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How To Develop And Support The Academic Writing Of Our Students In The Science Classroom

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HOW TO DEVELOP AND SUPPORT THE ACADEMIC WRITING OF OUR STUDENTS IN THE SCIENCE CLASSROOM

by

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To my family and friends for valuing learning.
In particular, thanks to my husband, Brent, who has consistently encouraged me, and to my parents, Don and Rhonda, for helping me in so many ways.

"Science is built up of facts as a house is of stones,
but an accumulation of facts is no more a science than a heap of stones is a house."
Henri Poincare, La Science et l'Hypothese (1908)

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CHAPTER ONE
Introduction

How to develop and support the academic writing of our students in the science classroom is a resource guide for classroom teachers in upper elementary. This chapter introduces the groundwork for why I have chosen to create an academic writing resource guide focusing on the genre of procedural recount to use in science for my capstone. This chapter will include my journey with writing, my experiences with science, my students, and my vision of incorporating non-fiction writing into science instruction.

My Journey with Writing

I am a writer, and therefore biased about writing. Writing appeals to me in that it gives me the ability to revise an idea before letting anyone else see it. As a child, I had dreams of becoming an author. As a young adult, I wrote reports for 4-H projects, FFA (formerly known as Future Farmers of America) leadership activities, and applications for scholarships and admission into colleges. As an international student in Norway and a rogue traveler in Guatemala, I kept an online journal for friends and family to stay up-to-date on my journey. Then and at this stage of my life, I have not gone a day without writing. Sometimes it is a list of tasks to complete, a lesson plan, a recommendation for a student, or an invitation to a wedding. In any case, I am continually putting pencil to paper or tapping the keyboard of a computer. To put it simply, I value writing and see clearly the practicality, necessity, and beauty of it.

My Experiences with Science

My last science course was over a decade ago as a freshman undergraduate: biology with a lab component at 8am. I was merely fulfilling a requirement for graduation. My focus at that time was on reading and writing as an English major. I had not yet decided on a career, but I did not for one minute imagine that it would be within the field of science.

My first year of teaching English Learners (EL), I found out three days before classes started that I would be teaching science to seventh through tenth grade ELs. There was no syllabus, classroom materials, or appropriate textbooks provided. I was overwhelmed and frustrated that year. The learning curve was steep. I realized that without prior knowledge obtained in elementary science classes, my students had a paralyzing amount of material to learn. While my EL students did learn about science, I felt that I failed them. I became keenly aware that science is a content area that requires significant amounts of specific background knowledge. It also can easily be intimidating and overwhelming without good curriculum, materials, and support.

The following year I worked at a different school, teaching fourth and fifth graders. My colleagues asked me to teach science. Having reviewed the Minnesota science standards (which are comprehensible to a non-scientist), I also was informed that the district used Full Option Science System (FOSS). This is a series of kits on different scientific topics that provide teachers with background knowledge, objectives, selected readings, and a letter informing parents of the unit basics, along with physical objects and required instruments. Furthermore, the school district provided an agenda of lessons and

benchmark assessments. I was elated to be supported in this way. Thus began my school year as a science teacher for EL and non-EL students in both fourth and fifth grade.

The science lessons were a major improvement from those of the previous year. In addition to the curriculum, I took a series of professional development classes on explicit vocabulary instruction, use of student self-assessment of vocabulary words, successful use of formative assessments, and implementation of structured oral language exercises. In my second year of teaching, I marveled at the extent to which my teaching had progressed.

Now two year later, I think back on those science academic standards of high school that had seemed so beyond my grasp and I ask myself what can I do now to prepare my students for future success in science? More importantly, is there something I can do to help ELs be more successful in other content areas as well? Every content area requires writing, including science. Writing has continually helped me make sense of what I am hearing and reading. Taking notes, creating reports, presentations, and writing reflections have helped me clarify the information being presented. Once clarified, I was able to internalize it. Perhaps writing could benefit my students as well.

Writing in School

Writing is currently being taught at the school where I work. What I have witnessed is that our students' 20 to 30 minutes of daily writing is focused almost exclusively on personal narratives. While this genre of writing is important, the writing that is often used in content areas such as science, math, and history is typically less personal and more formulaic.

What is the academic expectation for writing in the upper elementary grades? I turned to the Common Core State Standards (CCSS), which numerous states use as their academic standards. In them, I found that students in fourth and fifth grade are supposed to be able to "write narratives and other creative texts to develop real or imagined experiences or events using effective technique, descriptive details, and clear event sequences" ("Common Core Standards", 2005). These writings should include introducing narrator and characters, using dialogue and description, transitional words and phrases, both concrete and sensory words, and providing a conclusion.

As I kept reading the standards, I found "write informative/explanatory texts to examine a topic and convey ideas and information clearly" (p.18). As expected, the level of detail required of the students increases as they become older, as they build upon previously learned skills. Third graders must "provide a concluding statement or section" while fourth graders need to "provide a concluding statement or section related to the information or explanation presented" (CCSS, 2005). This is what I had hoped for, confirmation that students can and should be learning to write scientific texts such as procedural recounts in upper elementary.

Be that as it may, some states do not require a standardized test on writing until ninth grade. Reading and math are the two subjects measured each year in high-stakes standardized assessments. For that reason, schools often put their time and resources into those content areas while writing is regularly left behind, postponed for another day.

Even so, writing remains important for success beyond school. Reports published by the National Commission on Writing (2004, 2005) declared that the lack of writing skills negatively affects the likelihood of hiring in both business and government. The

2004 report was based on a survey of business leaders. It found that some companies were paying for employees to take remedial writing courses. More commonly, the lack of writing skills was preventing some candidates from getting salaried jobs and keeping them from any promotion or advancement in their field. According to this report, the need for effective writing instruction was clear: "Unless our society pays attention to developing all of the education skills (including writing) of all segments of the population, it runs the risk of consigning many students who are poor, members of minority groups, or learning English to relatively low-skill, low-wage, hourly employment" (p. 19). Those are my students.

Guiding Questions

I understand that teachers have extraordinary workloads. Indeed, there is never enough time to cover all of the necessary material in a school day and writing can be a time consuming skill to teach and to learn. My objective for this capstone is to create a resource guide to aid in the development of academic writing of upper elementary students during science class. It will include a quick review of academic language and introduction to the genre of procedural recounts. Additionally, it will discuss key components of effective writing instruction, appropriate scaffolds for academic English and text structure. Finally, it will contain ideas for authentic writing assignments, and several useable forms of assessment. In order to address all of these areas, I will be reviewing the research that has been done in these areas and applying those findings to this project.

