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Exploring Cognitive Models of Writing: A Comparative Analysis of Knowledge Telling and Knowledge Transforming in Engineering and Education Doctoral Candidates' Candidacy Exam Essays

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Abstract
In recent times, there has been an increase in the recognition of the complex cognitive and linguistic demands placed on doctoral students, especially those writing in a second language. Comprehending how these demands relate with disciplinary norms and writing models is vital for designing more effective instructional support and highlighting the implications of multilingual doctoral education. Thus, this study explores the application of Bereiter and Scardamalia's (1987) cognitive models of writing (i.e. knowledge telling and knowledge transforming) to two doctoral students from different disciplines: engineering and education. By examining their writing processes, textual outputs and writing strategies in composing their respective candidacy exam essays, this study investigates how disciplinary differences and multilingualism interrelate with these perspectives, revealing the cognitive and linguistic challenges faced by doctoral writers. The findings indicate substantial differences in writing strategies, text quality, and engagement with ideas, providing insights for educators and researchers in academic writing studies.
Keywords: International students, ESL, Multilingual, second language literacy, source-based writing, higher education, candidacy exam, synthesizing, doctoral education, reading-writing connections
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1. Introduction

In academic contexts, writing is sometimes used as a stand-alone skill, but it is more often the case that writing is linked in some way with reading, especially in later pre-college grades (middle school and high school) and in undergraduate and graduate study (Hirvela, 2016; Leki, 2007, Zhao et al., 2025). Reading and writing are vital contributors in the development of students' literacy skills, as a great deal of academic writing involves the use of source texts. In other words, their ability to write depends heavily on the quality of students' reading as well as what they gain from reading. As Hirvela (2016) explains, "the ability to read signifies not only skill in reading for the comprehension of meaning but also being able to use reading as a means of better understanding how to use texts" (p. 1). Thus, students learn about writing through reading while also identifying content that can be used in their writing. Consequently, academic writing instruction often focuses on how students can transfer information from source texts into a new textual product they are creating as writers.

In the realm of reading-writing connections scholarship, source-based writing has become an especially important topic of interest. This includes looking at the specific kinds of activities in which students compose using source texts. Frequently assigned essay types such as argumentative essays, book reports, research papers, and literature reviews require students to navigate between reading and writing. Whether these tasks are assigned for the purpose of learning to write, as in writing courses, or writing to learn, as in content courses, students must gain command of the various skills associated with source-based writing (Hirvela, 2011; Tatsanajamsuk, 2024; Zhao et al., 2025). This includes not just managing those essay types, but also the more specific applications of source-based writing within them: direct quotation, paraphrasing, summarizing, and synthesizing.

What stands out regarding synthesizing is not just its importance, but also its complexity. Here, Grabe and Zhang (2013b, p. 14) explain that synthesizing is "a more demanding reading-to-write task" than other source-based writing activities for two reasons. One is the reading and writing skills that one needs to develop in order to choose pertinent literature from multiple sources while reading. The other is being able to "select the information most appropriate for linking ideas and issues across texts" (Grabe & Zhang, 2013a, p. 114), that is, to evaluate what is read and then use it successfully while writing. These actions place considerable cognitive demands on writers, especially students, as they learn to write in a source-based environment (Zhao et al., 2025).

What makes synthesizing especially complex is the specific operations that must be performed to generate a synthesis. Spivey (1990) shed important light on the nature of the synthesizing process in the important mode of discourse synthesis. In Spivey's constructivist model of discourse synthesis, students are expected to perform three essential operations—organizing, selecting, and connecting--as they make connections from numerous sources, construct meanings, and create different textual products (Spivey, 1984, 1990, 1997; Spivey & King, 1989).

Lastly, graduate student writers that are engaging in a candidacy exam tend to present information about source texts in their writing in two ways. For example, Bereiter and Scardamalia (1987) noted two major differences that underlie student writers' utilization of source-based information while integrating reading and writing. The first is "knowledge telling", which is when the writer demonstrates their ability to identify and present appropriate source text information while exhibiting a broader comprehension of sources and addressing a particular topic. This is completed in a straightforward way like summarizing. The other avenue is "knowledge transforming", where the source text information is utilized by the student in a more interpretive and elaborate manner as a means of constructing a bigger theme or predominant argument through selected source information. This process highlights how the original source material is reshaped to fit a new purpose as opposed to the more perfunctory reuse that can be observed in knowledge telling. This paper will focus on how two doctoral multilingual writers adopt these in their candidacy exam writing.

