream, but they don't know what its ingredients, what's inside ice-cream.
R29: I see. Ok. This is still Ch. 6, right?		

R30: Oh yes. I notice that. On this page there was no highlighting.	Looking at later pages of the chapter	**P29:** Yes, and you see highlighting is less.
R31: Oh, it's because it's the end of the chapter.		**P30:** Yeah.
R32: Do you read these? What is this? Appendix or?	p. 169, section "In the classroom: Putting methods into perspective"	**P31:** Yes.

P32: They call these vintage. I read, I read the. It's just like. I am thinking of. Even in Chinese I cannot tell you right away. It's just like in chapters. The content in chapters, they have got some examples. This is putting the scene into the classroom. This is about curriculum. They just. It seems, because I don't have any teaching experience, I don't know what's the teachers mind. I mean, what I know about the teachers, they are very enthusiastic to teach, to correct, to encourage the students to learn more, but not in the side of very practical service. I know they try to stick to the syllabus but I don't know what their views, what they think about the syllabus. But here, here, you see, methodology, approach, method, curriculum, syllabus. Because. |
R33: Oh, they are actually showing differences between these? Or?		**P33:** Because what I mean, why I am saying is because teachers not how to different, they teach students. But what it tries to say, it's not don't let them.
R34: So basically, you read these?	pp. 172-173, section "Topics and questions for study and discussion"	**P34:** Just like, like… I will try to skip the topic questions. Because I don't have time.
R35: I see. So you just don't look at them?	p. 174, section "Suggested readings"	**P35:** Yes, I just skip them. And then I also skip the suggested readings because I know if you are in the field they are very useful, but I am not.
R36: What about journal entries?	p. 175, section "Language learning experience: Journal entry 6"	**P36:** Journals entries. This is asking you to, asking the reader to write something, to, about the meaning.
R37: Do you keep those things?		**P37:** No.

pp.	Notes (N)	Underlined / circled segments (U, C)	Highlighted segments (H)
	Abbreviation: Ch=Chinese		
142	**N1:** "an aspect of sth" above "facets"		
	N2: "learn second culture along with L2" next to para 1		
	N3: "include" above "encompasses"	**U1:** "encompasses extrinsic"	
			H1: "purely cognitive theories of learning will be rejected unless a role is assigned to affectivity"
143	**N4:** "hard to find" above "elusive nature"		
	N5: "1. self-esteem 2. inhibition 3. risk-taking 4. anxiety 5. empathy 6. extroversion" next to the heading of the section "The affective domain"		
	N6: "Affect" next to para 1 of this section		**H2:** "**Affect** refers to emotion or feeling"
			H3: "extended definition of the affective domain"
	N7: "receiving=giving attention" next to point 1		**H4:** "*receiving*" **H5:** "be willing to receive—to tolerate a stimulus, not avoid it—and give a stimulus their controlled or selected attention."
	N8: "responding" next to point 2 **N9:** "forcing sb to do sth" under "coercion"		**H6:** "*responding*, committing themselves in at least some small measure to a phenomenon or a person." **H7:** "willing to respond voluntarily without coercion, and then to receive satisfaction"
	N10: "valuing" next to point 3		**H8:** "va*luing*: placing worth on a thing, a behavior, or a person."
144	**N11:** "organization" next to point 4		**H9:** "the *organization* of values into a system of beliefs"
	N12: "value system" next to point 5		**H10:** "*value system*" **H11:** "act consistently" **H12:** "with the values they have internalized"

145	**N13:** ① Next to the subheading "Self-esteem"		
	N14: "spreading everywhere" above "pervasive"		
			H13: "self-esteem" **H14:** "evaluation which individuals make and customarily maintain with regard to themselves; it expresses an attitude of approval or disapproval" **H15:** "extent to" **H16:** "capable, significant, successful and worthy" **H17:** "personal judgment of worthiness" **H18:** "subjective experience"
	N15: **"1. general/global self-esteem" to the right from point 1** N16: **"1. general/global self-esteem" to the left from point 1** Ch **N17**: above "prevailing"		**H19:** "General, or **global**, self-esteem" **H20:** "relatively stable in a mature adult" **H21:** "resistant to change"
	N18: **"2. situational, specific in particular life situations"**		**H22:** "self-appraisals in particular life situations" **H23:** "social interaction, work, education, home, or on"
146	N19: **"particular tasks w/n specific situation"**		**H24:** "**Task** self-esteem" **H25:** "particular tasks within specific situations"
147	N20: ② **Next to the heading "Inhibition"**		
	N21: **"be resistant tto sth" next to "withstand"**		
	N22: **"hinder" next to "impede"**		**H26:** **"language ego"** **H27:** "Meaningful language acquisition involves some degree of identity conflict as language learners take on a new identity with their newly acquired competence. An adaptive language ego enables learners to lower the inhibitions that may impede success."
148			**H28:** "most interesting possibility: that the inhibitions, the defenses, that we place between ourselves and others are important factors contributing to second language success" **H29:** "'thin' (permeable) and 'thick' (not as permeable) ego boundaries"
			H30: "necessitates the making of mistakes"

149	N23: **"trial & error vs. mistakes→frightening"**		**H31:** "mistakes can be viewed as threats to one's ego" **H32:** "Internally, one's critical self and one's performing self can be in conflict" **H33:** "Externally, learners perceive others to be critical, even"
	N43: **"alienation → defence → inhibit learning"**		**H34:** "alienation" **H35:** "between the critical me and the performing me, between my native culture and mt target culture" **H36:** "arises from the defenses that we build around ourselves" **H37:** "inhibit learning"
	N25: (3) **Next to heading "Risk-taking"**		
	Ch N26: **next to "detriment"**		**H38:** "Learners have to be able to gamble a bit, to be willing to try out hunches about the language and take the risk of being wrong"
	Ch N27: **next to ramifications**		
150	N28: **"anti-fear"**		**H39:** "establish an adequate affective framework so that learners 'feel comfortable as they take their first public steps in the strange world of a foreign language'"
			H40: "successful language learners make willing and *accurate* guesses"
	Ch N29: **next to "daunted"**		
	N30: (4) **Next to heading "Anxiety"**		
	Ch N31: **next to "intricately"** N32: **"complex & difficult"** **Ch** N33: **next to "intertwined"**		
151	**Ch** N34: **next to "apprehension"**		**H41:** "is associated with feelings of uneasiness, frustration, self-doubt, apprehension, or worry"
	N35: **"trait anxiety more permanent"** N36: **"state anxniety—particular"**		**H42:** "experienced at various levels" **H43:** "at the deepest, or global, level, **trait** anxiety is a more permanent predisposition to be anxious" **H44:** "momentary, or situational level, **state** anxiety is experienced in relation to some particular event or act"
	N37:		

	Next to points 1-3		
			H45: " 'foreign language anxiety can be distinguished from other types of anxiety and that it can have a negative effect on the language learning process' "
	N38: **"make smb or sth weak" next to "debilitative"**		**H46:** "**debilitative** and **facilitative** anxiety" **H47:** " 'harmful' and 'helpful' anxiety" **H48:** "facilitative anxiety" **H49:** "some concern—some apprehension—over a task to be accomplished is a positive factor"
152	N39: ⑤ **Next to heading "Empathy"**		
			H50: "Transaction is the process of reaching out beyond the self to others, and language is a major tool used to accomplish that process"
153	N40: **"empathy"**		**H51:** "**empathy** is the process of 'putting yourself into someone else's shoes,' of reaching beyond the self to understand what another person is feeling"
			H52: "empathy" **H53:** "the projection of one's own personality into the personality of another in order to understand him or her better" **H54:** "Empathy implies more possibility of detachment" **H55:** "you cannot fully empathize—or know someone else—until you adequately know yourself"
	N41: **"go beyond limit" next to "transcend"**		
154	N42: ⑥ **Next to heading "Extroversion"**		
	N43: **"living apart from others" next to "reclusiveness"**		
155	N44: **"extroverse"** N45: **"introversion"**		**H56:** "**Extroversion** is the extent to which a person has a deep-seated need to receive ego enhancement, self-esteem, and a sense of wholeness *from other people* as opposed to receiving that affirmation within oneself" **H57:** "**Introversion**" **H58:** "a person derives a sense of wholeness and fulfillment apart from a reflection of this self from other people"
157			**H59:** "the Myers-Briggs test"

			H60: "introversion versus extroversion" **H61:** "sensing versus intuition" **H62:** "thinking versus feeling" **H63:** "judging versus perceiving"
			H64: "Extroversion-Introversion (E/I)" **H65:** "either 'turn inward' or 'turn outward' fro our sense of wholeness ad self-esteem" **H66:** "Sensing-Intuition (S/N)" **H67:** "the way we perceive and 'take in' the world around us. Sensing types are data-oriented and empirically inclined to stick to observable, measurable facts, while intuitive types are more willing to rely on hunches, inspiration, and imagination for perceiving reality" **H68:** "Thinking-Feeling (T/F)" **H69:** "arriving at conclusions and of storing reality in memory. Thinking" **H70:** "cognitive, objective, impartial, and logical" **H71:** "harmony, a capacity for warmth, empathy, and compassion" **H72:** "Judging-Perceiving (J/P)" **H73:** " 'Js' want closure, planning, organization, while 'Ps' are spontaneous, flexible, and comfortable with open-ended contexts"
160			**H74:** "*behavioristic* perspective" **H75:** "anticipation of reward"
			H76: "*cognitive* terms" **H77:** "individual's decisions, 'the choices people make as to what experiences or goals they will approach or avoid, and the degree of effort they will exert in that respect"
			H78: "*exploration*" **H79:** "*manipulation*"
161			**H80:** "*activity*"
			H81: "*stimulation*"
			H82: "*knowledge*"
			H83: "*ego enhancement*"
			H84: "A *constructivist*" **H85:** "emphasis on social context as well as individual personal choices" **H86:** "unique acts are always carried out within a cultural and social milieu and cannot be completely separated from that context"
162			**H87:** "Motivation is something that can, like self-esteem, be global, situational, or task-oriented"

			H88: "Motivation is also" **H89:** "**intrinsic** and **extrinsic** motives of the learner" **H90:** "their own self-perceived needs and goals are intrinsically motivated" **H91:** "receive an external reward from someone else are extrinsically motivated"
	N46: **"instrumental"** N47: **"integrative"**		**H92:** "**instrumental** side of the dichotomy referred to acquiring a language as a means for attaining instrumental goals" **H93:** "**integrative** side" **H94:** "integrate themselves into the culture of the second language group and become involved in social interchange in that group"
	N48: **"motivation→orientation"**		
163		**C1: "context"** C2: "orientation"	**H95:** "within either orientation, one can have either high or low motivation"
	Ch N49: **next to "disputed"**		
164	N50: **"intrinsic motivation"**		**H96:** "Intrinsically motivated" **H97:** "no apparent reward except the activity itself" **H98:** "internally rewarding consequences" **H99:** "*competence* and *self-determination*"
	N51: **"extrinsically motivation"**		**H100:** "Extrinsically motivated" **H101:** "reward from outside and beyond the self" **H102:** "money, prizes, grades" **H103:** "positive feedback" **H104:** "avoid punishment"
	Ch N52: **next to "stockpile"** **Ch** N53: **next to "incongruity"**		**H105:** "research on motivation" **H106:** "strongly favors intrinsic orientations" **H107:** "long-term retention" **H108:** "human beings universally view incongruity, uncertainty, and 'disequilibrium' as motivating"
165	**Ch** N54: **next to "autonomy"**		
166			**H109:** "the temporal lobes of the human brain, the *amygdale*, as a major player in the relationship of affect to language learning"
167			**H110:** "problem of validity" **H111:** "accurate"
168	**Ch** N55: **next to "absurd"**		
169	**Ch** N56: **next to "resemble"**		

Computing Dirichlet tessellations†

A. Bowyer

School of Mathematics, University of Bath, Claverton Down, Bath BA2 7AY

An efficient algorithm is proposed for computing the Dirichlet tessellation and Delaunay triangulation in a *k* dimensional Euclidean space (*k* > 2). The algorithm is designed in a way that should allow it to be extended to some of the simpler non-Euclidean metric spaces as well. The algorithm has been implemented in ISO FORTRAN by the author and execution times and stereoscopic pictures of the tessellation and triangulation are presented at the end of this paper.