This resource guide for integrating academic writing into science, designed for upper elementary classroom teachers attempts to answer the following questions:

1. What is the genre of procedural recount and why should it be taught during science class?
2. What are best practices in teaching academic writing in science class?
3. What strategies are effective for planning academic writing in science class?
4. Which scaffolds work well for procedural recounts?
5. What are some practical methods for assessing academic student writing in science?

Chapter Overviews

In Chapter One I prefaced my research by establishing the purpose, need, and significance for this resource guide. The context of the resource guide was introduced, as was the background and bias of the designer. I concluded the chapter with my vision of how to incorporate writing into the science curriculum and my guiding questions.

In Chapter Two I will provide a brief review of literature relevant to academic writing in content areas, purpose of genre study, best practice scaffolds for academic writing, and relevant feedback and assessment. Chapter Three will explain the setting in which this guide will be used, the rationale, goals, and development process of the guide. In addition, it will clarify the format of the resource guide and the method of reflection throughout its development. In Chapter Four, I will present my resource guide. In Chapter Five, I will reflect back on my guiding questions and consider future research and ponder other curriculum design possibilities for the future.

CHAPTER TWO
Literature Review

This capstone focuses on the question, how can we develop and support the academic writing of our students in the science classroom? This chapter will provide an overview of research that addresses the questions pertaining to this curriculum project. Topics that will be covered include academic writing in content areas, genres and text structures specific to science class, and best practice in using scaffolds for academic writing. The chapter will then address what research suggests about the evaluation of student writing, including both feedback and assessment. The chapter will conclude with recognition of the gap in current writing instruction, a restatement of my research question, and a summary of the following chapters.

Why Write?

There has been a variety of research done attempting to explain how, why, and when the connection between writing and learning occurs. Some researchers believe that the connection is due to the fact that the learning strategies that are used in writing and can also be implemented in other areas of learning. More specifically, writing can perhaps provide students with learning strategies for rehearsing, organizing, elaborating, and monitoring comprehension (Weinstein & Mayer, 1986). These strategies, taught and practiced during writing instruction, provide a template for how students interact with and make sense of new information. A meta-analysis conducted by Hattie, Biggs, and Purdie (1996) suggests that meta-cognitive strategies in particular, those that help students think about their thinking, can have powerful effects on learning. However,

research conducted by Gilbert and Graham (2010) found that writing instruction in elementary schools consists primarily of activities such as short answer responses, completing worksheets, note taking, and writing to summarize. At any rate, Bangert-Drowns, Hurley, and Wilkinson (2004) found the most effective writing-learning relationships occurred when students, elementary through college, wrote for brief periods of time, three to four times a week, and the intervention lasted for one or more semesters. Research conducted by Esmaeili (2002) came to the conclusion that adult EL students performed significantly better on a writing task when both the reading task and writing task have a similar theme. In addition, their ability to produce a summary recall of the reading comprehension also increased. Likewise, Brandenburg (2002) did research on the impact of writing on native English speaking students in pre-calculus and calculus and found that they became increasingly literate in math. Students were able to "pinpoint any confusion, compare and contrast mathematical methods, and ultimately deepen their understanding and retention" (p. 68). Research conducted by Chen, Hand, and McDowell (2013) suggests that collaborative writing between fourth grade science students and eleventh grade science students was beneficial for the majority of students. Improvements were more significant for students who were female, gifted, or from low socioeconomic status.

Writing in Content Areas

Simply put, writing has the ability to optimize student learning in various content areas (Knipper & Duggan, 2006). This is explained in more detail by Sedita (2013), who provides an apt metaphor for writing in content areas by comparing the materials that a content teacher is required to cover in class to a full plate. Writing to learn is not about

adding to the plate. Instead, it provides a stronger and more durable plate on which to put the content.

Indeed, writing across content areas and genres is a critical skill for 21st century academic and workforce success, requiring that writers be linguistically aware on a level not previously required (National Commission on Writing, 2003). The suggested remedy for the current situation is that writing be placed in the foreground of our educational curriculum, and included in all content areas. The National Commission on Writing states, "If students are to make 'knowledge their own' they must struggle with the details, wrestle with the facts, and rework raw information and dimly understood concepts into language they can communicate to someone else" (2003, p. 13).

Regarding writing in content areas, a distinction is frequently made by researchers as to the difference between learning to write and writing to learn (Chen, et al., 2013; Comer, Clark, & Canelas, 2014; Jani & Mellinger, 2015; Klein & Rose, 2010). *Learning to write* addresses the components of transcription skills (spelling, punctuation, capitalization) and composing skills (pre-writing, planning, drafting). Klein and Rose (2010) explain that *writing to learn* has a different intention. Educators provide opportunities to write not necessarily for the purpose of improving writing skills, but for the purpose of better understanding the content material, whether it is math, history, or science.

Other researchers agree with the concept of writing as a key component to student success. The act of putting words on paper allows students to gather, remember, demonstrate, reflect, and share the information from their classes. These skills can be

transferred beyond school, to employment, civic engagement, and personal satisfaction (Jani & Mellinger, 2015; Zumbrunn & Krause, 2012).

Indeed, Fisher, Frey, and Williams (2002) investigated a school-wide implementation of reading and writing strategies in all content areas at a high school with its entire student population qualifying for free and reduced lunches, almost 50% EL, and 96% minority. The focus was on seven literacy strategies and included professional development for teachers, partnership with university faculty, explicit instruction of strategies, and student recognition and use of the strategies. The result included students making visible growth in both reading and writing assessments and an increase is university acceptances.

Furthermore, Audet (1996) found that shared computerized learning logs among an advanced physics class led to learners being more reflective and prepared to share in classroom conversations about material and ideas. Meanwhile, Walley and Kommer (2000) researched writing in content areas at the middle school level and found that it works best when the writing is authentic, has a clear audience, and is appropriately scaffolded.

Similarly, Klein and Kirkpatrick (2010) concluded from their research that elementary students have limited experience with informational genres. More importantly, their knowledge of the genres can improve with instruction. Namely, mastering informational genres provide students with essential tools for creating quality texts in the future and understanding more complex content.