2. Reading-Writing Relationship

The relationship between reading and writing as literacy practices were not studied until the 1980s. Stotsky's (1983) innovative synthesis analysis on reading and writing connections plus Tierney and Pearson's (1983) assertion that both reading and writing were primarily similar practices of meaning making were the first pieces of literature on this topic. In L1 composition studies, scholars assumed reading (a counterpart of writing) was a constructive process instead of a receptive one (Bereiter & Scardamalia, 1987; Haas & Flower, 1988; Spivey, 1990). In authenticity, considering reading as a composing process challenged the insufficient notion that considers reading as decoding or encoding processes, that restated the preceding argument on the cognitive or social lens of literacy (Zhao, 2015).

Extremely inspired by their L1 contemporaries, L2 writing researchers have been enthusiastically exploring reading-writing relationships (Akinkugbe, 2021: Belcher & Hirvela, 2001; Carson & Leki, 1993; Grabe, 2001; Hirvela, 2004; McCulloch, 2013; Shen & Coker, 2022; Zhao, 2015) specifically when providing instruction on L2 writing started leaning towards and focusing on source-based writing during the 1990s. Responding to prior research that focused on the teaching of L2 composition where reading and writing were considered different, these scholars furthermore emphasized the noteworthy part that reading plays in L2 writing courses and encouraged using reading as a means to teach composition. Belcher and Hirvela (2001) highlighted several meaningful areas in connecting diverse types of literacy. For instance, some of these central themes are on how empirical research on textual borrowing and source use have contributed into a bountiful ground of research in L2 composition studies (Hirvela & Du, 2012; Shen & Coker, 2022; Polio & Shi, 2012; Shaw & Pecorari, 2013; Shi, 2004, 2010, 2012). Although the prominence of L2 reading-writing relationship has been broadly recognized, nevertheless it is still an inadequately examined and less-theorized area (Akinkugbe, 2021; Grabe & Zhang, 2013; Shen & Coker, 2022; Zhao, 2015). In other words, the L2 composition turf does not have a theoretical framework for reading and writing relationships and is very essential especially when it comes to L2 source utilization.

Related Research on L2 Source-Based Writing

In L2 writing research, synthesizing has received less attention than in the L1 context. Looking at the situation more broadly, the use of sources in academic writing has been explored widely by L2 researchers (Currie, 1998; Flowerdew & Li, 2007; Flowerdew & Wang, 2015; Li & Casanave, 2012; Pecorari, 2003, 2008; Pennycook, 1996; Polio & Shi, 2012; Shaw & Pecorari, 2013; Shi, 2004, 2010, 2012; Sultana, 2014; Wolfersberger, 2007; Zhang, 2012). However, much of the focus has been on such source-based tasks as summarizing (Shi, 2004; Keck, 2006, 2014; Macbeth, 2006, 2010) and paraphrasing (Hirvela & Du, 2013; Pecorari, 2003, 2008). Less attention has been devoted to synthesizing, and it continues to be an insufficiently researched and under-theorized area (Grabe & Zhang, 2013b; Hirvela, 2016; Zhang, 2012; Zhao, 2015, Zhao et al., 2025). However, as Hirvela (2004) contends,

Synthesizing, as a teaching and learning tool, provides rich opportunities for L2 students to develop their reading and writing abilities. By the same token, synthesizing is especially useful in drawing students' attention to connections between reading and writing (p. 93). There is value, then, in studying synthesizing, and some L2

researchers who have done so have employed Spivey's discourse synthesis approach, albeit in restricted ways, such as exploring one-shot writing tests (Plakans, 2009a; Plakans & Gebril, 2012; Yang & Plakans, 2012) or employing an experimental design (Zhang, 2013), while Zhao (2015) and Zhao and Hirvela (2015) examined it in the context of an ESL writing course.

The common denominator in the L2 synthesizing research is its focus on students at the undergraduate level. While this is an important domain, there is also a need to examine synthesizing at the graduate student level. This is because graduate students are far more likely to be assigned longer and more involved tasks that involve synthesizing, such as literature review and critical review papers. These tasks require the use of more source texts and thus more extended use of the kinds of synthesizing operations Spivey identified in her discourse synthesis model. To gain deeper understanding of synthesizing as a major type of source-based writing, then, there is a need to shift attention to the graduate student domain. The current study addressed this need by looking at synthesizing in the context of the doctoral candidacy examination.