(Received April 1980)

1. Introduction

1.1 Definitions

Suppose the positions of *n* distinct points $P_1 \ldots P_n$ in the plane are given as data. We may give each point a territory that is that area of the plane nearer to it than to any other data point. The resulting territories will form a pattern of packed convex polygons covering the whole plane. This construct is known as the Dirichlet tessellation of the points. Fig. 1 (from Green and Sibson, 1978) shows it (bold lines) for a small set of points (*n* = 12). Some data points (those on the convex hull) will have infinite territories, the rest will have territories that are finite.

From the definition above the straight line segments that form the territorial boundaries must be half way between the two points on either side of those whose territories they help to delineate. Each segment of territorial boundary is part of the perpendicular bisector of the line joining the point pair between whose territories the boundary lies. If all point pairs which have some segment of boundary in common are joined by straight lines the result is a triangulation of the convex hull of the data points. This triangulation is known as the Delaunay triangulation. In Fig. 1 the Delaunay triangulation is shown by the faint lines. Point pairs joined by lines in the Delaunay triangulation are said to be contiguous. Green and Sibson (1978) have published an efficient [$O(n^{3/2})$] can be reduced to $O(n \log n)$] algorithm for computing these structures in two dimensions.

The definitions given above apply more generally to Euclidean space in any number of dimensions, and it is to the problem of computing the Dirichlet tessellation and Delaunay triangulation in any Euclidean space that this paper is addressed. With care, it should also be possible to apply the algorithm for the solution of this problem to some of the better behaved non-Euclidean metric spaces as well (the surface of a sphere, for example).

Brown (1979) mentions the possibility of computing tessellations in *k* dimensions using transformations of convex hulls in *k* + 1 dimensions. In the absence of a general convex hull algorithm, however, it is difficult to see how this could be implemented. Indeed it may be possible to perform the reverse operation: computing convex hulls from a *k* dimensional Dirichlet tessellation.

1.2 Properties

In two dimensions the vertices of the territories occur where three territorial boundaries meet (except in degenerate cases, see Section 3.1). The three territories around a vertex belong to three points that form a Delaunay triangle. From the definition of the tessellation a vertex in it must be equidistant from all three of its forming points. It is the circumcentre of their Delaunay triangle. Each Delaunay triangle will have associated with it a unique vertex in the tessellation and vice versa.

†Editorial note: This paper and that by Watson (this issue) cover some material in common. As these contributions were received at approximately the same time, the Editor feels it only right to include both papers.

In a *k* dimensional Euclidean space the Delaunay triangles become simplexes with *k* + 1 data points as vertices. A vertex in the tessellation is where *k* + 1 territories meet and means that it is the centre of the hypersphere passing through all the vertices of the associated simplex. As before each contiguous pair of points is joined by a line that is an edge of some Delaunay simplex. The territorial boundary shared by the contiguous point pair is a convex polygon lying in the *k* − 1 dimensional hyperplane that bisects that edge.

In three dimensions the territory of each data point is a convex polyhedron; the region of space nearer to the point than to any other. The faces of the polyhedra will be convex polygons; the
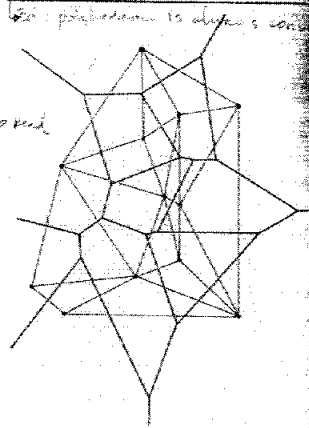
Fig. 1 The Dirichlet tessellation (bold lines) and Delaunay triangulation (fine lines) for a small-scale configuration, from Green and Sibson (1978)

territorial boundaries shared by contiguous points. Each such polygon will lie in the plane that bisects an edge of a Delaunay tetrahedron. Fig. 2 shows a three dimensional vertex and its associated Delaunay tetrahedron.

3. Applications

The availability over the past few years of an efficient two dimensional algorithm for calculating the Dirichlet tessellation means that it is now possible to investigate a number of applications for the tessellation that predate the algorithm, and also opened up some new applications. Most of these are specifically two dimensional problems.

Green (pers. comm.) has used the structure to model a random pattern of wells through which an epidemic is allowed to spread. A good deal is known about the spread of epidemics on regular lattices. The Delaunay triangulation and Dirichlet tessellation of some realisations of random point processes provide a convenient random lattice for these studies with a number of useful properties.

An obvious application of the two dimensional structures is to be used to investigate the territorial behaviour of animals. On a more abstract level the structures are useful in the analysis and simulation of certain spatial point processes (see Miles, 1970; Ripley, 1977). One of the models of crystal growth used by crystallographers calls for the use of the three dimensional version of the Dirichlet tessellation (Gilbert, 1962). Geo-

Fig. 2 3 dimensional Delaunay tetrahedron and its associated vertex

Fig. 3 The algorithm for finding the territory of point Q

graphers use the structures for a variety of purposes.

Lawson (1972) gives an optimality criterion for triangulations that are to be used for interpolation and finite element work. Sibson (1978) has shown that the Delaunay triangulation uniquely satisfies that criterion.

Perhaps one of the most important applications of the Dirichlet tessellation is in the fitting of surfaces to, and in the smoothing of, observations of some function (barometric pressures or height above sea level, for example) taken on an irregular pattern of observation sites (Sibson, 1980). The availability of a tessellation/triangulation algorithm which will work in higher dimensional spaces will allow this work to be extended to cover numbers of independent variables greater than two.

As the algorithm presented in this paper is designed for handling convex polygons in any number of dimensions it may well prove useful in some linear programming problems. The algorithm may also be of some use in the computation of convex hulls of sets of data points in more than two dimensions (Green and Silverman, 1979; Brown, 1979).

2. The algorithm

2.1 Data structure

Before considering how the structure may be computed a decision must be made on how to store it. Green and Sibson store the Delaunay triangulation in the form of lists of contiguous points for each point. Their algorithm takes advantage of the fact that these lists may be stored cyclically for the two dimensional case in order to facilitate the insertion of points into the structure one by one. In higher dimensions it is not possible to order the contiguity lists cyclically, though it might be possible to organise these lists in some other way (in order of increasing distance from the point of which the list entries were neighbours, for example).

Suppose it were desired to store the vertex structure of the tessellation. Consider Fig. 3. Here eight data points in the plane give rise to seven vertices, $V_1 \ldots V_7$. The territorial boundaries that extend to infinity can conveniently be considered as terminating in a vertex labelled zero. Each vertex is the circumcentre of three data points and a list of those points could be recorded for each vertex. In addition each vertex points to three other vertices, each one opposite one of the vertex's

Vertex	forming points				neighbouring vertices		
	1	2	3	1	2	3	

2.2 Adding a point

If it is possible to record the structure in the manner outlined above and then to add a new data point and modify the record appropriately, any number of points can be tessellated and triangulated by starting with a simple structure and building upon it. The obvious starting pattern is the Delaunay simplex formed by the first $k + 1$ points. This will give a tessellation containing one real vertex, all of whose neighbouring vertices will be $\emptyset$. The only restriction here is that the first $k + 1$ points must not all lie in a hyperplane in the k dimensional space that is being considered. This should not present a serious limitation.

Suppose we wish to insert a new point (Q in Fig. 3) within the current convex hull of the data points. The territory we wish to find is indicated by the dotted lines. The algorithm for doing this can be outlined as follows:

1. Identify a vertex currently in the structure that will be deleted by the new point (say, V_1). Such a vertex is any that is nearer to the new point than to its forming points. There will always be at least one such vertex, as the vertex corresponding to the Delaunay simplex in which the new point lies will always be deleted and the Delaunay simplexes completely fill the convex hull of the currently included points.

2. Perform a tree search through the vertex structure starting at the deleted vertex looking for others that will be deleted. This is an easy matter if the data are stored as indicated in Table 1. The result will be a list of all the vertices deleted by the new point, Q. In this case the list will be: $\{V_1, V_2, V_3\}$.

3. The points contiguous to Q are all the points forming the deleted vertices: $\{P_1, P_2, P_3, P_4, P_5\}$.

4. An old contiguity between a pair of those points will be removed if $P_i - P_j$ say) if all its vertices $\{V_1, V_2\}$ are in the list of deleted vertices.

5. In this case the new point has five new vertices associated with it: $\{W_1, W_2, W_3, W_4, W_5\}$. Compute their forming points and neighbouring vertices. The forming points for each will be the point Q and k of the points contiguous to Q. Each line in the tessellation has k points around it (the line $V_1 - V_2$, for example, is formed by P_3 and P_4). The forming points of the new vertices and their neighbouring vertices may be found by considering vertices pointed to by members of the deleted vertex list that are not themselves deleted, and finding the rings of points around them. Thus W_1 points ...

184 THE COMPUTER JOURNAL, VOL. 24, NO. 2, 1981

© Heyden & Son Ltd, 1981

Fig. 4 The Dirichlet tessellation in 3 dimensions

Fig. 5 The Delaunay triangulation in 3 dimensions

Fig. 6

bedrooms. Again all the contiguities of the central point have been plotted using thick lines. If the reader does not have access to a stereoscope the three dimensional images can usually be seen by placing a piece of card between the left and right eye images on the page, relaxing the eyes so that the two images coalesce, and then attempting to focus the resulting single image. It is the second part of this process that is the more difficult. Very early in life the brain learns to link the angle between the eyes and the amount of distortion of the eye lenses needed to produce a sensible image. One solution is to use two identical magnifying glasses, one in front of each eye. This allows the eyes both to focus at and to point at infinity, whilst actually observing the image from a short distance.

The original plots of Figs. 4 and 5 used colour to differentiate the various aspects of the structures. Unfortunately printing difficulties make it impossible to reproduce them here.

3.4 Timing

As has already been mentioned, the work done in finding an initial vertex to delete is $O(n^{1/k})$. For n points in k dimensions this will lead to an $n^{(k+1)/k}$ term in the time taken to compute the tessellation. Once such a vertex has been found the time of computation per point is constant (given k) leading to an $O(n)$ term in the computation time. Thus the algorithm should take $O(a_k n^{(k+1)/k} + b_k n)$ time to compute the structure for n points. The constants a_k and b_k will depend upon the initial choice of k. Simulations done by the author show that b_k in particular will increase quite rapidly with increasing k, as would be expected.

If the points were sorted before being presented to the algorithm (thus reducing the need for long nearest neighbour walks) the algorithm should take $O(a_k n \log n + b_k n)$ time, though, in practice, the saving thus introduced is usually negligible.

Fig. 6 shows some timings of the algorithm for various numbers of points in 2, 3 and 4 dimensions. The time for the Green-Sibson algorithm operating on the same two dimensional 500 point data was 5.5 seconds as opposed to 28 seconds for the author's algorithm. As the Green-Sibson algorithm takes advantage of the two dimensional nature of the structure it would be expected to be faster, and the author would have no hesitation in recommending its use rather than his own algorithm for the specifically two dimensional case. All the runs were done on a twin processor Honeywell level 68DPS, owned by Bath and Bristol Universities, running the Multics operating system.

References

BROWN, K. Q. (1979). Voronoi diagrams from convex hulls, Inf. Processing letters, Vol. 9 No. 5, p. 223.
COXETER, J. and HICKEY, J. (1979). Two algorithms for determining volumes of convex polyhedra, JACM, Vol. 26 No. 3, p. 401.
GILBERT, E. N. (1962). Random subdivision of space into crystals, Ann. Math. Stat., Vol. 33, p. 958.
GREEN, P. J. and SIBSON, R. (1978). Computing Dirichlet tessellations in the plane, The Computer Journal, Vol. 21, p. 168.
GREEN, P. J. and SILVERMAN, B. W. (1979). Constructing the convex hull of a set of points in the plane, The Computer Journal, Vol. 22 No. 3, p. 262.
LAWSON, C. L. (1972). Generation of a triangular grid with application to contour plotting, Cal. Tech. JPL Technical memorandum No. 299.
MILES, R. E. (1970). On the homogeneous planar Poisson process, Mathematical Biosciences, Vol. 6, p. 85.
RIPLEY, B. D. (1977). Modelling spatial patterns, JRSS Ser. B, Vol. 39, p. 172; Discussion, p. 193.
SIBSON, R. (1978). Locally equiangular triangulations, The Computer Journal, Vol. 21 No. 3, p. 243.
SIBSON, R. (1980). A vector identity for the Dirichlet tessellation, Math. Proc. Camb. Phil. Soc., Vol. 87, p. 151.