More specifically, writing has been found to possibly increase the recall and comprehension of both text and lecture (Beins, 1993; Foos, 1995; McCrindle &

Christensen, 1995; Wiley & Voss, 1996). Tucknott and Yore (1999) found that students whose classrooms implemented writing about and during science made large increases in test scores. The highest gains were made when students actively transferred information between genres. This included turning notes into summaries or drawings and labels into sentence explanations.

Kinds of Writing in the Classroom

Both *writing to learn* and *learning to write* can be used in the elementary classroom. The focus of this capstone will be on *learning to write* and more specifically on writing in a specific non-fiction genre. In the classroom, genres refer to different types of writing including poetry, novels, and plays. In a broader linguistic sense, genres consist of a culturally dependent range of ways to use language in order to get things done (Gibbons, 2015; Schleppegrell, 2012). Examples of this view of genre include a marriage license, written instructions, a newspaper report, transcription of an interview, and a shopping list. Each genre has a particular overall structure and several likely language features.

That being the case, linguists have classified the various written genres used in the school context, each having a purpose and clear organizational structure. This work began in Australia the 1980s and is known as the Sydney School. It is based on systemic functional linguistics (SFL). Common school genres include narrative, argument, recounts, information reports, procedures, discussions, and explanations (Gibbons, 2015; Martin & Rose, 2005).

Arguably, personal recounts and narratives are the genres that most elementary students are most familiar with writing (Wray & Lewis, 2000). The primary purpose is to

entertain, possibly to teach. The organization consists of orientation, series of events, a problem and a resolution. The connectives (transitions) most often used have to do with time. The narrative genre often uses past tense, contains both action and thinking words, and may contain dialogue.

On the other hand, informational genres, those that transmit knowledge, seem to not be commonly taught in elementary schools (Duke & Bennett-Armistead, 2003; Martin, 1989; Wray & Lewis, 2000). However, as a student progresses through primary to secondary school, there is a gradual but definite shift from narrative texts to more informative texts. In order to make this transition successfully, students are required to add more formal structures to their writing as this enables them to communicate with increasingly distant audiences (MacArthur, Graham & Fitzgerald, 2006).

Science writing is highly formal, setting it apart from typical social writing. The purpose also differs, in that the reason for much writing in science is to communicate with the broader science community (Keys, 1998). Wray and Lewis (2000) have concluded that students struggle with writing non-fiction texts due primarily to lack of sufficient exposure and practice. Additionally, this type of writing focuses on technical language, scientific principles and procedures (Christie & Derewianka, 2008; Zwiers, 2008).

In fact, the highly structured writing in science has received some pushback, due to its reputation of being dry and uninteresting. Some believe that the dense writing is responsible for the lower participation in science of both women and people from non-European cultures. There have been suggestions that if a greater variety of writing genres

was accepted in science these minority groups would be more likely to participate and even excel in the field (Hilldebrand, 1996; Prain & Hand, 1996; Spanier, 1992).

On the other hand, Halliday and Martin (1993) hold the view that instead of being replaced with other genres, the traditional scientific genres must be explicitly taught in schools, so that all students have access to these texts. In fact, substituting narratives for scientific genres of academic writing clearly puts students with low socioeconomic status and those with no resources for learning them on their own at a serious disadvantage for learning the scientific content. Berkenkotter and Huckin (1995) go a step further, stating that if schools continue to ignore structure and conventions of genre in science, students will simply not have the tools necessary to succeed in science at the secondary and tertiary level.

While these non-fiction genres may be more challenging for students, Purcell-Gates, Duke, and Martineau (2007) have found that explicitly teaching text structure can lead to an improvement in both reading comprehension and composition. This explicit instruction of a genre includes naming, describing, an explaining the function of genres and the genre features.

The Value of Writing in Science Class

As mentioned earlier in this chapter, writing is a mode of learning information and allows for better communication of ideas and knowledge, increases understanding, and facilitates the creation of new ideas (Emig 1977; Klein 2000; MacArthur et al., 2006; Newell & Winograd, 1989). Research indicates that the purpose, authenticity, and other factors of the writing play a significant role in whether or not the writing benefits the learning of content material (Bangert-Drowns, et al., 2004).

Increasingly, both science and writing have been receiving less classroom time. Teacher surveys collected by Dorph, Goldstein, Lee, Lepori, Schneider and Venkatesan (2007), Fulp (2002) and McMurrer (2008) (as cited in Taylor & Duke, 2013) revealed that many elementary classroom teachers are actually skipping science instruction, or devoting a brief 1-2 hours a week on it. This decrease of instructional time and occasional combination of science and writing instruction is due in part to the significant educational time spent on reading and math, a result of high stakes testing.

On the other hand, due to the recent implementation of Common Core State Standards, students are required to write a wider variety of texts including information reports and explanatory texts, which make the combining of science and writing a natural fit. In fact, research continues to point towards the benefits of incorporating writing into content classrooms, as a means for preparing students to engage in the interdisciplinary world (Boix Mansilla, Miller, & Gardner, 2000; McQuitty, Dotger, & Khan, 2010; Tucknott & Yore, 1999). Undoubtedly, literacy in science is different than in other content areas. It has particular language features, and knowledge of these features is necessary to build understanding of the science discipline itself (Fang, 2006; Halliday & Martin, 1993).

While the language of school science differs from professional science in its relative simplicity, the language of school science does share some of its attributes. These include a high density of information, lots of technical vocabulary, abstract ideas, and authoritativeness (Fang, 2005; Fang & Schleppegrell, 2008). The language of science is central to the learning of science (Fang, 2005).

The language of science poses numerous challenges, which are broken down by Fang (2006). Technical vocabulary words are one part of these challenges; these words are commonly multi-morphemic, have Latin or Greek roots, and appear in already dense sentences. There are also ordinary words, of which students may be familiar, but in science they have new meanings and/or word function that are often "non-commonsensical" (page 494). Beyond the new words, there are additionally new uses of prepositions, ellipsis, subordinate clauses, abstract nouns, lengthy noun phrases, complex sentences, interruption construction, and passive voice (Fang, 2005; de Oliveira, 2010).

In the end, the literacy component in science is challenging. However, studies have shown that subject-based learning can be highly effective when the literacy component is mindfully planned, integrated, and scaffolded (Gibbons, 2009; Walqui & van Lier, 2010).