In the graduate school setting, what is commonly called the Candidacy Examination is an especially interesting location for the use of synthesizing at a highly advanced level. In many Western universities, this is an examination which students must take and pass in order to move on to the doctoral dissertation. Its questions often call upon students to display their knowledge and understanding of assigned topics by reading and writing about large numbers of source texts in meaningful ways.

According to Kamler and Thomson (2014), a reason why being admitted into a graduate program presents new challenges for L2 writers is that they are rapidly expected to comprehend how to write in genres that some of them have never written before or are unfamiliar with. This is the same notion that is extended to L2 doctoral students as well because they are considered advanced writers, and it is presumed that they have learned how to write in different genres while acquiring their undergraduate degrees. In other words, they are not told what to do explicitly because it is assumed that these students already know what is expected of them.

One of the most common genres of writing at the doctoral level are the candidacy examination and dissertation because "these texts are themselves difficult to write, primarily because writers must take on a degree of authority over their subject that they did not need to hold when they were undergraduates" (Kamler & Thomson, 2014, para. 1). Therefore, one major avenue that graduate schools and doctoral programs adopt in evaluating students' academic progress is by written assessments even though they vary depending on the country and educational system. For instance, in some PhD programs in the UK, Australia, and New Zealand, students do not need do a candidacy or comprehensive examination prior to transitioning to their theses or dissertations (Burakgazi & Yildirim, 2017; Tinkler & Jackson, 2000; Bourke, Hattie, & Anderson, 2004; Kiley, 2009). While at some other universities in the US, such as the setting of this study, PhD programs require that students complete a candidacy examination before proceeding to the dissertation stage.

3. Research Methodology

3.1 Research Context and Background

This study was derived from a larger research study that investigated how English as Second Language (ESL) doctoral students from education and engineering departments approach synthesizing while preparing and writing candidacy exam essays (Akinkugbe, 2021). This research was conducted during one academic semester (spring 2018) at a mid-western university in the United States that admits a large group of international students. What both departments also have in common is PhD programs requiring students to engage in substantial research and offering numerous lines of research to pursue as well as faculty members who are leading experts in their fields. As a result, expectations for student performance are high, including for the candidacy examination. A main avenue of assessing whether doctoral students have learned satisfactorily from coursework and are equipped to produce a PhD dissertation of suitable quality is through their performance on the high-stakes candidacy examination. The university's graduate school refers to the candidacy examination as an initial examination consisting of two parts (written and oral) that all doctoral students must take and pass to proceed to the dissertation stage of their programs. This examination is managed with the support of each department's Graduate Studies Committee in collaboration with the student's candidacy examination committee and the Graduate School. This study utilized a case study-based qualitative research methodology in exploring the reading-writing connections (i.e., synthesizing) of L2 doctoral students by analyzing one of their Candidacy Examination essays. The focus was on their task representation—how they understood what they were expected to do—as well as how they approached the reading and the writing they did, with a focus on how they handled the synthesizing in their essays.

3.2 Participants

The participants were two doctoral students (John and Alicia-pseudonyms) from Iran and South Korea respectively. This study and the larger research it came from focused on two additional students from China and Saudi Arabia because I wanted to unravel the candidacy examination essay experiences of individuals, not groups, and individuals with varying backgrounds. John and Alicia were selected because even though they were both PhD students preparing for their candidacy exams, they were still from different departments, had diverse backgrounds and different experiences with synthesizing essays. Their stories of engaging with composing a candidacy exam essay are very unique and provide insight into understanding reading-writing connections within the context of the candidacy exam. The table below (Table 1) highlights that the two participants have diverse backgrounds. John was a doctoral student in the College of Education with a specific focus on race, justice, and activism in literacy instruction. This was his first-degree experience in the United States and outside his native country. His native language is Persian and had lived in the US at the time of the study for two and a half years. He started writing his first candidacy exam essay on March 20 and submitted it on April 4. He took four days off and started his second exam essay on April 9, which he submitted on April 16. He started his third and final paper on April 20, submitted it on April 27, and defended orally on May 3. He considered his academic writing for the candidacy exam as a means of using relevant literature to support and produce new information about his topic (knowledge transforming, Bereiter & Scardamalia, 1987) as was indicated from this quote by him, "*But at the end of the day, the candidacy exam is about literature, you have to say what is there that worked for you."*