Section	Verbal data	Observational data	Textual data
Notation		**P=participant**	**H=highlight** **U=underline** **N=note on the text** **C=circled segment**
Abstract		P does not read the abstract, but there is a section already highlighted	**H1:** "a *k* dimensional Euclidean space (*k* ≥ 2)"
1.1 Definitions (~5 min)	**V1:** They call it Dirichlet Tessellations instead of Voronoi diagram. That's weird. **V2:** I just don't understand this sentence. **V3:** I just don't know what he means by this. I guess it is not that important. **V4:** There is one reference. Now I will check if I have got it. I've got it I've never read it. So I should read it… **V5:** Because I thought it was about one part of Delaunay triangulation but here they say there is a complete algorithm to create it. So I should read it.	P starts from beginning P goes back to the title to highlight "Dirichlet" P comments P underlines, looks concentrated, plays with the pencil I ask to TA P comments P highlights P continues to comment P leafs forward to References, checks computer, comments P writes notes P explains P drinks water	 **U1:** <u>"Some data points (those on the convex hull) will have infinite territories,"</u> **H2:** "Point pairs joined by lines in the Delaunay triangulation are said to be contiguous." **C1:** "Green and Sibson (1978)" **N1:** "to read" next to Green and Sibson (1978)
1.2. Properties (~5 min)	**V6:** Well this is difficult as I said because technical terms are not the same so sometimes I am like. **V7:** It's a technical paper. This is a definition oh not definition but properties of Delaunay triangulation.	P comments P concentrates, scratches his head P comments again	

	So I am reading quite slowly because I must make sure I understand every sentence. So I must look at the diagram make sure I understand. **V8:** This is quite interesting. I have never noticed this I in my work on 3 dimensions.	P seems restless, scratches his nose P highlights, then writes notes P comments P reads non-linearly, looks down at Figure 1 P highlights and makes a note P reads pp. 162 and 163, constantly leafs over, highlights	**H3:** "a k dimensional Euclidean space the Delaunay triangles become simplexes with $k + 1$ data points as vertices" **N2:** "interesting! for 3 d" above highlight **H4:** convex polyhedron **N3:** 3d: "polyhedron is always convex" under highlight **H5:** "The faces of the polyhedra will be convex polygons: the territorial boundaries shared by contiguous points."
	V9: Something I have never noticed and now I am looking at. Because I made a program and I am not sure if it works.	P checks his program P comments P continues reading, leafs back to p. 162 and makes a note P leaf over to p. 163 again P highlights P looks at Figure 2 and highlights part of the figure caption P concludes	**N4:** (!) next to highlight **H6:** "Each convex polygon will lie in the plane that bisects an edge of a Delaunay tetrahedron." **H7:** "3 dimensional"
	V10: Yeah, it seems to be true		
1.3. Applications (~5 min)		Student enters office, H drinks water and concentrates P underlines	 **U2:** "spread of epidemics"

		I ask to think aloud P comments	
	V11: I don't know what he means by this, never seen those terms 'spreading epidemics'.	P continues to concentrate P comments	
	V12: They give examples of application. And they have one very stupid application because now everybody has it. Back in 1981 they only had one or two.	P scratches his head, leafs over to the References, checks his computer, looks on the desk P comments	
	V13: Checking a reference. I don't know. I've got this paper somewhere.	P finds an article, leafs over this article, goes straight to the References page, notes something on that page, leafs through the article (I see there are highlights on that article already), finds a section P comments	
	V14: I don't have the article they are citing but I have another one by the same guy and he is citing the 1972 articles and he explains it so I don't think I need to read it. It should be ok.		
2.1. Data structure (~6 min)		P highlights the title of the subsection P moves in his chair, concentrates, bites on a highlighter, changes the highlighter for the pencil, leafs over to p. q164, scratches his head, looks very concentrated P writes a note next to Table 1 P scratches his head P leafs back to p. 162 P leafs back to p. 164, shrugs his shoulders P goes back to p. 163, keeps the page half-open, counts numbers in Figure 3, moves eyes from	**H8:** "Data structure" **N5:** "Voronoi data structure" Numerous lines in Figure 3

		table to diagram, draws lines, sighs, appears very restless I ask to TA P replies P continues	
	V15: I am not thinking. I am just looking at the figure.		
	V16: Ok strange because they are starting with data structure of solution instead of DT. I think it is worse because nobody is doing this these days. It is cumbersome and stupid. So I don't' know why they were doing it. Because I've never seen this.		
		P reads on and constantly looks at Figure 3 P finally says	
	V17: I am just checking if this… yeah they are really doing Voronoi instead of Delaunay.		
		P highlights and leaves a note	**H9:** "Supposes it were desired to store the vertex structure of the tessellation." **N6:** "→Voronoi vertices!" next to highlight
		P reads both pp. 163 and 164, constantly goes from one to the other	
		P reads the highlighted sentence P continues	
	V18: Supposes it were desired to store the vertex structure of the tessellation. Yeah, I can suppose but I don't see why.	P drinks water, scratches his head P leafs over, counts pages, goes back to p. 164	
2.2. Adding a point (~15 min)		P starts reading the section and next to the first sentences of it, writes a note P comments	**N7:** "instrumental algo" next to first 2 sentences of paragraph 1
	V19: And here he is explaining the incremental algorithm. That's the one I am using.		
		P coughs, scratches his head, leafs over to p. 163 and Figure 3 P comments	
	V20: Again, he is referring to the same figure	P adds a circle within the figure Preads and leafs back to Figure 3, looks	

	concentrated, taps on the back of his neck with the pencil, leafs back and forth, scratches his head P comments	
V21: Well, the fact that they are working directly with Voronoi is confusing. I am not lost but, it's weird. This is complicated.		
	P makes notes next to point 4	**C2:** 4 **N8:** "Swap"
	P leafs back to Figure 3 P underlines a segment and leaves a note next to it	**U3:** <u>"Each line in the tessellation has k points around it (the line V3-V2, for example, is formed by P3 and p4)."</u> **N9:** "!"
	P comments	
V22: This is interesting again. But I am not sure this is true in three dimensions.		
	P checks his computer, reads, bites his nails, checks his computer again, scrolls up or down, looks at the computer, at the text, takes the pencil, checks Figure 3	
	P takes a hand-made object, looks straight at the object P comments	
V23: It is complicated		
	P continues looking at the object, reads on P highlights	**H10:** "wish to insert a new point" **H11:** "The algorithm"
	P highlights again P reads the highlighted sentence and comments	**H12:** "How may a vertex that will be deleted be identified for step 1?"
V24: How may a vertex that will be deleted be identified for step 1? Here they explain		

	something. This is useful. But it is not explaining the algorithm.	Student enters, P gets distracted for a sec	
		P writes a note next to description of Green and Sibson's algorithm P comments	**N10:** "W"
	V25: Here they are referring to another article where there is an interesting idea about the same thing. The article I read last week, the same stuff. The first paper that used this algorithm.	P leafs to p. 163 P checks his computer P turns the tape over P leafs from p. 163 to p. 164 and back, looks very concentrated and surprised, plays with his nose P turns to p. 165 P comments	
	V26: I am not sure I understand everything but it is not very important that I understand everything. Because I know what they are doing. What they are doing is summarizing the other article… Shit, complicated. Because I am used to think in terms of triangles and not polygons. It is the same thing but… I mix up.		
3.1. Degeneracy (~3 min)	**V27:** Well I don't understand everything and it will take me three days and I don't think it is very important. I can skip some parts like this. Not very relevant because this problem has been solved a few years ago.	P highlights P looks concentrated, sighs P comments P skips sections	**H13:** Degeneracy (subsection heading)
3.2. Programming		P goes for water P comes back, starts reading, bites on his pencil P drinks water	

(~3 min)	**V28:** I don't need to read this part either. About how they implemented the algorithm. But 20 years ago computers were totally different.	P comments	
3.3. Pictures (~3 min)	**V29:** First time in my life I see this stereoscopic images in an article. But I am not sure I can see.	P reads on p. 165 P turns to p. 166 P smiles P comments P looks at pictures (Figures 4 and 5), by bringing the paper forward and backwards P smiles P comments	
	V30: So now I am just checking to see in three dimensions. Actually it is stupid b/c we cannot see anything but it is cool to put images in 3d. **V31:** Here they explain how to see in 3d but I know.	P reads on and comments	
3.4. Timing (~1 min)	**V32:** I don't need this part because it is timing and 20 years ago it was 10 million times slow. **V33:** And there is no conclusion	P uses the pencil to cross over the subsection P comments P skips to the last paragraph P turns over the page P shrugs his shoulders P comments	
Acknowledgements			
References (~2 min)	**V34:** I am just reading the references.	P reads the references and comments He leaves a note next to Green and Sibson (1978)	**N11:** "*"(star)

Compensating for Cognitive Deficits Following Brain Injury

Barbara A. Wilson[1,2,3]

Two of the most important goals of rehabilitation are to (a) reduce everyday consequences of impaired cognitive functioning (disabilities) and (b) reduce the level of handicap (the extent to which these problems prevent successful return to society). One of the ways by which we can achieve these goals is to enable people to compensate for their cognitive deficits. This paper (i) describes a theoretical framework for understanding compensatory behavior, (ii) discusses different forms of compensation, (iii) considers compensation for several cognitive disorders, and (iv) presents suggestions for predicting which patients will find it easy to compensate and which require more intensive and focused rehabilitation.

KEY WORDS:

The ultimate goal of rehabilitation is to enable people with disabilities to function as independently as possible in their most appropriate environment (McLellan, 1991). In the early days and weeks following brain injury attempts are usually made to restore lost functioning; for example, we try to teach people who have lost the ability to walk and talk, how to walk and talk again. After a while, however, if restoration of function has not occurred, typically when the natural recovery period has slowed down or stopped, therapists are likely to adjust their objectives and, in this instance, perhaps concentrate on wheelchair independence or alternative communication systems. Although restoration of function (or partial restoration) can occur even several years post injury (see e.g., Taub et al., 1993, who improved the motor performance of people with hemiplegia following a stroke), in the majority of cases of cognitive deficits the move in rehabilitation, if restoration of function is not achievable, is towards the teaching of compensatory strategies. Anderson (1996) suggests that attempts to restore lost functioning are based on belief in neural plasticity whereas compensatory strategies are based on the assumption that many cognitive deficits are resistant to treatment and rehabilitation should, therefore,

concentrate on teaching coping strategies. For further discussion of plasticity and compensation see Robertson and Murre (1999).

There is evidence that some restoration of functioning can be achieved in some areas of cognitive functioning. For example, Robertson et al. (1995) trained people with unilateral neglect to sustain their attention through a self-alerting procedure. Benefits generalized to real-life situations. Although some would argue that this is a behavioral compensation, Robertson et al. believe their approach led to restoration of a basic underlying function. Language, too, might be amenable to strategies aimed at restoration of function (Kolb, 1995; Thomas et al., 1997). Memory, on the other hand, appears to be more resistant to restoration of function (Schacter and Glisky, 1986). The most famous amnesic patient in the world, HM (Scoville and Milner, 1957), appears to have shown no recovery since his operation in 1957 (Freed et al., 1998). Another amnesic patient, CW, has shown no recovery over a 10-year period (Wilson et al., 1995). There are, however, a few reports of some people with memory impairments showing improvement or even recovery over time (Victor et al., 1989; Wilson, 1991). Nevertheless a common approach to the remediation of cognitive deficits is to teach or enable people to compensate. It is possible to do this as we shall see, later, although specific teaching strategies and extra time may be required (Wilson, 1995).

To compensate is to "offset the disability in another direction" (The Concise Oxford Dictionary, 1990), and,

[1] MRC Cognition and Brain Sciences Unit, Cambridge.
[2] Oliver Zangwill Centre for Neuropsychological Rehabilitation, Ely, UK.
[3] To whom correspondence should be addressed at MRC Cognition and Brain Sciences Unit, Box 58, Addenbrooke's Hospital, Hills Road, Cambridge CB2 2QQ; e-mail: barbara.wilson@mrc-cbu.cam.ac.uk

---

Wilson

with some exceptions noted in the previous paragraph, is likely to be employed in rehabilitation when the rate of natural recovery has stopped or noticeably slowed down. Compensation can be achieved in several ways. For example one can arrange the environment to avoid the need for a particular function. Thus people with severe physical disabilities can use environmental control systems to enable them to open doors and windows, turn pages of a book, answer the telephone, and so forth. The ability to use one's limbs is no longer required in these instances as the environmental control systems can be manipulated by a mouth-control stick or voice-operated system. Similarly, people with severe cognitive problems can avoid the need to use their damaged cognitive skills in suitable structured environments where, for example, signposts are supplied, doors to different rooms are labeled, or warning alarms are triggered if somebody wanders off. There are already environmental systems designed for people with dementia (Wilson and Evans, 2000), which attempt to "disable the disabling environment," and are used with cognitively impaired video links, and telephones to remind people when to take medication, use bathrooms, turn electrical appliances on and off, and ensure water temperature is not too hot or cold.