Genre and Text Structure in Science

School science introduces students to the understanding of both scientific knowledge and scientific methods. To accomplish this task, students need to learn a considerable amount of new and technical vocabulary, as well as how to read and write specific genres which encompass scientific principles and procedures (Christie & Derewianka, 2008). Research has shown that science writing has distinctive features and structures that must be taught in order for students to be successful (Halliday & Martin, 1993). Writing, like reading, is very much genre-specific. Unlike personal narratives, the genres used in science are more formal and require increased use of academic English. Essentially, academic English is the more complex language structures used for various schooling activities (Schleppegrell, 2012).

Admittedly, several of these formal writings are more frequently used in science than others. These genres include, but are not limited to, procedural recounts, research articles, field studies, and informational reports. Due to the targeted age group of upper elementary students and the scope of this capstone, I have chosen to focus on procedural recounts.

Procedural recounts

Procedural recounts are found in the broader category of informative writing, whose purpose is to convey information about the natural world (Purcell-Gates, et al., 2007). More precisely, Christie and Derewianka (2008) describe procedural recounts as "the prototypical experimental genre, learned in childhood and early adolescence, and remaining important throughout adolescence" (p.181). Gibbons (2009) and Derewianka (1991) explain procedural recounts as a student's retelling of an experiment that he/she carried out.

As shown in Table 1 and the sample text (below), the purpose of procedural recounts in science is to provide important information about an investigation. This includes the aim, a detailed and careful record of how the investigation was conducted, and a conclusion. Teachers may choose to add a hypothesis to the elements included in the following table. Illustrations are also commonly found in this genre to add more detail. The field of science requires experiments to be replicated to ensure validity and accuracy of the results, so each of these steps is important. Procedural recounts begin with a clearly defined aim of the experiment and a list of materials necessary to conduct the work. This is followed by an account of the experiment. The writing concludes with stating the results and coming to a conclusion.

Table 1

Procedural recount genre

Genre	Purpose	Text structure	Grammatical features
Procedural recount	To recount in order and with precision; a procedure recount records the aims, steps, results, and conclusion of a scientific activity already conducted.	• Aim • Record of events • Conclusion	• Declarative sentences • Use of 1st person pronouns to retell events • Action processes • Past tense • Sequential words

The vocabulary that is necessary for this genre include sequential words, technical words specific to the topic, and transition words for cohesion. Typical language features of procedural recounts include use of past tense action verbs, relating verbs to introduce concepts (*means, is called*), expressions of cause and effect, and field-related vocabulary (Gibbons, 2015).

Sample Text.

Procedural recount	Text
Materials required	*2 pill bottles (one with a cup)* *50 beans* *water*
Aim	*To demonstrate that plants need air*
Record (What we did, what we observed)	What we did: *First we soaked 50 beans. Then we filled both bottles with the soaked beans and put a little water in the bottom of each. Next we put the cap tight on one of the bottles and left the other open. Finally we shook the water over the beans.* What we observed: *The seeds [in the bottle with the cap off] started to sprout.*
Conclusion	*Plants need air to grow.*

(Adapted from Christie & Derewianka, 2008, p.155)

Best Practice in Writing with Special Considerations for ELs in Science

According to the National Center for Education Statistics (2015), in the 2012-13 school year an estimated 4.4 billion EL students were attending public schools in the country, making up roughly 9.2% of the student body. These numbers, and the fact that they are continually growing, suggest that mainstream teachers need to be familiar not only with best practice in writing instruction but also with best practice in writing instruction that addresses the unique needs of ELs. While this teaching is important for EL students, the fact is that this type of instruction is beneficial for all students (Schleppegrell, 2012).

According to Raimes (1985), writing is an important modality and tool in overall language learning. Unlike speaking or listening, writing allows students to "experiment, play with language, take their time to find appropriate words and sentences, test out a text and change their minds, and guarantee a response from an audience" (p.68). This is a unique and powerful distinction that can be employed to further the language development overall.

Yet it is sometimes presupposed that upper elementary students have developed the language and literacy skills necessary for communicating in content areas. Fradd and Lee (1999) conducted research on teachers' expectations of upper elementary diverse learners and concluded, "by the time students arrive in fourth grade, many skills are assumed and therefore not taught. Foundational skills, including the language and literacy for communicating science, and a recognition of what science is cannot be assumed" (p.19).

One pedagogical model that addresses this gap between skills that are assumed and the students' actual skills is the Teaching and Learning Cycle. It was developed by Rothery (1994) in partnership with the Sydney School and has been adapted by many other people and organizations since then. It consists of four phases: building the field, deconstruction, joint construction, and independent construction. Building the field consists of being introduced to and getting to know the content knowledge. It addresses what the students will be writing about. Deconstruction is another phase. Students study models of the genre and investigate the purpose, audience, and text features. There is also joint construction. The students write a piece of the genre about the content material as a group, with active participation of the teacher. The following phase is independent construction. Students use the information from the deconstruction phase and the model they co-created to write their own piece. As mentioned by Martin and Rose (2005), the Teaching and Learning Cycle helps to establish a system of writing that involves students, teachers, and real text. The Teaching and Learning Cycle was created specifically for use with EL students. However, native English-speaking students may also benefit from such explicit genre writing instruction.

As seen in the Figure 1 (below), the phases of deconstruction, joint construction, and independent construction follow a clear order. However, both setting the context for the writing and building the field of content knowledge are continual processes that happen throughout the entire cycle.

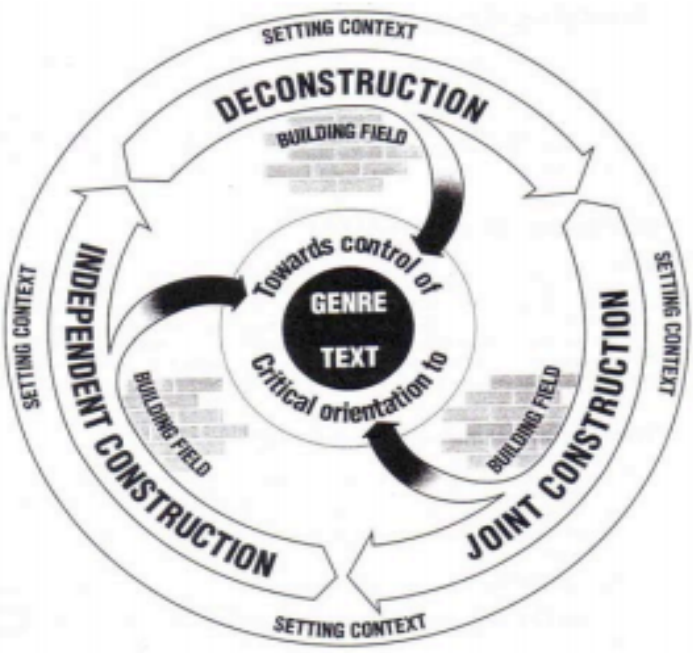

Figure 1. Adapted Teaching and Learning Cycle (based on Martin & Rose, 2005, p. 252).