In contrast, Alicia was a doctoral student in the Engineering department with a specific focus on using Transmission Electron Microscopy (TEM) to assess structural details in Metallic Glasses (MGs). This was her first degree-related experience in the United States and outside her home country. Her native language is Korean and at the time of the study had been in the US for three years. Alicia wrote only two essays which was a requirement in her department. An interesting and important feature of Alicia's context is the relationship between her two examination essays. Her first essay, the "Research Summary," which she completed and submitted in February, fed directly into her second paper, the "Literature Review Essay." In that respect, she was in effect writing a two-part examination essay, with the Research Summary as the first part and the Literature Review as the second part, though they were treated as separate essays. As a quote from her suggests, "I just read other people's literature review and follow their steps so when I see model literature reviews, I just follow that." Thus, it seemed that she perceived her academic literacy for the candidacy exam from a replication lens (knowledge telling, Bereiter & Scardamalia, 1987). For this study, I only examined one of John and Alicia's papers.

Table 1. *Participants' background information*

Name	**Gender**	**Country**	**Years of Residing in the US**	**Major**	**Number of essays**	**Academic Writing Perception**
John	Male	Iran	2.5	Education	3	Knowledge transforming
Alicia	Female	South Korea	3	Engineering	2	Knowledge telling

Background of the participants' academic literacy

Furthermore, it is imperative to comprehend the background of the participants' academic literacy in their native language and English. At the beginning of this study, the students were first interviewed about their prior learning experiences in their first language and second language (English). The interview was approximately an hour long and was conducted in English. The first semi-structured interviews also elicited their initial understanding of their initial understanding of synthesizing, and their task representation of the written portion of the candidacy examination. Both students conveyed that they had synthesized in English and Korean and Persian before. While they both had their struggles, John was able to emerge more confident, but Alicia struggled more and stated that she is still learning how to write in English. Hence, they each had to construct a task representation for synthesizing based solely on their past experiences and task representation of the candidacy exam.

Regarding English writing, John started learning English when he was in his first year of middle school, he noted that he "could not speak or write in English because the style of teaching was rote focused, teacher centered and very mechanical" (first interview, 3/9/18). John felt limited by this situation; consequently, his parents enrolled

him in private classes to supplement his regular English classes, but John reported being indifferent to this situation at the time. However, he became really interested in learning English during his third year in college at the age of 21, which is when he decided that he wanted to obtain a PhD degree in the US. Therefore, he decided to go back and attend the private classes that he had abandoned previously.

In Alicia's case, she was enrolled in an after-school private institute where most of the topics taught were elementary focused and once she started applying for admission to colleges, she left the school when she became involved in writing essays which was very rare because of the nature of the undergraduate Engineering program she was admitted to in South Korea When Alicia was coming to the US, for her doctoral studies, she took both the TOEFL and GRE before applying to schools in the US, and she prepared for the exams by attending a different private English institute where students were trained specifically for both exams. At this preparatory institute, Alicia said that "…their instructors would give students "four different types of essays to read and then they practice typing these essays on a computer until the students memorize for them for a month before writing the exam" (first interview 5/2/18). This memorization or cramming technique was how they were coached in all of the other integrated tasks for both exams as well. As a result, for the integrated writing tasks Alicia memorized six independent essays (three for each exam). When it came to authentic writing and speaking for her doctoral courses, Alicia saw the limitations of what she had been taught to do, along with difficulties related to L1-L2 language differences.

3.3 Research Questions

1. How do multilingual writers differ in their use of knowledge telling and knowledge transforming approaches?

2. What are the implications of these differences for their writing processes, text quality, and cognitive strategies?

3.4 Data Collection

In a multiple qualitative case study, data sources usually include participant observation, written artifacts, and interviews (Yin, 2014). Whatever the types of data gathered, what matters in case study research is that multiple sources are involved to ensure that the study is valid and reliable and produces meaningful answers to the research questions it addresses (Creswell, 2007; Flick, 2006; Glesne, 1999; Yin, 2014). Thus, the data sources that I utilized for this study were participants' written products, my research notes, stimulated recall protocol (Mackey & Gass, 2005) and semi-structured interviews which were also used for the larger study.

The first data collection used was participants' written texts that comprised of essay outlines, drafts, source materials that they read and incorporated into one of their essays and writing samples from previous coursework. Adopting this method assisted me in examining their production of a candidacy examination essay from numerous lenses. I also tracked the progression of an essay by considering varioust phases in the essay writing activity: the beginning stage (planning), middle stage (drafting), and final stage (completion).