In addition to structural environments, compensation can be achieved by teaching people to use strategies and techniques to reach their goals in alternative ways. For example, people who lose the ability to read following brain damage can still enjoy "talking books," and people with severe memory problems can use external memory aids to enable them to remember their daily schedules. The principle here is to use an intact skill to overcome a damaged one. Luria et al. (1969) referred to this as "functional adaptation," and as early as 1947, Zangwill argued that it was one of the most important procedures in rehabilitation (Zangwill, 1947).

Even people with dense amnesia retain some memory functioning (see, e.g., Baddeley, 1992), so a third way to enable people to compensate for cognitive difficulties is to encourage them to use their residual skills more efficiently, as is done in the case of people with memory impairments, who are taught to use any remaining ability to remember more effectively. Rehearsal strategies and the use of mnemonics to enhance learning are two of the ways by which this is achieved (Wilson, 1995). Errorless learning principles can also be employed to enable people with memory impairments to learn more efficiently than they would with trial-and-error learning (Baddeley and Wilson, 1994; Clare et al., 1999; Wilson et al., 1994).

The three approaches mentioned earlier are not mutually exclusive and can be employed together to help an individual compensate for cognitive deficits. A person

with unilateral visual neglect, for example, can be assisted by (i) reorganizing the environment to make it easier to attend to visual material (e.g., putting a red strip to the left of the telephone, cooker, or writing pad), (ii) providing aids to help cope with visual demands (e.g., supplying a ruler to place below each line when reading), and (iii) enabling the person to use residual skills more efficiently (e.g., teaching scanning strategies such as those recommended by Weinberg et al. (1977), or limb activation techniques such as those recommended by Robertson and North, 1993).

COMPENSATION SHOULD ADDRESS DISABILITY AND HANDICAP RATHER THAN IMPAIRMENT

The World Health Organization (1980) produced a conceptual framework (soon to be superseded by a different albeit similar model) describing three levels of health problems: impairments, disabilities, and handicaps. Impairments are deficits caused by damage to physical and mental structures. Thus the consequences of frontal lobe damage cause impairments such as verbal fluency deficits, or inability to switch from one solution to another. Impairments to mental structures such as language, perception, or memory are identified typically by neuropsychological tests, which provide scores to enable clinicians to state with a degree of confidence that a patient might or might not be suffering from a particular impairment.

Identification of these impairments allows us to build up a picture of an individual's cognitive strengths and weaknesses so that when we plan a rehabilitation program for an individual we can use this map to guide us. The main purpose of cognitive rehabilitation, however, is not to improve test performance, although it may aim to improve underlying impairments and thus reduce disability and handicap (Robertson et al., 1995; Taub et al., 1995). Rehabilitation is more likely to target the functional consequences of the impairment, or, to use the WHO model, the disabilities, which are the problems faced in everyday life by the individual and his or her family. An individual with frontal lobe damage and the supporting family are probably unconcerned that scores of a verbal fluency test are low while at the same time they are likely to show great concern that the individual cannot make decisions or cannot get started on an activity, or cannot cope with more than one thing at a time. Disabilities of this kind, which are manifested in the everyday life of the individual and encountered by the supporting family, are the ones we should be trying to overcome or circumvent in our rehabilitation programs. This might be by indirectly targeting the impairment or directly targeting the disability.

Reducing handicap is also the concern of rehabilitation. Handicap, according to the WHO model, refers to problems imposed by society on an individual because of his or her disability. For example, a person in a wheelchair is not handicapped in environments with good wheelchair access, but is handicapped in buildings with no suitable access. Similarly, the person with frontal lobe damage may cope well in a very structured setting where the requirements are spelled out clearly, but fail to cope in a setting that is less well organized and where individual choices have to be made. If we can provide the structure or teach the person concerned to cope with less structure then we have reduced the handicap.

Reduction in disability and handicap may or may not lead to improved scores on neuropsychological tests. If we are teaching people with brain injuries to apply a strategy in everyday life that can also be used to improve test performance, this is all to the good, but ultimately good rehabilitation outcome does not depend upon improved test scores. A person with amnesia, for example, might be able to live independently and even hold down a job through good use of external aids (see Wilson, J. C., and Hughes, 1997). In such a case, disability and handicap are minimized and yet there may be no change in standardized neuropsychological test performance as far as that individual is concerned. It would, therefore, be inappropriate, to say the least, to use scores on neuropsychological tests as an outcome measure for that individual. Instead, we should consider the individual's situation in terms of level of independence in everyday life, return to work and other functionally relevant outcome measures in order to evaluate the success or otherwise of our rehabilitation program.

A FRAMEWORK FOR UNDERSTANDING COMPENSATORY BEHAVIOR

Why do some people with cognitive deficits compensate well and others do not? This question has interested workers in rehabilitation for several years. In 1996, Peter Watson and I described a practical framework for understanding compensatory behavior in people with organic memory problems (Wilson and Watson, 1996). Our framework, grew out of work by Bäckman and Dixon (1992), who believed that compensatory behavior takes place when there is either (a) a decrease in a given skill without an accompanying decrease in environmental demands, or (b) an increase in environmental demands without an accompanying increase in the skills required for successful performance. These consequences, say Bäckman and Dixon, are the result of compensation (or having, They go on to discuss the mechanisms, forms, and consequences of compensatory behavior.

Mechanisms are ways in which a match between everyday demands and skill deficits is achieved. One way is to offset the mismatch by an increase in time and effort, a second way is to use a substitute skill, and a third way is to adapt or adjust to the new situation by relaxing the criteria of success or by changing expectations.

Forms of compensatory behavior refer to the manner and extent to which compensatory behavior differs from the behavior of a "normal person" (in Bäckman and Dixon's terminology) in a similar situation. These forms may involve the same behavior a "normal person" would use with more time and effort expended, or they may involve substitutable skills and these may be ones "normal" people use but only infrequently, or they may be entirely new behaviors not used by the general population.

Consequences of compensatory behavior may be functional and adaptive, and reduce the mismatch between environmental demand and skill, or they may be maladaptive and fail to reduce the mismatch.

Wilson and Watson (1996) considered how this framework of Bäckman and Dixon might apply to people with memory impairments consequent upon brain injury. They found much of the framework useful but insufficient to account for all the successes and failures in learning to compensate, demonstrated by people with organic memory impairment. For example, Bäckman and Dixon (1992) consider severity of impairment affects the extent to which compensation occurs and suggest compensatory behavior follows a U-shaped curve whereby people with very mild or very severe deficits will not compensate whereas those with moderate deficits will. They provide examples of "normal" elderly adults who compensate better than young adults who do not need to compensate, and people with Alzheimer's disease who do not have the wherewithal to compensate. Wilson and Watson (1996) regarded this as only partially true. Thus, people with mild deficits may not feel or recognize the need to compensate, and people with moderate impairment may well recognize the need. However, people with amnesia may also be able to compensate despite very severe problems, provided they have no or few additional cognitive deficits, particularly no marked executive ones.

HOW DO PEOPLE COMPENSATE FOR COGNITIVE DEFICITS?

In the introduction, it was pointed out that there are at least three ways by which compensation can be achieved: through structuring, adapting, or organizing the environment; through finding another way to reach a final goal; and by functional adaptation, or through enabling people to use their residual (albeit damaged) skills more

effectively. In the previous section, we considered the four-stage framework of Bäckman and Dixon: origins, mechanisms, forms, and consequences of compensatory behavior. In this section, forms and mechanisms will be considered in more detail, particularly in so far as they relate to people who have sustained a brain injury.

Time and effort were considered by Bäckman and Dixon to be important elements in compensation, and their view can be borne out by observing how many people with cognitive impairments work hard at coping with their problems. Some people with amnesia, for example, concentrate very hard on the materials to be remembered and may be heard verbally encouraging themselves to do just this. Such attempts may help when memory problems are secondary to attentional deficits but probably do not help much in cases of primary amnesia. Some people who return to work after brain injury try to cope by spending more time and effort on their daily routine and may, for example, spend longer hours at work or being work home, sometimes involving members of their family in work activities. This is not necessarily a good thing and may lead to greater stress on both the client and family.

Employing substitute skills to meet environmental demands is a second commonly used compensation method according to Bäckman and Dixon. This is another way of describing functional adaptation (Luria, 1963) or using an alternative means to achieve a final goal (Wilson, 1989). Rehabilitation therapists frequently use this approach, providing, for example, specially adapted clothing for people with arthritis or one-handed equipment for people with hemiplegia. There may be problems in persuading people to use these substitutes. People with memory impairments sometimes have difficulty in using external memory aids as compensations because they cannot remember to use them. Teaching the use of such aids calls for patience and ingenuity on the part of the psychologist or therapist. Nevertheless, some people use them well (Kime et al., 1996), and for many people external memory aids are the most helpful compensatory systems and the most likely to be used in the long run (Wilson, 1991).

The third mechanism mentioned by Bäckman and Dixon was adjustment or adaptation to the mismatch between environmental demands and skills. Such adaptation is commonly employed by many people with cognitive problems and indeed is a major focus of many rehabilitation programs. Holistic programs, in particular, typically spend some time each day helping people to understand what has happened to them, to help them make sense of this knowledge, and to come to terms with their new status.

Helping people learn more efficiently can also be considered as a method of compensation. Repetition is one strategy widely used by the general population and by

people with brain injury. Although repetition used alone is probably of limited use for people with severe memory deficits, there are ways in which repetition or rote rehearsal can be enhanced. Expanding rehearsal, otherwise known as spaced retrieval (Landauer and Bjork, 1978) has proved an effective learning method. Camp (1989), Camp and Shaller (1989) and Moffatt (1989) have used the technique with people with dementia. More recently Clare and her colleagues have used expanding rehearsal to teach practical everyday information to patients with Alzheimer's disease (Clare et al., 1999, 2000). The results of one patient can be seen in Fig. 1.

So far we have considered compensatory strategies used by people with and without brain injury. Are there strategies or skills that can be used by those with specific problems that are not normally used by the general population? The Braille system is one example. I can think of another in the use of higher-order cognitive systems employed by older typists (Salthouse, 1984). Thus, although the motor speed of older typists is slower than that of younger typists, they may compensate by better scanning and benefiting from previous experience. Even so, it is hard to see how these are genuinely new skills, rather than latent skills brought into play more and more as compensation such as reaction time or tapping rate deteriorate.

Similarly, compensatory strategies used by people with cognitive impairments are, for the most part the same as those used by people without organic deficits. Diaries, pill reminders, organizers, and alarms are used by those with and without brain injury. Even when particular cognitive strategies are used, such as asking people to repeat what they have said, it is typically the frequency of the behavior rather than the behavior itself which differs between people with and without significant cognitive problems.

Most compensatory strategies or aids are not designed specifically for people with brain injuries although there are a few examples. The scanning board described by Weinberg et al. (1977) to teach people with unilateral neglect to scan more efficiently may be considered as one kind of aid; communication systems for people with speech and/or language disorders are perhaps the most frequently found aids specifically designed for those with neurological damage; in the field of memory some computer software programs have been designed specifically to help compensate for memory loss (e.g., Cole and Dehdashti, 1990; Kirsch et al., 1987, 1992).

Another specifically designed memory compensation aid is NeuroPage® (Hersh and Treadgold, 1994) which is a portable paging system used to send messages to those with significant memory problems. In 1997, Wilson and colleagues reported a study in which 15 people with
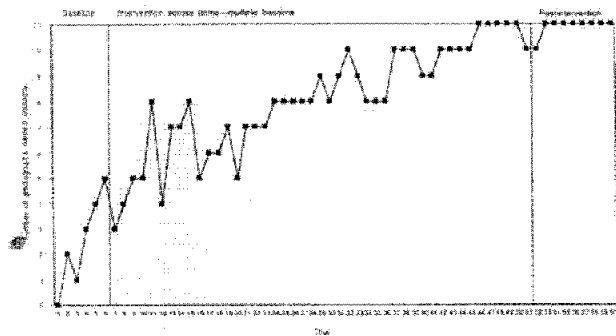
Fig. 1. Number of correct responses on successive trials.