With such explicit instruction, students may become more familiar and confident in their understanding of the purpose of the writing, the particular audience, as well as the appropriate language to use. They will be able to explain how the genre is organized and structured in relation to other genres. They will also have a common language to discuss the parts of the text structure. As a result, they are able to make their writing explicit enough to be understood by their audience. Finally, they can grow in tenacity as writers of science.

Assessment of Writing

Two of the reasons teachers give for being reluctant to incorporate writing in their classrooms is their lack of confidence in grading it and the amount of time that it takes to grade (Pearce, 1983). The use of checklists and rubrics can greatly reduce the workload and empower students with clear details for what is expected from them. Specific

feedback, presented in both these forms of assessment, is ideal. The writer is provided insight on how to improve their writing, without becoming overwhelmed with information (Zumbrunn & Krause, 2012).

The Teaching and Learning Cycle effectively prepares students to evaluate their own writing, as well as that of fellow students. The students have a clear idea of what the purpose of the writing is, which components are required for each specific genre, and several models of which they can correlate. In fact, having the students create a rubric together during the deconstruction phases could lead to more ownership of the writing process overall.

The Gap

Looking specifically at science classes in the upper elementary grades containing both EL and native English speakers, there are several gaps in what my mainstream colleagues know about teaching the writing of science genres. These include lack of knowledge about how to teach academic writing, appropriately scaffold academic writing, tie academic writing into content in an authentic way, address the linguistic needs of both EL and native English speaking students, and provide feedback for continually improving writing skill.

As stated in the introduction, teachers are continually given more responsibilities and tasks to complete. This capstone addresses the gap between the valuable research conducted on the topic of academic writing instruction in science and the limitations of time in a teacher's day. The goal is to provide teachers with a go-to resource guide that provides valuable information for developing the academic writing skills to the benefit of all students.

Research Questions

This curriculum capstone project seeks to answer the question of how to develop and support the academic writing of our students in the science classroom. How can teachers of upper elementary classrooms be equipped with practical, informative, research based strategies to explicitly teach and appropriately scaffold academic writing in science class? Several of the questions that this project will be addressing include:

1. What is the genre of procedural recount and why should it be taught during science class?
2. What are best practices in teaching academic writing in science class?
3. Which scaffolds work well for procedural recounts?
4. What are some practical methods for assessing academic student writing in science?
5. What strategies are effective for planning academic writing in science class?

Chapter Summary

In this chapter, I began by looking at the research that has been done in the area of academic writing instruction. I looked at the research concerning using writing in content areas, with a closer look at writing and science. From there, I investigated the genre of procedural recounts. After that, I delved into research based strategies and scaffolds used with academic writing. Finally, I reviewed the research about feedback and assessment of student writing. The chapter concluded with an explanation of the gap and a summary of how this project intends to help bridge that gap.

In Chapter Three, I will describe in detail the setting that was in mind when the resource guide was created. Next, I will include the rationale for the creation of this resource guide, as well as its goals and development.

CHAPTER THREE
Methods

The fourth and fifth graders I have taught have been really excited about science. At the same time, I have seen both native English-speaking and EL students struggle with non-fiction academic writing. I want to capitalize on their interest and equip them with the language tools to write authentically and academically about science. This has led me to develop a resource guide for upper elementary classroom teachers to develop academic writing in science class. The questions that guide this project include:

1. What is the genre of procedural recount and why should it be taught during science class?
2. What are best practices in teaching academic writing in science class?
3. Which scaffolds work well for procedural recounts?
4. What are some practical methods for assessing academic student writing in science?
5. What strategies are effective for planning academic writing in science class?

The research provided in Chapter Two identifies arguments for why writing should be incorporated into content areas. It also points to why it is necessary to provide explicit instruction in genre, text structure, features, and purpose. Furthermore, it addresses how writing in specific genres helps all students learn academic English needed to succeed academically. Based on my review of the literature, I found five necessary

components of a writing curriculum: clear focus on specific genre, academic language scaffolds, structure scaffolds, authentic writing tasks, and appropriate assessment.

The Setting

District

The district I teach in has more than 30 elementary schools, seven middle schools, and eight high schools. Including specialty programs, charter schools, and district alternatives, there are a total of 76 schools. Approximately 35,000 students attend those schools. Of the student population, 63 percent qualify for free and reduced meals. White Americans are in the minority at 33 percent of the student body. African American students constitute 37 percent of our overall student body. Roughly 26 percent of our students are English language learners, speaking 96 different home languages and dialects.

School

I currently teach fourth and fifth grade EL students at one of the K-8 magnet schools within this district. The school serves roughly 550 students, 71 percent of whom are Asian American. African Americans make up 22 percent; Hispanic Americans are four percent. Native Americans and White Americans each make up one percent of the student body. Currently, 90 percent of our students qualify for free or reduced price meals and 53 percent of the student body is English language learners. Our attendance rates are some of the highest in the district. Our test scores are some of the lowest. As a result, we were given the label of "high priority school" and are required to show improvements within a five-year timeline or the school will be closed.

Classrooms

As an EL teacher, I work with three fourth grade classrooms, two fifth grade classrooms, and one self-contained classroom for students who are developmentally cognitively delayed. My caseload is currently 62 EL students. Of those students, 53 speak Hmong, four have a home language of Spanish, four others have a home language of Somali, and one has a Creole as their home language. The bulk of the EL students were born in the United States; their parent(s) and/or grandparent(s) immigrated here. The vast majority of the EL students are fluent in social English.

In short, there is not enough time in the day for me to work with all of the EL students that need academic language support. Additionally, many of our native English-speaking students also lack the academic language skills necessary for school success. The majority of students struggle with grade level content in general and the teachers can become overwhelmed.