The second data I collected were semi-structured interviews. A total of three semi-structured interviews was conducted with each of the participants during the spring academic semester from February to May 2018 owing to varying schedules and timelines. These interviews were audio recorded and lasted between sixty and ninety minutes. Also, I sometimes noted points in my research notebook during interviews, particularly if I had a follow-up question to ask the participants based on their responses to my questions. After each interview, I wrote research notes, saved them as Microsoft Word documents, and transcribed the interviews because I did not want to risk missing any important information.

The third is stimulated recall interviews with participants. The stimulated recall approach is a two-fold process by which a participant describes an already completed writing or reading experience, and where the researcher must be with the participant(s) and ask questions they have planned in advance on the completed activity (Mackey & Gass, 2005). It is "stimulated" because the research targets specific points to pursue. This process can also be likened to an interview-based approach. I chose target reading or writing products first and then developed an interview protocol that allowed my participants to reflect on that reading- writing experience. The questions that I asked were associated with their composing processes or why they approached their writing in a specific manner (e.g., selecting, organizing and integrating sources). I also took a copy of their essay with me to enrich the stimulated recall process. The recalls typically ran between forty- five minutes or an hour and, like the interviews, were audio recorded, conducted in English, on campus, based on the participants' availability and when they completed their essays. This audio recording was later transcribed verbatim.

The last is my research notes. According to Sutton and Austin (2015), research notes permit the researcher to reflect and remark upon impressions, situational factors, attitudes, and nonverbal signs that audio recordings might not have sufficiently recorded or captured which could be useful while analyzing data. Thus, during each

interview, I made bullet points of certain statements or comments that the participants made that either served as a reminder of a follow-up question, I wanted to ask immediately or as a note for me to reflect on and develop more fully later after our conversation. After each interview, I expanded on those notes, which helped me reflect on the interview with participants, such as comments they made and facial expressions they had, and to think about questions that I needed to pose to them later based on my reflections from our conversations.

3.5 Data Analysis

After collecting the data, I reviewed the data analysis framework and its relation to the research questions. I focused on two students who had different writing ability as the larger research on this topic revealed because I felt that it was worth comparing. I used the evidence that the larger research used to describe their academic perceptions (e.g. Knowledge telling and knowledge transforming) In order to provide a "thick description" (Merriam, 2009, p. 43) of these doctoral students' reading and writing actions in composing a candidacy exam essay, this study utilized a qualitative cross-case analysis (Yin, 2017). First, I analyzed both participants' papers using the processes of selection of sources, organization, integration of sources, and strategies for source use (Spivey, 1990; Solé, Miras, Castells, Espino & Minguela, 2013) as a guide. This framework is grounded in the constructivist model of discourse synthesis of L1 writers as proposed by Spivey (1984, 1991, 1997) and its applications to L2 writers' integrated tasks (Plakans, 2008, 2009a; Zhao, 2015). Since the candidacy examination offers students with the chance and flexibility of selecting the essay type that they would like to write (e.g., theoretical, comparative, and methodological literature reviews), choosing the suitable sources for their papers, arranging and integrating them, I utilized this information to generate a structure that I used to code their papers.

Additionally, I generated a profile of both participants' reading-to-write processes and their synthesizing in their candidacy examination essays. Adopting this technique permitted me to capture and convey each participant's candidacy examination essay experience. Creating their profiles helped me compare both cases by using a cross-case analysis process that included triangulating the students' semi-structured interviews, stimulated-recall protocols, and textual documents. Furthermore, I sometimes noted points in my research notebook during interviews, particularly if I had a follow-up question to ask the participants based on their responses to my questions giving me the opportunity to member check (Lincoln and Guba, 1985) with them as well.

Regarding the stimulated-recall interviews, I examined the participants' rhetorical moves (Graff, Birkenstein, & Durst, 2009; Harris, 2006) they engaged in during their writing process and focused on the reflective comments on their essays, especially as related to synthesizing. Also, I explored each participant's responses to the questions related to their decisions and choices about the organization, selection and integration of sources (Greene & Higgins, 1994; Spivey, 1984; 1991, 1997). These various data sources were triangulated to describe the main themes and recurring patterns that encompasses all the data sources, with balanced weight assigned to each data source while I engaged in the process of triangulation.