Fig. 2. Mean percentage of tasks completed successfully in baseline, treatment and posttreatment stages.

memory impairments benefited significantly from the provision of NeuroPage® (Wilson et al., 1997). The mean success rate in achieving target behaviors in the baseline period was 37%, and this rose to over 85% when the pager was tried. These results can be seen in Fig. 2. Evans et al. (1998) demonstrated that it was not only people with memory impairments but also those with a dysexecutive syndrome who could also benefit from NeuroPage®. However, even with systems such as NeuroPage®, which was originally designed for a young man with a severe head injury, one could argue that the compensatory skills of people using buttons and reading messages required for their use are no different from those used by people without neurological impairment or brain injury.

Bäckman and Dixon (1992) state that one of the mechanisms used to compensate is adjustment or adaptation to the mismatch between skill and environmental demands. Such adjustment or adaptation is almost certainly used by many survivors of brain injury. They adjust to different risks and employment opportunities, and to the fact that their cognitive skills are not what they used to be. In the words of one young man (Wilson, 1999, p. 42):

"I don't notice the loss of my memory as I can't remember what caused it to be so. The condition has helped me to cope, I think, was a different type of person. Although I may have become more sensitive, I have also, noticeably, become more confused, my thinking more cautious, and I am very comfortable with that. I think it quite my character."

COMPENSATING FOR DIFFERENT COGNITIVE DEFICITS

Memory

There is evidence that some people with a particular syndrome are able to compensate for their memory difficulties reasonably well (Wilson and Watson, 1996). JC, the young man mentioned earlier, is a good example. At the age of 20 years JC had a hemorrhage caused by a ruptured posterior cerebral artery aneurysm. As a result, he became densely amnesic and remains so at the time of writing 12 years later. Despite this he is able to live alone, earn his living by making cane furniture, and is completely independent. He developed (and continues to develop) a sophisticated system of compensatory memory strategies. Soon after his hemorrhage he started writing on scraps of paper. Over the years he has progressed to using a data-bank watch, a personal organizer, and a small tape recorder as his main memory aids. These are supported by a number of additional strategies, used less often. JC records information in at least two systems so that if he fails to access it one way he has a back-up. The first 10 years of the development of his system is described in Wilson et al. (1997). It was possible to describe this natural history of a compensatory system as JC kept a journal over this period; his aunt also kept a record of how she helped JC, and I kept records of my assessments. By combining information from these three sources we were able to trace the increasing sophistication of JC's employment of strategies.
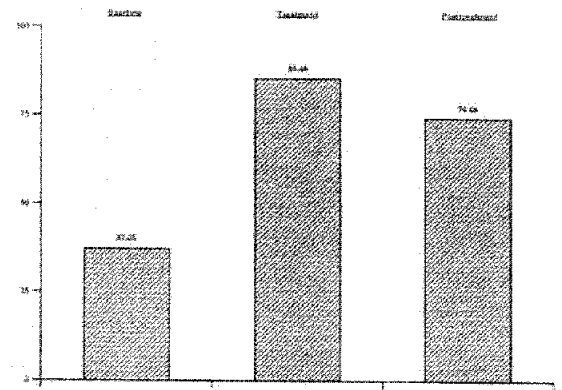
Returning to the framework described earlier, it is clear that to a considerable extent JC was able to reduce the mismatch between environmental demands and his cognitive skills. This mismatch, according to Bäckman and Dixon, is the origin of compensatory behavior. The mechanisms by which compensation occurs can be to (i) offset the mismatch by an increase in time and effort, (ii) use a substitute skill, and (iii) adapt or adjust to the disability. There is little doubt that JC uses all three of these mechanisms. He certainly puts considerable time and effort into making sure his system does not fail, spending hours every evening transcribing from his tape recorder; he also uses substitute skills by relying upon external memory aids to a far greater extent than he did prior to his hemorrhage; finally he has adapted and adjusted to his disability. Initially studying law, he now accepts his work is to be a furniture maker. Despite early depression because he could not fulfill his expectation of returning to university, once he had overcome this, he gained self-esteem from his independence, his successful work as a furniture maker, and his realization that he was a very unusual person in coping so well with his disability.

JC's compensatory behavior takes the following form: his daily life is very structured, he follows set routines, he uses his alarm watch, his organizer, and his tape recorder very frequently. He has developed an almost foolproof method to ensure that he does not forget appointments or to carry out his furniture-making commitments. He claims that he was always very organized as a child and this behavioral style has stood him in good stead. Although he uses strategies that many of us use, the frequency and consistency with which he uses them ensures that he is able to live a reasonably independent life.

What about the consequences of such compensatory behavior? The framework described here suggests that the consequences may be functional and adaptive (this

Language

Reading

Visuoperceptual and Visuospatial Difficulties

WHICH PEOPLE ARE LIKELY TO COMPENSATE WELL?

CONCLUSIONS

REFERENCES

Section of the text	Verbal data		Observational data	Textual data
Notation			**P=participant**	**H=highlight** **U=underline** **N=note on the text** **C=circled segment**
Title "Compensating for Cognitive Deficits Following Brain Injury" (p. 234)			Green highlighter is right next to the computer mouse. P starts reading, his finger on his cheek. He starts sub-vocalizing right away. In just 9 seconds, he says…	
	V1	This paper this paper the title compensating for cognitive deficit following brain injury. Ah. I think the focus is on compensating. Maybe the author told a, told me ah for cognitive deficits use which compensating.		
	V2	Silent reading? or …	P subvocalizes a bit again and then suddenly asks	
The Abstract (p. 234)			I remind him to read as he usually reads P takes his green marker. Starts reading the abstract. The marker is open but he is not underlining yet. He is constantly subvocalizing. Nodding his head. After one minute of reading and subvocalizing, P coughs. I ask "think aloud". P responds	
	V3	yeah. I I I just, I just the I guess compensating maybe the author told told me several compensating method. From the abstract this paper there are…		
			P looks back at the abstract. What he says next closely resembles the words of the abstract.	

	V4	there are four purpose first <u>describe ah theoretical framework for understanding compensatory,</u> two <u>discuss different forms of compensation</u> and <u>considers compensation for several cognitive disorders</u> and four <u>present suggestion for predicting which patients will find it easy to compensate and which require more intensive and focused rehabilitation.</u>		
Introduction (pp. 233)			P continues to read and subvocalize. In 30 seconds he starts highlighting. He is reading the introduction now. When he highlights another segment, I ask him to think aloud. That's 2 minutes after the last verbalization.	**H1:** "we try to teach people who have lost the ability to walk and talk how to walk and talk again" **H2:** "Although restoration of function (or partial restoration) can occur even several years post injury"
	V5	Yeah. This is an introduction. It tells aaa about patients with tbi or strike we first hope the restoration of their functional ability. The restoration includes the teaching patient to walk and talking with others. So on. If the restoration is stopped, stopping, not continue we use another method. The topic of the method called many method is compensating. This is order of treatment patients.	Here, P does not read from the text, but explains in his own words. He gestures quite a bit. The explanation is of the first paragraph of the text. He starts reading again with his usual sub-vocalization. He highlights and then continues	**H3:** "if restoration of function is not achievable, is towards the teaching of compensatory strategies"
	V6	Restoration. If. Theory of restoration is the different from compensation. Resto. Article, this article told us medical think, medical doctor think <u>attempts to restore lost functioning are based on belief in neural plasticity</u>	P reads the bottom of the first paragraph on p. 233.	

	whereas compensatory strategies are based on the assumption that many cognitive deficits are resistant to treatment and rehabilitation should, therefore, concentrate on teaching coping strategies. For further discussion of plasticity and compensation see so and so.	He does not read the names of the authors.
V7	I think this is important. If the neural plasticity is limited, you use, you continue to restore it. Restoritation is no is no problem, is impossible. Ah, you change another method. Compensatory.	He continues
		P cannot pronounce "compensatory". I suggest the pronunciation and he repeats after me. P continues to read with sub-vocalizing and keeps his highlighter handy. He comes to the word "Amenable" and highlights it while vocalizing it even louder. **H4:** "amenable"
		P is very concentrated. One finger of the left hand is on the text, while the other hand is gesturing/articulating. His gesturing resemble gestures of a person who is explaining something to another person. P highlights a sentence closer to the end of the second paragraph on p. 233. Right after that he verbalizes. **H5:** "Nevertheless, a common approach to the remediation of cognitive deficits is to teach or enable people to compensate"
V8	Cognitive deficits include many many fields, for example memory, and solving problem and attention and executive function.	Here, P looks at me, then refers to the text and looks at me again, and refers to the text again. The fields he mentions are not from the sentence he highlighted and not from the immediate text. He

	V9	Ah the in clinical we use restorating the deficits. Or compensating deficits. But the compensation compensatory is similar to restoration.	continues
			P seems nervous and I reassure him. He continues
	V10	The author give the example for unilateral neglect. You know unilateral. I don't vision that is but the patient don't attention. One side. Yeah, unilateral, unilateral neglect. We told the patients not unilateral the patients receive my suggestion and maybe correct the deficit. This is called the restoring. Now we use another method. for example we left the neglect we use the attractive method. For example the, color. For example I read the right side and don't attention left side, I use color. Attract to the patient's attention. This is called the compensatory.	P points to his colorful highlighter
			P goes back to reading. Sub-vocalization starts right away. His fingers are tapping on the desk. After about 30 sec of reading, P opens a word document, types in the word "offset", and then clicks on the right mouth. An explanation/translation window appears. P writes down the Chinese translation next to the word "offset" on the text.	**N1:** Chinese for "offset"
Introduction (p. 234)			P turns over the page and continues reading (and subvocalizing). After reading for some time, he leafs back to the previous page and reads at the bottom of it. [text says "some exceptions noted in

previous paragraph"]

P turns back to p. 234 and continues reading, nodding his head. His hands start moving as if he were talking to somebody. In his subvocalization, some words get certainly more emphasis than others. P takes his highlighter and highlights

H6: "Compensation can be achieved in several ways"

N2: 1 + Chinese for "to the body__ barriers compensation"

Soon afterwards P starts writing his notes. I ask him to think aloud.

P coughs, but does not verbalize and continues reading. He vocalizes a word ("signposts" in the middle of para 1 on p. 234) and then checks it on his computer as before. He vocalizes the word again while writing down the translation.

His hands move as if he were talking to smb. P highlights several segments. He checks another word but does not records its translation. Now he has his pen in the left hand, and his highlighter in the right. He nods his head as if in approval.

H7: "environmental control systems"

H8: "signposts are supplied, doors to different rooms are labeled, or warning alarms are triggered if somebody wanders off. There are already environmental systems designed for people with dementia (Wilson and Evans, 2000), which attempt to 'disable the disabling environment,' and are used with computers, video links, and telephones to remind people when to take medication, use bathrooms, turn electrical appliances on and off, and ensure water temperature is not too hot or cold"

N4: Chinese for "can quote __ description to invent techniques for those who have disabilities"

P finishes highlighting the segment which started with "signposts" and starts writing notes next to the highlight. He is subvocalizing while writing as well.

P goes to the References and looks at the last page (2nd page of refs). He reads some references and then goes back to the main text. [Wilson and Evans, unmarked]

P intensively gesticulates with his right hand and shakes his head.

P highlights

H reads on and underlines a segment with a pen. He uses his hand to visualize smth. He writes down notes and then highlights again.

P continues to highlight and loudly vocalizes
P takes notes

After starting to read the next paragraph, P goes back to the previous paragraph and puts numbers next to two main points. He goes back to the paragraph he was reading, puts number 3 and starts highlighting

P checks another word and subvocalizes. He does not record the translation. His movements are very rigorous afterwards.