Science Curriculum

The science program used at my school was developed by Lawrence Hall of Science at the University of California, Berkeley and is used throughout the United States. According to their website, "The FOSS Program was created specifically to provide students and teachers with meaningful experiences through engaging with this active participation in scientific practices" (Delta Education, 2016). The fact is that many of our students lack background knowledge of the content. The FOSS program provides hands-on investigations addressing a variety of science concepts. While the investigations provide interactions with science concepts, there is little continuation of this learning into literacy. Guidance about science writing is buried in the teacher's

guide. It consists of a short paragraph labeling the genres as descriptive, persuasive, narrative, and expository. In addition, a handful of sentence starters are suggested for students in grades K through eight.

Resource Guide Rationale, Goals and Development

Rationale

Based on my own experiences and my interactions with colleagues, I know that science can be undervalued in schools where high stakes testing in other content areas is required. Science can also be intimidating to teach. The amount of materials crammed into the Rubbermaid bins can overwhelming. Yet even when teachers are aware that both writing and science are important, they may not have the time to plan how to incorporate them together. Reading through the manual and setting up the investigations is already time consuming. It is for these reasons that I want to create this resource guide. I believe that teachers will be more likely to include academic writing in science with the assistance of these strategies, templates, and helpful suggestions. Ultimately, this guide could be used district-wide to improve the science literacy of students.

Goals

With the creation of this resource guide, I hope to accomplish the goal of providing classroom teachers with tools that guide them in developing and supporting the academic writing of our students in the science. In order to do this, I will attempt to accomplish the following goals:

- Present a quick introduction/review to teachers on what academic language is and its importance for all students.

- Familiarize teachers with the genre of procedural recounts, including its purpose, audience, text structure and language features.
- Introduce the Teaching and Learning Cycle and its phases of deconstruction, joint construction, and independent construction.
- Create a sample science unit with the academic writing piece included in the schedule along with appropriate language objectives.
- Furnish teachers with a selection of procedural recount models.
- Provide teachers with checklists and rubrics for useful self, peer, and teacher assessment of various writing tasks.

Development

Before the creation of my resource guide, I obtained permission from the Human Subjects Review Committee at Hamline University. As I did not involve any students during the development of this resource guide, I did not need parents to give their consent.

After approval by the committee, I began to develop my curriculum in March, 2016. In order construct this guide I employed several high quality resources. Those that I found myself returning to for clear explanations, solid examples, and interactive strategies include the following:

Building Academic Language: Essential Practices for Content Classrooms by Jeff Zwiers

Scaffolding Language, Scaffolding Learning: Teaching English Language Learners in the Mainstream Classroom by Paula Gibbons

Exploring How Texts Work by Beverly Derewianka

A New Grammar Companion for Teachers by Beverly Derewianka

Handbook of effective literacy instruction: Research-based practice K-8 edited by Barbara M. Taylor and Nell K. Duke

Strategy Guide Format

The title of my resource guide is "How to develop and support the academic writing of our students in the science classroom". There is quite a bit of information involved in this project. As a result, the resource guide is split up into various sections including:

A quick review of Academic English

Genre in writing: Procedural recounts

Procedural recount model texts

Teaching and Learning Cycle

Developing Lessons

Appropriate assessments of writing (checklist and rubric)

Sample Unit Outline

Resources for Teachers

The resource guide will be assembled in a tabbed binder so that teachers may make it their own, adding to it and rearranging according to their personal preferences.

Conclusion

In this chapter, I have chronicled how I will use my understanding of current research to answer the question: How to develop and support the academic writing of our students in the science classroom: A resource guide for classroom teachers in upper elementary. I want to furnish teachers with research-based tools to build the academic

writing skills of their students. I hope that more teachers will implement the Teaching and Learning Cycle as it can benefit both EL and native English speaking students improve their academic writing. In the end, my ambition is for my students to continue to love science and feel empowered in organizing, explaining, and analyzing their learning in science.

I have explained the setting in which this guide will be used, the rationale, goals, and development process of the guide. In addition, I have shared the format it will have and the method of reflection throughout its development. In Chapter Four, I will present my resource guide. Chapter Five will include discussions about the entire capstone process, including ideas for further research and curriculum development.

CHAPTER FOUR
The Resource Guide

In this chapter, I will present my academic writing resource guide, designed to facilitate the integration of academic writing and science content in the upper elementary grades. This guide is a companion text that may be used to supplement any hands-on science curriculum. It is based on what the research shows, as described in Chapter Two, the importance of writing skills, the unique challenges of academic writing for EL students, lack of confidence in the teaching of academic writing by classroom teachers, and limitations of the school day itself (Christie & Derewianka, 2008; Gibbons, 2015; Halliday & Martin, 1993; Jani & Mellinger, 2015; Klein & Kirkpatrick, 2010; Martin & Rose, 2005; Schleppegrell, 2012; Zumbrunn & Krause, 2012). The guide begins with an introduction that outlines the rationale for its creation. It then presents the genre of procedural recounts and how it fits with the Common Core State Standards. The guide also contains an in-depth look at the pedagogical approach to teaching academic writing known as the Teaching and Learning Cycle (Gibbons, 2015; de Oliveira & Lan, 2014). Suggestions for language objectives, lesson activities, and assessment are also included. My goal was to create a resource guide that is practical and useful for upper elementary classroom teachers to combine writing and science instruction.

How to develop and support the academic writing of our students in the science classroom

Teacher Resource Guide

Developed by Hannah Hermanson Rivard, 2016

Table of Contents

Dear Educator,

Teachers are under perpetual stress to fit an ever-increasing amount of content into an already stuffed school day. As an EL teacher, I have seen my colleagues struggle to carve out time for teaching content and skills beyond reading and math. Specifically, science and writing are often cut short or eliminated entirely. This resource guide seeks to address both of these areas of crucial learning.

This resource guide is for you, a knowledgeable educational professional. My hope is that it will guide you in the task of implementing authentic writing instruction during science class. In order to achieve this, the resource guide includes a quick refresher on academic language and a no-fuss introduction to the academic writing genre of procedural recounts. It also contains an explanation of and orientation to the Teaching and Learning Cycle. I have included sample lessons for each of the phases of writing instruction, as well as unit overviews for several fourth and fifth grade FOSS kit units.

The resource guide is meant to be versatile, as each classroom is unique. It was designed to be located in a 3-ring binder so that more can be added to it or some can be removed in an effort to streamline. Make of it what you will. I hope that it serves you well.

Hannah Rivard

Academic Language

The English found in a school textbook is not the same English heard on the playground. Though neither of these types of English is superior, the ability to use and understand the more formal type is necessary for students' academic progress and future workplace success.