4. Findings

Writing Processes

Alicia's Reading to Writing Process

Owing to the literature-focused essay type that Alicia had to write for her candidacy exam, she was operating in a reading-to-write position of reading source materials and then writing about them. In other words, her reading transitioned into writing. And since she was taking an argumentative stance in her paper, she used sources intentionally to build her argument(s). Alicia spent approximately two months on the reading side of her examination experience.

When she moved from reading to writing, the first step involved preliminary work on her Research Summary, which was an outline and findings of a prior experiment that was connected to what eventually become her Literature Review topic. This outline included a breakdown of her ideas on her topic, information about a previous experiment she conducted that was connected to her research topic, results of the experiment, and material she wanted to cite. Later, while developing her Research Summary, Alicia would summarize more notes from her further reading on Conventional Transmission Electron Microscopy as she processed her thoughts so that she "could have access to them later" (stimulated recall, 5/11/18) when she was writing her Literature Review.

Knowing that she was not going to be meeting with her committee members once she started writing her literature review and could not ask them for feedback on her writing and was going to be engaging in some synthesizing in her essay, during her reading phase, Alicia adopted a reading-to-write strategy of reading a lot, writing notes and summaries, and extracting relevant information from her source materials (e.g., articles and

books). These notes and summaries were placed into Microsoft Word files where she categorized the notes based on each section of her literature review paper (stimulated recall, 5/11/18). To enhance her efficiency, Alicia utilized an elimination strategy in her search for relevant source texts by searching for topics using key words, reading abstracts, and skimming and scanning parts of the discussion and conclusion portions of the source materials (instead of the whole texts) to ascertain whether she wanted to read them closely. Alicia called this technique she adopted "screening papers" (stimulated recall interview, 5/11/18). Later, during her close reading, she paid a lot of attention to sources that were being cited frequently, because this would help her choose the texts to emphasize. This was a significant step towards synthesizing in her writing, as it gave her an opportunity to consider some possible connections across texts.

Throughout her writing that followed, she made decisions about using sources and synthesizing based on how significant the relevant content was. She was not particular about the time in which a source was published, because the introductory section of her literature review focused on generational timelines of TEM machines, which dated as far back as 1954, and she felt that she had to acknowledge the pioneering work that authors had done because they were important sources to cite in her paper. Since she was writing an argumentative literature review that focused on how using Scanning TEM machines was better than Conventional TEMs in assessing structural details in Metal Glasses, she selected sources that focused on both techniques to enhance and support her argumentation.

In terms of choosing when to summarize, paraphrase or directly quote as she synthesized, Alicia was concerned about being identified as a plagiarist, so she opted to mostly paraphrase or summarize instead of directly quoting source material, because she wanted to "avoid the high percentage of the Turnitin" (stimulated recall, 5/11/18). That is, direct quotes, even if presented accurately, could still be falsely flagged as acts of plagiarism. After she had produced the first draft of her Literature Review, she reviewed and edited her essay six more times to generate the final draft.

Based on the explanation above, Alicia's story is that of a novice and reluctant writer who learned to use sources and to synthesize by imitating (and possibly appropriating) models to write her candidacy examination literature review essay and engage in a process of argumentation at the same time. She was also learning how to perform these acts relative to the practices of her discipline of engineering. This was a daunting situation given the role of the candidacy examination as a gate-keeping device that separates the coursework phase of doctoral study from doctoral dissertation research. Thus, Alicia relied heavily on drawing upon pre-existing knowledge from memory and directly translating those ideas into text. Based on the findings from this study, it appeared that she did marginal planning and revision. She seemed to focus more on mechanical accuracy and correctness which led to her to adopting a knowledge telling approach in her paper.

John's Reading to Writing Process

John adopted a strategy of reading a lot, writing notes, and recording relevant quotes from the source texts (e.g., articles and books). These notes and quotes were entered into Microsoft Word files, where he categorized the notes based on each exam topic he had to write about. To maximize his efficiency, John adopted a process of elimination in his search for relevant source material by searching for sources that were associated with his topic using key words, then read abstracts and parts of the discussion and conclusion sections of these texts (instead of the whole texts) to decide if he wanted to read them more closely. Thus, he was selective and strategic as he screened the texts. Then, during his close reading, he paid attention to which sources and authors were being cited frequently, as this would help him decide on the texts to emphasize. This was an important step toward eventual synthesizing in his writing.