P moves to the second column of the text. P

H9: "compensation can be achieved by teaching people to sue strategies and techniques to reach their goals in alternative ways"
U1: "talking books"

N7: "maybe voice books"
H10: "The principle here is to use an intact skill to overcome a damaged one."
H11: "'functional adaptation'"
N8: Chinese "in fact it is compensation"

N5 and 6: 1 and 2
N9: 3 + Chinese for "what is the difference between 3 and __ recovery"

H12: "to encourage them to use their residual skills more effectively, as is done in the case of people with memory impairments, who are taught to use any remaining ability to remember more effectively. Rehearsal strategies and the use of mnemonics to enhance learning are tow of the ways by which this is achieved"

			finishes reading the section, leafs back to the first page (p. 234).	
			P starts explaining, he looks at the text while doing so, and occasionally looks at me.	
	V11	I just half and one page. From the introduction I know the author describes the three compensation methods. The first <u>structured environment</u>, The second <u>teaching people to use practice and techniques to reach their goals in alternative ways</u>. The third <u>encourage people to use their residual skills more effectively</u>. This is the method. I read compensatory give the example. Now I continue to read next. The introduction I write the comment and the think. But I use Chinese.		
Section "Compensation should address disability and handicap rather then impairment" (p. 234)	**V12**	Compensation should address disability and handicap rather then impairment	P starts reading the next section He reads loudly [heading]	
			P rereads the heading and highlights After sometimes, he records	**H13:** "address disability and handicap" **N10:** Chinese for "this point is very important. 3 included. It belongs to something before"
			His hands are moving, his left hand taps on the desk, head nodding. He leaves a series of highlights in the same paragraph.	**H14:** "individual's cognitive strengths and weaknesses" **H15:** "this map to guide us. The main purpose of cognitive rehabilitation, however, is not to improve test performance"
			P writes a note and vocalizes	**N11:** Chinese "__ limitation not within" + English "test performance"+ Chinese for "whereas it should be" + English "functional

			consequences"
		P highlights	**H16:** "Rehabilitation is more likely to target the *functional consequences* of the impairment" **H17:** "An individual with frontal lobe damage and the supporting family are probably unconcerned that scores on a verbal fluency test are low while at the same time they are likely to show great concern that the individual cannot make decisions or cannot get started on an activity, or cannot cope with more than one thing at a time" **N12:** Chinese for "circumvent"
		P checks the word "circumvent" on the computer, checks which meaning fits his context and writes down the translation.	
Section "Compensation should address disability and handicap rather then impairment" (p. 235)		He turns to the next page and vocalizes the word "handicap" several times. He takes the highlighter, puts it down, takes the pen and records notes	**N13:** Chinese for "to use" + English "handicap + Chinese "to deal with __ avoid " + English "handicap"
		P highlights another series of segments. He is reading between highlighting, his hands are moving energetically.	**H18:** "Reduction in disability and handicap may or may not lead to improved scores on neuropsychological tests" **H19:** "but ultimately good rehabilitation outcome does not depend upon improved test scores" **H20:** "It would, therefore, be inappropriate, to say the least, to sue scores on neuropsychological tests as our outcome measure for this individual."
		After finishing the highlights, P writes notes	**N14:** Chinese for "this point is important" **N15:** Chinese for "__ different __ different__"

		P scratches his head, turns back to p. 234, and starts explaining.
V13	Ok. This is a subtitle. I feel it is very important. She says "<u>Compensation should address disability and handicap rather than impairment</u>". Before I neglect the problem. Ah.	He stops to think and continues.
V14	Ah, according to the world health organization the patient have three level of disorder: impairment, disability and handicap. In clinical, the clinician focus on impairment. How to solve impairment. Is good. How to prove effective, patient measurement, we usually use neurological test. If the neurological test score is higher, maybe the effective. But the. But is the. From the rehabilitation is not effectiveness. If recover from impairment but the patient don't use ah don't cope with the problem in real life, it's it's…	P seems to be looking for a word I suggest "effective". P says
V15	Not effective. So the author address the disability and handicap is important. Give me think.	P looks back at the text. He explains, reading some sections of the text.
V16	We evaluate the standard from the patient from the diseases or from impairment. Is ah. Not <u>use scores on neuropsychological test as our outcome measures for this individual. Instead we should consider individual's situation in terms of level of independence in</u>	

		everyday life, return to work and other functionally relevant outcome measures.		
			He stops, looks up from the text and says	
	V17	This is a different view. I approve the view. Return to work, school, real life. The patient how to, how to do.		
			At this stage, looking a bit tired, he asks	
	V20	Continue to read?		
			I ask him if he wants to continue reading. He responds	
	V21	Ah. I want to stop. Yeah.		

363

Radial temperature distributions within solid concrete cylinders under transient thermal states

Gabriel A. Khoury*, Patrick J. E. Sullivan* and Brian N. Grainger†

UNIVERSITY OF LONDON: IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

SYNOPSIS

Radial temperature gradients develop within typical concrete test cylinders during heating and can introduce structural effects which distort the material strain response of the concrete. Analytical solution of the Fourier equation, assuming infinite specimen length and invariable material properties, indicates that the maximum radial temperature difference (ΔT) obtained during heating at constant rates is directly proportional to the rate of heating and the square of the radius, and inversely related to the thermal diffusivity. A finite difference solution for a specimen heated on all sides confirms these relationships and indicates that the temperature at the centre is unaffected by end heating for a specimen length/diameter ratio greater than 1·4·5 during heating at 1°C/min. This is confirmed experimentally for gravel and lightweight concrete specimens. The effect of variations in thermal diffusivity is to cause two peaks in the ΔT versus surface temperature relationship at about 160°C and 550°C corresponding to the processes of moisture loss and dissociation of $Ca(OH)_2$ respectively. A weighted average temperature was calculated which suggests that the most suitable location to place a thermocouple to measure the average specimen temperature is at 58% of the radius. Radial temperature differentials can be minimized by reducing the rate of heating and particularly the radius of the specimen. They can also be estimated by a simple relationship which, if used in conjunction with the specific test technique reported here, can provide an evaluation of the thermal diffusivity of materials.

Notation

a	=	radius of specimen
D	=	thermal diffusivity of material
l/d	=	length/diameter ratio
r	=	radial distance
R	=	rate of heating
T	=	temperature
t	=	time
ΔT	=	maximum radial temperature difference

Introduction

The transient thermal strain behaviour of cement paste, mortar and concrete heated under uniaxial compression or torsion has normally been investigated by using solid cylindrical specimens, although hollow cylinders and prisms have also been used.

Temperature, moisture and stress gradients develop within such test specimens during thermal transfer which, by introducing complicating structural effects, can distort the material strain response. The study of these factors is, therefore, necessary if the nature of the problem is to be understood and structural effects are to be minimized by appropriate design of the experiment. Knowledge of the temperature, moisture and stress states within the specimen during heating will thus help towards explaining the strain behaviour of the concretes tested.

This paper is devoted primarily to examining the nature of the radial temperature gradients, and the factors influencing their magnitudes, that inevitably develop within solid cylindrical specimens during heating and cooling at constant rates. These gradients are functions not only of the heating conditions and rate of heating but also of the geometry of the specimen and the thermal properties of the concrete.

By contrast, axial temperature gradients are caused

*Department of Civil Engineering, Imperial College of Science and Technology, Imperial College Road, London SW7 2BU.
†Central Electricity Research Laboratories, Kelvin Avenue, Leatherhead, Surrey KT22 7SE.

146

Radial temperature distributions under thermal gradients

by non-uniform axial heating (which can be minimized by appropriate design of the furnace and of the heating conditions) and as a result arise at the specimen ends. This latter effect will be considered here.

Upper limits of radial temperature differentials used by previous research workers were in excess and is some cases temperature differentials over 100°C were obtained during the heating of unsealed concrete specimens of 150 mm at heating rates of up to 8·9°C/min. The rates of heating were deliberately used in order to simulate conditions of fire exposure.

Temperature gradients, however, introduce a host of problems. The specimen does not possess a temperature at any given time during heating but a temperature range, which can be represented by an 'average' temperature. The question then is where best to locate the measuring thermocouple. Large temperature differentials also make it difficult to arrive at a precise correlation between the concrete properties and temperature level. Physical and chemical transformations that take place during heating are functions of both time and temperature. Thermal gradients will cause different reactions to take place at different locations within the specimen at any given time. Consequently, a greater degree of overlap will occur related to different temperatures. The last complication can be extended to include the effect of internal stresses, themselves functions of temperature, which can cause damage to the concrete upon its measured properties. It can also be that the moisture state of the specimen is affected and, consequently, the properties of the concrete.

Analytical investigation

The aim of this analytical study is to establish the relationships between radial temperature differentials and the various controlling parameters. This is done by solving the transient heat conduction equation for the specimen, and making a number of simplifying assumptions.

The transient heat conduction equation, developed from the principle of conservation of energy, can be mathematically described in its most general form by:

$$\rho c \frac{\partial T}{\partial t} = \operatorname{div}(k \operatorname{grad} T) + H \qquad \dots (1)$$

where
ρ = material density;
c = specific heat;
k = thermal conductivity;
H = rate of internally generated heat;
T = temperature scalar field;
t = time.

Equation 1 expressed in cylindrical co-ordinates, assuming invariant material properties and the

---

Radial temperature distributions under thermal gradients

absence of a heat source or sink, becomes:

$$\frac{1}{D}\frac{\partial T}{\partial t} = \frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial T}{\partial r}\right) + \frac{1}{r^2}\frac{\partial^2 T}{\partial \theta^2} + \frac{\partial^2 T}{\partial z^2} \qquad \dots (2)$$

which is the Fourier parabolic second-order partial differential equation for transient heat conduction, in which D is the thermal diffusivity equal to $k/\rho c$.

Equation 2 can be solved for the specimen, given the following testing conditions and assumptions:

(1) The initial and boundary conditions are taken to be independent of the θ and z co-ordinates. This is achieved in practice by uniform heating round the curved surface of the specimen and by minimizing axial temperature differentials. The temperature within the specimen then becomes a function of the radial co-ordinate r and time t only, which reduces the partial differential equation 2 to one with two variables only:

$$\frac{\partial T}{\partial t} = D\left(\frac{\partial^2 T}{\partial r^2} + \frac{1}{r}\frac{\partial T}{\partial r}\right) \qquad \dots (3)$$

The specimen is, therefore, considered to be infinitely long and one in which the flow of heat takes place radially in planes perpendicular to the specimen's axis. It will be shown later that the assumption of infinite length for the purpose of calculations can be valid for specimens of sufficiently large length/diameter ratios (see Figure 7).

(2) The thermal diffusivity of the concrete is considered to be spatially invariant and independent of temperature or time. Although this assumption is not strictly true, particularly during first-time heating, it is necessary for the analytical solution of the Fourier equation for the specimen. The implication of variable material properties will, however, become apparent later, when the results of the experimental investigation are discussed.

The prescribed initial and boundary conditions necessary for the solution of equation 3 are as follows.

Initial conditions. The temperature throughout the specimen at the beginning of heating is considered to be zero. Once a solution is found in terms of $T(r, t)$, the ambient temperature can be simply added to the calculated temperature to give the true temperature. The ambient temperature, however, can be ignored if only temperature differences between say r_1 and r_2 are required for any given time. The initial conditions are therefore:

$$T(r, 0) = 0 \text{ for } r \leqslant 0 \qquad \dots (4)$$

Boundary conditions. The temperature at the specimen's surface is a linear function of time only:

$$T(a, t) = Rt \text{ for } t \geqslant 0 \qquad \dots (5)$$

where a is the radius of the specimen and R is the rate

147

of heating but rate of temperature increase at the surface.

This condition is realised in practice by the furnace's temperature control system which can maintain a constant rate of heating for any given test, albeit with minor deviations due to endothermic reactions experienced by the concrete during transitions experienced by the concrete during transient heating.

Equation 5 can be solved by using the Laplace transformation technique, which reduces a two-variable partial differential equation to an ordinary differential equation. The method of solution is fully described in references 5 and 11.

The radial temperature distribution within the specimen at any time t after the start of heating becomes:

$$T(r, t) = R\left(t - \frac{a^2 - r^2}{4D}\right) + \frac{2R}{aD}\sum \ldots \ldots$$

where I_0 and I_1 are the first-kind Bessel functions of orders zero and one respectively, and where a_n, ... are the roots of $I_1(a_n) = 0$.

The second part of equation 6 is the contribution of the initial transients which decreases in magnitude as time progresses, however, better described by $D t / a^2$ than by t alone, since the time taken for the heat to diffuse initially into the specimen depends upon its radius and upon the value of the thermal diffusivity. For sufficiently large values of $D t / a^2$, therefore, the contribution to $T(r, t)$ from the second part of equation 6 can be ignored.

$$T(r, t) = R\left(t - \frac{a^2 - r^2}{4D}\right) \ldots \ldots (7)$$

which indicates that, after a period of time from the start of heating, the radial temperature profile settles to a constant shape and the temperatures at any two points increase linearly with time at the same rate, provided that R and D remain constant.

Under these conditions, the temperature difference ΔT, between the central axis of the specimen ($r = 0$) and any location at radius is:

$$\Delta T = T(r, t) - T(0, t) = Rr^2/4D \ldots (8)$$

which indicates, as expressed, that the temperature difference profile increases from a minimum at $r = 0$ to a maximum value at $r = a$.