Though both social and academic English are used to communicate ideas, the level of formality varies. Below is a chart briefly demonstrating the contrast between social and academic English.

Social English	Academic English
I like this one more.	This story had a better problem and solution than the first one we read.
I'm done.	I have completed the project.
Because she wanted to.	The character left the island because the living conditions were not improving.

Within the EL field, this more academic type of English is referred to as cognitive academic language proficiency, or CALP (Cummins, 1979). Based on research conducted by Thomas and Collier (1995), basic fluency in academic English can be achieved in an average of 5-7 years. It should be noted that there is a strong link between a student's proficiency in their first language and their previous schooling with acquiring proficiency in academic English. Students with limited prior formal education may take upwards of 7-12 years to become proficient in academic English.

Academic English is what students need to be successful in school and promoted in the workplace (Scarcella, 2003). That being the case, it is in the students' best interest

that educators provide examples of strong writing, model effective writing, explicitly teach, and encourage the use of academic English to meet the language needs of all of our students.

Genres and Common Core State Standards

According to Common Core State Standards, the writing that students develop should be 30% persuasive, 35% explanatory, and 35% writing to convey experience (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). Although there are numerous genres suitable for academic writing, this resource guide will address the explanatory genre that works especially well with science content: procedural recounts.

Purpose and Audience

The purpose of procedural recounts is to describe a series of sequenced steps that show how a task was carried out. Most notably, this is used in science class in the form of lab reports. The genre is similar to how-to texts in that it is descriptive, precise, and chronological. Procedural recounts are different than how-to texts as they are written after the experiment has been completed and use verbs in the past tense. Success in science, in grade school and beyond, is dependent upon the ability to read, follow, and write detailed lab reports.

Common Core State Standards

The following chart shows the writing requirements, as stated in the Common Core State Standards, and how procedural recounts can address these standards (National Governors Association Center for the Best Practices and Council of Chief State School

Officers, 2010). Overall, the teaching of procedural recounts in science class is a creative and authentic way to incorporate informative writing into the education of students.

How Procedural Recounts Address Common Core State Standards

Common Core State Standards	**Detailed Requirements**	**Procedural Recount (PR)**
ELA-Literacy 4.2	Write informative/explanatory texts to examine a topic and convey ideas and information clearly.	PR includes the materials needed for an experiment, the aim of the experiment, what the students did, what the students observed and their conclusion.
ELA-Literacy 4.4	Produce clear and coherent writing in which the development and organization are appropriate to task, purpose, and audience.	PR is an excellent genre for science class. It helps students organize their thinking about science investigations in order to share with other scientists.
ELA-Literacy 4.4 A	Introduce a topic clearly and group related information in paragraphs and sections; include formatting (e.g., headings), illustrations, and multimedia when useful to aiding comprehension.	PR has clearly defined and formatted sections including aim, steps taken, and results. Illustrations are often incorporated into this genre.
ELA-Literacy 4.4 B	Develop the topic with facts, definitions, concrete details, quotations, or other information and examples related to the topic.	The facts in PR come from readings, notes, labs, and observations.
ELA-Literacy 4.4 C	Link ideas within categories of information using words and phrases (e.g., *another*, *for example*, *also*, *because*).	Sequential transition words are integral in the writing of PR. They link the various steps while describing the timeline of events.
ELA-Literacy 4.4 D	Use precise language and domain-specific vocabulary to inform about or explain the topic.	The language used in science and procedural recounts is different than that used in language arts class. It is technical, contains objective knowledge, and is dominated by causal explanations.
ELA-Literacy 4.4 E	Provide a concluding statement or section related to the information or explanation presented.	The results of the lab are included in the PR. The student will need to reflect on the experiment, in order to describe what happened and give a reason for how or why.

Models of Procedural Recounts

Model 1.

<table>
<tr><td>Materials</td><td>Refrigerator, freezer, three slices of bread, 3 Ziploc bags, marker</td></tr>
<tr><td>Aim</td><td>To see if temperature affects the rate of mold growth on bread.</td></tr>
<tr><td>Record</td><td>First, we put one slice of bread in each Ziploc bag and closed them firmly. Next, we put one slice of bread in the freezer (A), one in the refrigerator (B), and one at room temperature (C). We drew detailed pictures to record how the bread looked on day 1, day 3, day 5, day 7, and day 9.
<table>
<tr><td>Bread</td><td>Day 1</td><td>Day 3</td><td>Day 5</td><td>Day 7</td><td>Day 9</td></tr>
<tr><td>A</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>B</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>C</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Conclusion</td><td>The higher the temperature, the faster the mold grows on bread.</td></tr>
</table>

Model 2.

<table>
<tr><td>Materials</td><td>2 plants similar in variety, size, appearance
1 room with no windows or dark curtains drawn
1 room with good sunlight
1 lamp</td></tr>
<tr><td>Aim</td><td>To find out if plants are healthier with a natural or artificial light.</td></tr>
</table>

Record	First, we labeled the plants. Then, we photographed them to record their appearance. We also recorded the measurement of the plants and described their appearance. After that, we moved one of the plants to the windowless room, with the lamp turned on. Next, we put the other plant in the room with good access to sunlight. We watered the plants the same amount, each Monday of the experiment. Every Tuesday we observed the plants and recorded their physical properties with a photograph and written description. After three weeks, we removed the plants from their rooms. Again, we photographed and recorded their description (including measurements). While both plants lived, the plant with natural sunlight grew.
Conclusion	Plants need light and seem to be healthier with natural light than with artificial light.

Model 3.

Materials	A plastic cup, a Styrofoam cup, and a paper cup of equal size 9 similar- sized ice cubes Timer Beaker/measuring cup Small colander
Aim	To determine which material is a better insulator
Record	First, we placed three ice cubes of the same size in the plastic cup and let it set at room temperature for 20 minutes. Then we placed the

	colander above the measuring cup and poured in the contents of the plastic cup. We recorded the amount of melted ice (water). We discarded the water and ice. Next, we repeated the experiment using the paper cup and then the Styrofoam cup. Each time, we accurately recorded the amount of melted ice. The more the ice melted, the less insulating the material of the cup was.
Conclusion	The ice in the Styrofoam cup melted the least and was therefore the most insulating of the materials tested.