The next step involved writing an outline that included a breakdown of his ideas on the different sections of his essays and points he wanted to make, as well as material he wanted to cite. While writing an outline, John would also jot down more notes as he processed his thoughts. According to him, this jotting helped him a lot, because he went "*back to them more than the earlier notes*" (third interview, 5/3/18) he had written. Once he had a comprehensive outline for an essay and received committee member approval to move forward, he continued writing until he had a final product. His preference here was to produce one draft he was happy with instead of multiple drafts that underwent revision.

During his writing process, he made decisions about using sources and synthesizing based on how deep or important the relevant content was along with when a source was published. In the latter regard, he preferred to use more recently published work; he tended to ignore sources published in the 1990s or earlier except for a book that was written in 1965 (stimulated recall interview, 4/18/18) that was included in his paper because it was an important source that he needed to cite. In terms of choosing when to summarize, paraphrase or directly quote, this depended solely on how vital the information was. For example, if the quote was very important and he

needed to capture its essence, he opted to quote directly instead of summarizing or paraphrasing. After he had produced a full draft, he reviewed and edited his essay.

In summary, John's story is that of a meticulous, strategic, and perfectionist reader and writer who used sources adequately to support his topic and present a new perspective on it. One major point stands out in looking over his experiences, especially as revealed in connection with his first exam essay. One is his understanding of the importance of working effectively with sources, as reflected in comments he made that were cited earlier and, in the quote, framing this chapter: "But at the end of the day, the candidacy exam is about literature, you have to say what is there that worked for you." As such, he knew that techniques such as synthesizing were essential in successful completion of his essay writing. As discussed above, findings revealed that John engaged in extensive planning, generating a draft and revising his ideas throughout his writing process. He often took time to reflect on the logical flow of the argument he was making, consequently integrated new information, and adapted the text to suit the theoretical framework he used to present the information in a transformative way.

b. Text Outputs

Alicia's Writing Style

In the essay selection below, Alicia used source information as a tool to assist her in making a point about how nano-sized crystalline phases or long-range orders were not formed by shear bands behavior which was emphasized in the lines presented in the bold type face. Interesting here is her balanced combination of two syntheses and three uses of individual citations.

In terms of sentence structure, Alicia incorporated a combination of simple, complex and compound sentences. She moved amongst these sentence styles as she developed her argument. There was also variety in the length of her paragraphs, with few of them very long; these paragraphs revealed her ability to combine different types of content (source information and her own reasoning). Generally, these style-focused features of her writing could be associated with the statement she made about "trying to understand what she read very well" (first interview, 5/2/18) before writing, or "mimicking" models and transferring them to her essay. Hence, it seemed that Alicia might have studied sample sentences and then imitated their structures while supplying her own information about her research topic. This would have meant studying how the authors of her source texts expressed themselves in scientific English, including how they dealt with source material from a language perspective. This would enable her to present herself as an effective writer of scientific, and more specifically engineering, English in her high-stakes candidacy examination context.

Example of Alicia's Writing Style

> ***However, there are several investigations to reveal that nano-sized crystalline phases or long-range orders were not formed by shear bands behavior under imposed stresses***. According to the study of a Zr-based MG conducted by Schuh et al. [44, 50], there was not any long-range order presented in shear bands. In addition, Wilde and Rösner verified Schuh's hypothesis through the result that shear bands in Al88Y7Fe5 alloy exhibited no crystallization at room temperature [51]. Along the same lines, Nekouie and co-workers substantiated the results without forming any nanocrystalline phases that were found under the area of the indentation test in a Zr48Cu36Al8Ag8 MG as well [8]. Also, through the observation using the deformed as-cast sample by SAED pattern, they pointed out that there were no compositional changes under shear bands. In Greer's study, they corroborated that nano-sized crystals or long-range orderings sometimes could be detected in the shear band areas if they come from artifacts of sample preparations [44, 52]. On the other hand, there was an experiment in the same composition with Nekouie's study but had different experimental conditions, such as a higher temperature, and they revealed the nano-sized crystallization of Ag-rich particles because of phase separation from an annealing process [53] (essay, pp. 6-7).

In some instances, Alicia struggled with balancing linguistic accuracy and producing content. Her limited engagement with the candidacy exam's writing task's rhetorical demands seemed to come from cognitive overload when managing linguistic constraints in L2. Thus, Alicia's essay revealed clear but simplistic arguments that focused on mechanical precision. Some of her ideas were presented sequentially without in-depth synthesis or analysis. Her essay reflected a reliance on established disciplinary knowledge with minimal integration of new perspectives.