The maximum radial temperature difference ΔT, hereafter referred to simply as ΔT, is:

$$\Delta T = Ra^2/4D \ldots \ldots (9)$$

which is the relationship required. It indicates that

the maximum radial temperature difference is proportional to the rate of heating R, inversely proportional to the thermal diffusivity D but proportional to the square of the radius a. The radius of the specimen is, therefore, a very critical factor affecting the magnitude of radial temperature differentials during heating and cooling. These relationships are shown diagrammatically in Figures 8 to 10.

Another useful result that emerges from equation is that a "weighted average" temperature can be calculated which is more representative of the specimen. This is evaluated by integrating the temperature profile ΔT, over the specimen's radius and dividing by a:

$$\Delta T_a = \frac{1}{a}\int_0^a \frac{Rr^2}{4D}\,dr = \Delta T/3 \ldots \ldots (10)$$

The average temperature of the specimen can, therefore, be considered to be approximately equal to:

$$T_a = T(r = 0, t) + \Delta T/3 \ldots \ldots (11)$$

The location of this average temperature can be evaluated from equations 8, 9 and 10, which gives:

$$r_a = a\sqrt{1/3} = 0.58a \ldots \ldots (12)$$

which could be the most suitable location to place the thermocouple for measuring the weighted average concrete temperature, i.e. at a radius which is about 60% of the radius of the specimen.

Numerical investigation

The Fourier equation has also been solved by the finite difference method, primarily to confirm the validity of the analytical solution for a specimen heated on all sides and to investigate the effect of the length/diameter (l/d) ratio of the specimen. The finite difference program used was developed at Imperial College[12] for the solution of a range of steady-state and transient heat conduction problems.

The program reduces the integration of the heat conduction equation to the solution of a system of algebraic equations for a suitable mesh design. With steady-state heat conduction, this process gives N equations for N mesh points to be solved simultaneously. In the case of transient heat conduction, the partial differential equations are approximated along one or two rows of mesh points at a time, so that the procedure results in the successive solution of small sets of algebraic equations. This particular solving scheme is characterised by numerical analysis terms as fully implicit with block iteration by lines. Convergence is checked by minimising residual energy sources to a pre-specified small value. The results are finally displayed graphically or in tabular form.

RESULTS OF NUMERICAL INVESTIGATION

Development of temperature profile with time

As predicted analytically, the relative radial temperature distribution develops during heating to reach, for invariant material properties, a fixed profile (Figure 2) after which the temperature increases at the same rate throughout the specimen's cross section.

Figure 2. Development with time of radial temperature profile during heating at 1°C/min at mid-height of specimen (60 mm dia × 175 mm long). D = 0.83 × 10⁻⁶ m²/s.

The temperature response at the centre of the specimen to a 1°C/min heating ramp at the surface is given in Figure 3 for two different specimens with thermal diffusivities nominally representing those of normal-weight and lightweight concretes ($D = 0.83$ and $0.32 × 10^{-6}$ m²/s respectively).
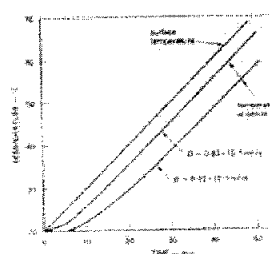
Figure 3. Temperature response with time at the centre of specimen for two different thermal diffusivities heated at 1°C/min.

Because of the axisymmetric conditions of heating and symmetry about the mid-height, only a quarter of the specimen needs to be represented by finite elements as shown in Figure 1, divided into 165 rectangular elements and nodal points for use in the axisymmetric program. Since the temperature is expected to be steeper near the specimen's surface, the mesh is divided into small regions there, but gradually larger for regions nearer the centre. This mesh has been used in a finite element program for determining the thermal stresses.

Figure 1. The finite difference mesh design representing one-quarter of the specimen divided into 165 nodal points.

BOUNDARY CONDITIONS

The specimen is considered to be heated from its surface and its flat ends. The same temperature is applied at all surfaces at any given time and rises linearly with time $t = kt$, whereas the conditions at the axis of symmetry are zero heat fluxes.

Effect of length/diameter ratio

Axial temperature gradients develop in the specimen when it is heated from its ends as well as from its

R, D and a

Experimental investigation

therefore, be compared with the conditions arising from the theoretical analysis given earlier. The parameters investigated were as follows:

(1) *Materials.* Two types of concrete were tested (Table 1): Thames river-gravel concrete and lightweight-aggregate (Lytag) concrete. The former was chosen to represent normal-weight concrete, while the latter is an example of a concrete possessing a low value of thermal diffusivity.

(2) *Initial moisture condition.* Both air-dried (20°C, 65% R.H.) and oven-dried (at 105°C) specimens of the two materials were tested.

(3) *Pre-heating temperature.* In addition to the specimens pre-heated at 105°C, one specimen was tested after pre-heating to 600°C.

(4) *Rate of heating.* Two rates of heating were investigated, 1 and 2°C/min.

The conditions in practice differ from those considered in the previous theoretical analysis in a number of respects, chief amongst which is the variation in the thermal properties of concrete which takes place during first-time heating. The thermal diffusivity of

concrete is sensitive to the various physical and chemical transformations, mostly endothermic, which occur throughout the temperature range from ambient up to 600°C and above. These include the loss of the various forms of water (free to chemically combined), the decomposition of $Ca(OH)_2$, above 400°C, the α–β inversion of 573°C of any quartz present in the concrete, the de-carbonation of $CaCO_3$ at higher temperatures and so on.

Such temperature and time-dependent transformations are indicated by an apparent transient increase in the specific heat of the material and can be conveniently followed by techniques such as differential thermal analysis (DTA). DTA detects both endothermic and exothermic reactions which appear as peaks and troughs on thermograms.

In addition to variations in the thermal diffusivity of concrete during heating, the rate of heating in practice is not linear from the start but gradually increases with time to reach the desired value some time after the start of heating, whilst the heating conditions at the ends of the specimen are not necessarily the same as those at its curved surface. The effects of these factors upon the temperature distribution within the specimen during heating are examined in the following sections.

EFFECT OF END HEATING

The nature of heating at the specimen's ends depends on the design of the specimen furnace in question. Normally, heating takes place axisymmetrically around the specimen, which is in physical contact at its ends with a platen-and-yoke arrangement, which possesses its own thermal characteristics and can even act as a heat sink. The results (Table 2) from 10 thermocouples placed at various locations in the specimen (Figure 11) indicate that, during heating at 1°C/min, the temperatures at the ends of the specimen fall, in this particular application, between those at the curved surface and those at the specimen's central region. For the lower range of temperatures, the temperature at the specimen ends is similar to that of its interior and the conditions resemble those of an infinitely long specimen being heated at its curved surface as assumed in the analytical solution of the Fourier equation. For the higher range of temperatures above about 200°C, the temperature at the specimen ends becomes closer to that of the curved surface and the conditions resemble those of a specimen heated from all sides as assumed in the numerical finite-difference analysis.

Another conclusion that can be drawn from the results is that small differences exist between the temperature readings of the three internal thermocouples (normally less than 5°C over a distance of 100 mm) and can be attributed to slight non-uniformity in the axial heating of the curved surface rather than to contributions from end-heating. This

suggests that the temperature in the central region is largely unaffected by end-heating, as concluded in the numerical analysis for specimens with l/d values greater than about 1·2. The central region, which experiences the largest radial temperature differences, can, therefore, be mathematically regarded as part of an infinitely long specimen, thus justifying the analytical approach. The effects of end-heating will, therefore, not be referred to again and the following analysis will be devoted to examining the nature of the maximum radial temperature difference ΔT as represented by the difference obtained between the readings from thermocouples g and e (Figure 11).

PROFILE AND CHARACTERISTICS OF ΔT

Typical ΔT curves obtained for initially air-dry lightweight and gravel concrete specimens are given in Figures 12 and 13 respectively. Different symbols are used to represent the specific rate of heating at the time the reading was taken; this demonstrates the sensitivity of ΔT to heating rate. The curves connecting

the readings were plotted through the points that represent most closely the desired rate of 1°C/min. An impression of the degree of replication obtained from the two concretes can be gained from the results given in Figures 14 and 15.

The curves indicate a consistency of results such that discernible peaks exist at surface temperatures of about 166°C and 550°C corresponding to the processes of moisture loss and dissociation of $Ca(OH)_2$ respectively. The first peak corresponds closely to one found for the rate of moisture loss for the same materials heated at the same rate and is clearly absent for specimen pre-dried at 105°C (Figures 16 and 17).

As expected, the ΔT curves are not unlike those of DTA except that they are smoother in profile. Also as with DTA curves, the reactions appear to be shifted towards higher temperatures than might be expected from static or quasi-static tests.

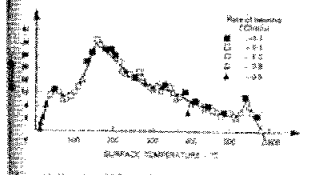This complex behaviour on first heating is clearly absent in the specimen pre-conditioned at 600°C.

TABLE 1. Mix proportions of concretes used.

TABLE 2. Readings from 10 thermocouples at selected times during the heating of a pre-dried gravel-concrete specimen at 1°C/min.

Figure 12. Variation of ΔT for lightweight-aggregate concrete specimen during first-time heating from an air-dry condition at 1°C/min
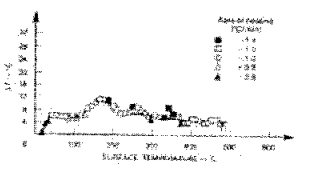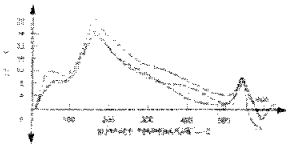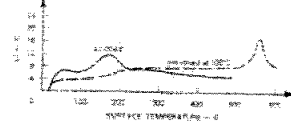
Figure 13. Variation of ΔT for gravel-concrete specimen during first-time heating from an air-dry condition at 1°C/min

EXPERIMENTAL INVESTIGATION

The temperature distribution within gravel and lightweight concrete cylinders (1 dia 3) was investigated experimentally during heating at 1 and 2 C/min by means of 30 thermocouples placed at various locations of the specimens. The results confirm that over 80% of the middle section of the specimen is largely uninfluenced by end effects.

The shapes of the AT curves are not unlike those of DTA except that they are smoother in profile. Discernible peaks exist at about 160°C and 550°C corresponding to the processes of moisture loss and dissociation of Ca(OH)$_2$ respectively. As predicted theoretically, the AT values were doubled when the rate of heating was 2°C/min compared with 1°C/min.

PRACTICAL APPLICATION OF RESULTS

It was shown that the above simple formula can be used to obtain a quick and approximate prediction of the radial temperature differentials that are likely to develop within specimens during heating and cooling. Coupled with the specific test method reported in this paper, it can also be used to provide an approximate estimate of the thermal diffusivities of materials. Another implication is that radial temperature differentials can be minimized by reducing the rate of heating and particularly the radius of the specimen.

ACKNOWLEDGEMENT

Part of this work was undertaken in co-operation with the Central Electricity Generating Board and this part is published with their permission.

REFERENCES

1. ENDELL, K. Über das Verhalten von Zementmörtel und Beton bei höheren Temperaturen. (Behaviour of cement mortar and concrete at high temperatures.) Berlin, Wilhelm Ernst und Sohn, 1929. Deutscher Ausschuss für Stahlbeton, Heft 224, pp. 66–126.

2. THELANDERSSON, S. *Mechanical behaviour of concrete under torsional loading at transient, high-temperature conditions.* Lund, Lund Institute of Technology, 1974, pp. 85. Division of Structural Mechanics and Concrete Construction Bulletin 46.

3. BAZANT, Z. P. and others. On the behaviour of nuclear reactor concrete under steady state and transient conditions. Proceedings of the Third International Conference on Structural Mechanics in Reactor Technology. London, 1975. Amsterdam, North-Holland Publishing Company, 1975. Paper H1/8.

4. MARÉCHAL, J. C. The effect of temperature and humidity on the creep of concrete. London, Cement and Concrete Association, July 1970, pp. 44. CACA Technical Note 1 TN 14.

5. KHOURY, G. A. *Transient thermal creep of nuclear reactor pressure vessel type concretes.* Thesis submitted to the University of London for the degree of PhD, 1983, Vol. 1 pp. 1126 Vol. 3 pp. 418, Vol. 3 pp. 448.

6. ILLSTON, J. M. and SANDERS, P. D. The effect of temperature change upon the creep of mortar under torsional loading. Magazine of Concrete Research, Vol. 25, No. 84, September 1973 pp. 136–144.

7. ANDERBERG, Y. and THELANDERSSON, S. *Stress and deformation characteristics of concrete at high temperatures. 2: Experimental investigation and material behaviour model.* Lund, Lund Institute of Technology, 1976, pp. 84. Department of Mechanics and Concrete Construction Bulletin 54.

8. MARECHAL, J. C. and others. Strength and elastic properties of concretes at elevated temperatures. Concrete for Nuclear Reactors. Detroit, American Concrete Institute, 1972. ACI Special Publication SP-34, Vol. 1, pp. 417–421.

9. PARROTT, L. A study of transitional thermal creep in hardened cement paste. Magazine of Concrete Research, Vol. 31, No. 107, June 1979, pp. 99–103.

10. SCHNEIDER, U. and others. Apparatus for measuring the transient thermal strain behaviour of unsealed concrete under constant load for temperatures up to 750°C. Magazine of Concrete Research, Vol. 35, No. 125, December 1983 pp. 229–236.

11. CARSLAW, H. S. and JAEGER, J. C. Conduction of heat in solids. Second edition. Oxford, Oxford University Press, 1959 pp. 510.

12. GOSMAN, A. D. TEACH-T computer program for the study of combustion, heat transfer and analogous phenomena. London, Imperial College. Prepared under the auspices of the National Development Program in Computer-assisted Learning, September 1973.

13. HARMATHY, T. Z. Thermal properties of concrete at elevated temperatures. Journal of Materials (ASTM), Vol. 5, No. 1, March 1970, pp. 47–74.

14. RAMACHANDRAN, V. S. Application of differential thermal analysis in cement chemistry. Chemical Publishing Co., 1969 pp. 308.

15. SUZUKAWA, K. and KUZUH, T. M. A simultaneous semi-isothermal method of thermogravimetry and derivative thermogravimetry, and its application to cement pastes. Cement and Concrete Research, Vol. 7, No. 3, May 1977, pp. 247–257.

16. DOUGILL, E. C. and Mastsuoka, D. G. Prediction of concrete durability from thermal tests of aggregate. Proceedings of the American Society for Testing Materials, Vol. 53, 1953 pp. 951–1001.

Contributions discussing the above paper should be in the hands of the Editor not later than 31 March 1985.

Researcher (R)	Texts and textual segments which mediated the discussion	John (P)
	Notation: N=note H=highlight O=orange Y=yellow	
R1: Which text do you want to discuss today?	P leafs through the collection of articles and points to Khoury84	**P1: Now I am conducting a series of numerical tests. I want to make a comparison with the experimental results and theoretical results.**
R2: Your results with the results in this paper?		**P2: Yea yeah. Because my focus is on numerical simulation so I must make out verification before apply the software. So find a lot of experiment.**
R3: Have you read this article before? This is about radio and temperature distributions, for the records.	P shows his off-text notes	**P3: Maybe one year ago read this paper. Now I find get a lot of numerical results and I find they have a good agreement. Now I want to read this paper in detail. And so I find some interesting problem. So I write down.**
R4: These are your notes?		**P4: Yes, but not very much.**
R5: Oh, you have notes in Chinese too?	R locates a page in Chinese and points it to P. P shows the last note dating 20 Feb	**P5: No, I think it's I have retrieved a Chinese book related to temperature distribution, because the paper is published in Chinese, so I take notes, just write down in Chinese. So right. Today I have write down somehting. All this related to heat transfer.**
R6: So this note. 16th of Feb. Which article did you read?	P points at Khoury84	**P6:** I think it's this one. This title. Actually I just do somehting, it is concrete specimen. The specimen is exposed I mean high temperatures so this is the heat source. So concrete specimen is heated
R7: from different directions?		**P7:** Yeah, right. So there is a temperature distribution along the specimen section. Now I have developed a program

R8: like software?		P8: **Yeah yeah. Actually this software has… no no sorry. Maybe in the future sorry sorry. This program I think becomes commercial software very soon.**
R9: You are going to sell it?		
R10: they are not real?		**P9:** I wish, I wish. So now I have get a lot of results about temperature distribution but these results are based on numerical simulation.
R11: so this is for your verification?	R points at Khoury84 P points at section "Numerical Investigation"	**P10:** Yeah. So I am not sure all these results are true. So I must make verification.
R12: your simulation?		**P11:** Yeah. This is theoretical analysis. I think this is very important. First, I want to make a comparison with this temperature distribution. In comparison with this result, I found they have good agreement so I am sure my simulation…
	P turns to p. 150 where "settling time" is circled. P points at his off-text notes while explaining.	**P12:** is correct, correct. In this paper the author proposed a definition. I think it is very important for our research. The definition is the settling of time. But they don't give detailed definition. So but so I want to make sure what is the settling time, so I write down something. It's juts my viewpoint. So as you can see, the detail is settling time. Now in the future paper, in my future paper I want to make a clear definition of settling time. So I write down something, I think thoughts. And the next I will conduct another numerical simulation to confirm my definition.
R13: Why do you conduct so many simulations?		
R14: Why?		**P13:** I think it's important part of my thesis.
R15: Where is simulation?		**P14:** I think the problem research problem is from the experimental results. I mean a lot of phenomena so but you don't know what is the problem first. And second is why why the phenomenon takes place. So why and third is how to quantify. I think so there are three levels. The first is problem or phenomenon. The second is mechanism, I think the third is quantification.
	P points at the highlighted number	**P15:** I think my simulation first focused on mechanism. We can see, the

		numerical results have good agreement with the theoretical results. So I am sure my understanding to this problem is proper.
R16: Do you have any real-life cases?	on p. 146.	
		P16: Yeah right. I think it is next stage. This paper is focus on thermo stresses I mean based on the temperature distribution. As you can see this is a temperature distribution. But it just first stage. So second he also conducted calculation so he get stress distribution. Also another papers, but the same author. So this is the stress distribution. This one is temperature distribution. They are the same work but in different stages. First you must get the temperature distribution and then calculate thermo stresses based on the temp distribution. The first stage I think I have finished the calculation of temp distribution. I also finished the thermo stress. They have good agreement but for the author they have found out what they want. But for me the work is not finished. Because in the next stage I want to calculate the fracture process. You know, concrete specimen is subjected to temperature. Elevated temperatures. So there is temperature gradient occur and then the thermo-stresses. Later the thermo-stresses will cause fracture. But until now there is no any publication related to thermo fracture. So this is what I want to do. But before make the analysis of the fracture process, must finish the temperature distribution and thermal stress and also I should make verification.
	P goes through his collection to find that other article	
R17: And that's what you have been doing?		
R18: Simulation and verification?		**P17:** Yeah… I think recently I just do this work.
R19: What's the next stage for you now?		P18: **Yeah right. Until now I think I am satisfied with the numerical simulation and also satisfied with verification.**
R20: they'll be no criticism?		P19: **I think fracture process. So as you know the temperature distribution and thermo stresses obtained by me is the same as theoretical. Now I put my heart. So as you know till now I think the review cannot … to my model.**
R21: You must be very happy?		**P20:** Yeah right because there is very good agreement.
		P21: Yeah right, but because the fracture concrete fracture is a complicated

		problem, there is a few publication related to this problem. I think the reviewer must have to check my research. I should do verification and justification. Based on verification I think maybe the reviewers can accept the results of the fracture process.
R22: Are you going to put these notes into your dissertation?	R pointing at the off-text notes	
		P22: Yeah, yeah right. Actually when I write my thesis, before I write my thesis I write my...generally I summarize the work finished into a journal paper or research report. And then combine them. So because when I finish writing paper my supervisor can make a proofreading. So after this I can put the papers into my thesis.
R23: So this is about this text. What else did you read in the last week?		
		P23: Just all this. Because last week I accompanied my mom and sister. And at the same time also debugging my program. Very boring, very boring.
R24: Where did you get this collection of articles?		
		P24: On the website. I retrieved the index SCI.
R25: Did you make this?	R points at the bound collection	
R26: So you have sections in this book?	R shows the different colored pages separating the collection into sections	**P25:** Yeah. I have a lot of collections in different topic. This one is heat transfer.
		P26: Yeah, but the fundamental problem is the same.
R27: Ok, shall we go through your notes on the text? What about this one?	N1**: "36 (128) 1984, 146~156"** P extends N1 by writing "Magazine of concrete research"	**P27:** The volume, the volume of the magazine
R28: When did you make these comments? Long time ago?		
	P leafs through the pages	**P28:** I think it's a good article because he gave a detailed and clear statement of heat transfer. I think it's very good article because the author they are maybe Britain they are from Imperial college. Imperial college is very strong in civil engineering. Actually I like, what I like about this paper I think the author can give a very clear review, very clear and correct. Clear and correct review. So but

R29: Different colors?		at the same time the author can use a simple model to explain a complex problem. So I think the author is very good.
	P shows at the letters he added	
R30: So you wrote the missing letters?		**P29:** Because the I make a photocopy. But this…
R31: This color is pink and this color is orange? Why?	**R points at highlights of different colors**	**P30:** Yeah
	H1: "structural effects" (O)	**P31:** I think this color is this term is related to problem or the as you know the author proposed a model, but the problem is simply after the problem is simplified…if the author some aspects so I think maybe there will be some potential problem. So the author didn't as you can find the author didn't consider the variable material properties. The author make an assumption: the material's properties is invariable.
	H2: "is at 58% of the radius" (O)	
	H3: 100C and **H4:** 200C (O) **H5:** "Such temperature- and time-dependent transformations are indicated by an apparent transient increase in the specific heat of the material" (Y)	However, this one is data from theoretical calculation. I think I want to make a comparison. This is also data…I think the data is very critical. The author make a discussion by using theoretical results but this statement is related to experimental results, not from theoretical numerical. So I think the statement of the problem is very good, so I think I can use this statement, because this is not the author's view point, just objective factor.
R32: **Will you use the same words?**		
	H6: "The corresponding temperature gradients at 0.2 C/min would be one-fifth of the value for the higher rate of heating and can be regarded as negligible" (O)	**P32:** Sometimes I also mark some sentences because I like the English. Maybe I can use English, just use other words instead…. So different color. This is also some data…
R33: I see. What about this one?	**H7:** "The T curves were, however, significantly influenced by variations in thermal properties during first-time heating which are cased by transient thermally activated physical and chemical transformations" (Y)	**P33:** Because we are not expert of concrete technology, if I want to make a good discussion in my paper, I should know about the concrete not just related to temperature problem. Also about so I must get some good statement from the other people's publications. I think so from this part is very important. If my numerical simulation does not match with the results, my results is not correct.
R34: But this paper is 1984. It's a little bit old,		

isn't it?

|		
R35: **so it's ok that it is a little bit old?**		**P34:** Yeah, yeah right…
		P35: Actually the heat transfer is very old problem. I think. But the why I use this paper because the author give a very good discussion the same problem in the concrete. Concrete is subjected to heat. So this is why I choose this paper as a reference. I have retrieved this paper, till now the paper haven't been cited.
R36: Really? Why not?		
		P36: I don't know, so I think maybe I can cite this paper. Actually I use this paper to verify my simulation results. As you know, you must get some new findings so my paper will be reliable and valuable. So the temperature distribution is same as here but it's not my main concern. So my concern is the induced fracture. So I think it's very interesting.
R37: There is work to be done?		
		P37: Yes. …I think writing a paper is simple process include prepare and then reading then taking note then write down paper. And if all this ok then I can make numerical simulation. So if the numerical results is what I want, so write up the full paper.
R38: Another paper?		
		P38: Write down full paper because I have got some results.

MEMO

To
From
16/02/03

The thermal cracking by temperature gradient is ~~formed~~ occurred before reaching settling time, after which the temperature increases at the same rate throughout the specimen's cross-section.

Hence the stress increase after settling time t_0 is ~~ever~~ approaches (zero) T due to the uniform temperature increment. During this period, the thermal cracking is mainly caused by the thermal mismatch between the ~~top~~ and the aggregates.

MEMO

To
From
20/02/2003
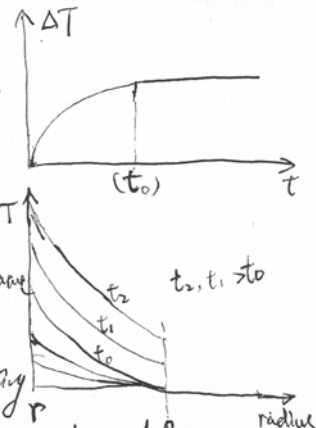
Definition of settling time

The settling time can be regarded as a time at which the increment of temperature difference between the surface and the center ~~begin~~ begins to keep constant.

312216