John's Writing Style

On the other hand, as indicated in the example below, John used the source texts as a tool to help him make a point about how social-structural and cultural significance of race should be a crucial concept for comprehending inequality, which is reflected in the lines presented in the bold type face. Here he combined source text use and writing style to develop his stance.

In terms of sentence structure, John wrote a combination of simple, complex, complex-compound, and compound sentences. He moved between these sentence styles as he developed his syntheses. There was also variety in the length of his paragraphs, with some of them very long; these paragraphs displayed his ability to mix different kinds of content (source material and his argumentation). Altogether, these style-focused characteristics of his writing are likely connected to the statement he made about "thinking deeply" and "reflectively" (first interview, 3/9/18) before writing. He appeared very intentional in the ways in which he approached this essay, and this intentionality was perhaps the outcome of his before-writing reflections on how he wanted to express himself, especially considering comments he made earlier in the chapter about the expectations of the committee member who was most connected to this essay. It was clear from those comments that he was acutely aware of the need to address that committee member's expectations, especially with respect to establishing his stance toward his topic. At the same time, John's first essay was a type of preparation for and connection to his remaining two essays that would follow, leading him to summarize his first essay experience as "difficult and time consuming" (second interview, 5/2/18).

Example of John's Writing Style

Omi and Winant (1994), they argue that such mutation and marginalization has become possible through a form of thinking that understands race "as either an ideological construct or an objective condition" (Ladson-Billings & Tate, 1995, p. 48); the former line of thought denies the reality of a racialized society which influences "raced" people while the latter ignores existing subjective categorizations of non-white people. Therefore, they emphasize the social-structural and cultural significance of race as well as the fact that it should be the "central construct for understanding inequality" (p. 50). ***But how is whiteness as an epistemology which is ontologically racial and is responsible for de facto racial inequity in education, still able to hide itself behind the façade of objectivity and successful in ruling out race as a decisive factor which contributes to inequality? In other words what makes whiteness "central"?*** (essay, p.4).

John exhibited better cognitive adaptability, effectively managing linguistic and rhetorical demands required of him from his candidacy exam committee. His multilingual proficiency seemed to augment his ability to navigate between languages and incorporate diverse perspectives. Consequently, John's essay was well-organized, with nuanced arguments and consistent transitions. He incorporated theoretical perspectives, counterarguments, and analysis, demonstrating a higher level of conceptual engagement and knowledge integration.

5. Discussion and Implications

These findings highlight the considerable differences between knowledge telling and knowledge transforming in candidacy exam disciplinary writing. While Alicia is a graduate student, her dependence on knowledge telling in her essay aligns with Bereiter and Scardamalia's (1987) description of novice writers, who prioritize information recall over analytical engagement. In comparison, John's knowledge transforming approach reveals expert-level writing, depicted by problem-solving and reorganizing of ideas.

This study indicates that disciplinary writing conventions (e.g. the candidacy exam in this case), can impact an individual's cognitive demands or processes during writing, especially for those dependent on adopting a knowledge telling approach. Nevertheless, it also emphasizes the potential for disciplinary training to nurture deeper cognitive engagement, as demonstrated by John's ability to navigate between theoretical frameworks and integrate diverse perspectives.

Additionally, these findings have implications for doctoral writing instruction, specifically for multilingual students across disciplines. Educators should:

- Support strategies that encourage knowledge transforming, such as outlining, iterative drafting, and theoretical synthesizing.
- Continually provide scaffolding to assist students in managing linguistic and cognitive demands

specific to their disciplines.

- Promote an environment that values critical thinking, disciplinary discourse conventions, and audience awareness in academic writing tasks.

In conclusion, this study emphasizes the value of Bereiter and Scardamalia's models in understanding disciplinary writing processes. By comparing knowledge telling and knowledge transforming in engineering and education doctoral students' candidacy exam essays, it offers insights into the various insights and challenges encountered by academic writers and highlights strategies for supporting effective doctoral writing instruction. Future research directions could investigate a larger sample of doctoral students across a broader range of disciplines to explore how writing models manifest in various academic settings. Longitudinal studies could also examine how doctoral students develop move from knowledge telling to knowledge transforming over time. Lastly, there could be a study conducted on the effects of tailored instructional interventions on enhancing knowledge transforming strategies in multilingual writers.

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