Writing Instruction: Teaching and Learning Cycle

The Teaching and Learning Cycle is based on Systemic Functional Linguistics (SFL) and focuses on genre-specific writing. SFL is a tool that can help both teachers and students, especially ELs, analyze the language of a particular text in a particular genre from a point of view that allows them to understand what they read and write. The Teaching and Learning Cycle was developed by Rothery (1994), and was later expanded upon by Martin and Rose (2005) (as cited in de Oliveira & Lan, 2014).

The cycle itself depicts the interactions and guidance required for the successful teaching of genre-based writing and reading instruction. The main phases include deconstruction, joint construction, and independent construction (as cited in Gibbons, 2015).

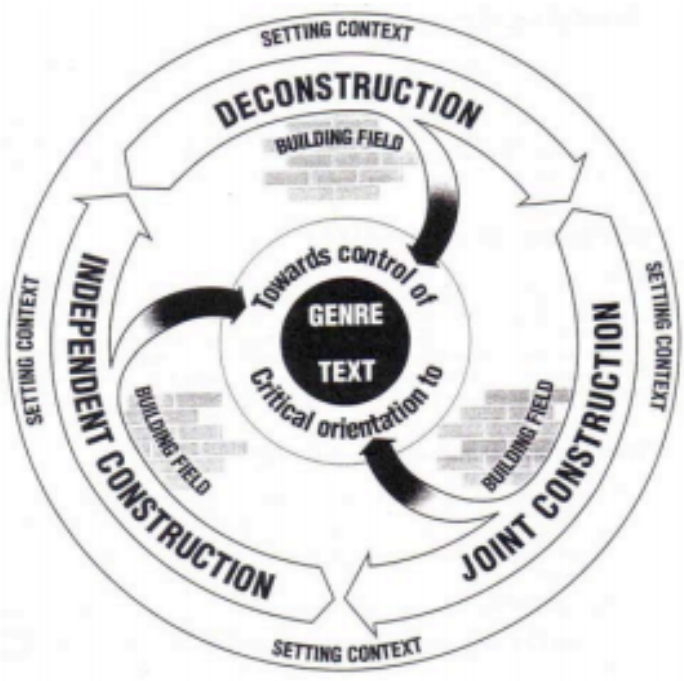

Fig. 1. Adapted Teaching and Learning Cycle (based on Martin & Rose, 2005, p. 252).

Two other components are shown on the figure above: building the field and setting the context, both of which are continuous throughout the entire cycle. Building the field consists of the science content being introduced and students interacting with it. This can include hands-on science experiments as well as: brainstorming, reading, word walls, interviews, field trips, discussions, taking notes, watching videos, creating a personal dictionary, and matching pictures and words. Setting the context involves forging a familiarity with the purpose and intended audience of the specific genre. This is done through repeated exposure and discussion about the text.

Deconstruction

This phase of the Teaching and Learning Cycle familiarizes students with the new genre that they will be writing. According to Gibbons (2009), this stage involves sharing models of the genre. Teachers guide students to deconstruct these texts through

demonstration, modeling, and having discussions about their appearance and purpose. Additionally, text structures and language features are identified and discussed by the students. It is at this point that the class is learning to use a common language to describe the structure and language features. In fact, language for talking about language, also known as meta-language, helps enable students to describe their own writing in future phases.

Joint Construction

This step of the Teaching and Learning Cycle involves the teacher(s) and students working together to construct a piece of writing of the specific genre. This can include frequent references back to what the class has learned so far about the content and the genre, and having the teacher demonstrate a think aloud about the text. This is also when students are encouraged to reread what is written so far and ask if it makes sense, rewording or reorganizing it if necessary. If there are grammatical or spelling errors that seem to continually reappear, that may be addressed at this time as well. The text that is created during this step is not identical to what the students will be producing independently. However, it should be similar, such as a different experiment for the genre of procedural recount.

At this phase the teacher is still actively providing support through modeling, asking questions, and thinking aloud. Students are invited to build onto other students' ideas and apply the linguistic features of the genre they have been studying as well as use the new vocabulary of the unit. Commonly, the teacher is writing based on input from the students. This needs to be done in a way that all students may watch the progress of the writing and copy the example in their notebooks for future reference.

Independent Writing

After the deconstruction and joint construction, another hands-on experiment is conducted to further build the field of content knowledge. During this phase students are invited to review the models and refer back to the jointly constructed list of genre specific text features in order to write their own piece in the specific genre. At this time, teachers are to take a step back, allowing for their students to demonstrate what they have learned. In some cases, it may work well to have students work in pairs to write this piece.

Language Objectives

In addition to content learning targets, language objectives help clarify the reading/writing skill that students are working to improve. These may address the Common Core Standards or represent a smaller step towards a larger goal. Depending upon your school, the phrasing will differ, but the idea is the same. The following section on lesson planning includes some examples of language objectives, based upon the Common Core Standards in writing. These can be used with each of the phases of the Teaching and Learning Cycle. Building the field standards would be those standards specific to the scientific content. Another objective for building the field could be, I can take accurate notes and recall information from experiences to use in content-specific writing. Additionally, a language objective that could be used for the entire unit on the genre of procedural recounts is: I can produce clear and coherent writing in which the development and organization are appropriate to task, purpose, and audience.

Developing Lesson Plans

Of course, the amount of time you spend on each phase is up to you. Ideally, more than one lesson would be devoted to each phase of the Teaching and Learning

Cycle. The information below is based on the impressive work of de Oliveira and Lan (2014), Fauntas and Pinnell (2012), and Gibbons (2015). The use of quick formative assessments to check for understanding and address confusion will help you decide when to move on. These will be discussed in more detail in the assessment section of the resource guide. Below each phase are some suggested language objectives and lesson plan ideas. It is a buffet. What are your students' needs?

Examples of deconstruction language objectives

- I can identify the different parts of a text of procedural recount genre.
- I can explain the purpose for using the genre of procedural recount.
- I can identify and describe the three parts of the procedural recount text.
- I can create and use a word bank of science vocabulary and sequence words.

Choose a text that is similar to what students will be asked to write. This may be one that is from this resource guide, written by you (the teacher), written by former students, or commercially sold. Ideally, this model text would be large enough for all students to view it together, perhaps as a PowerPoint, large sheet of paper, or through use of a document camera.

Deconstruction lesson ideas

- Show and read a model of the genre to students.
- Have students work in groups with a variety of writing levels to look for words that show the order of the steps or science specific vocabulary.
- Talk about its purpose. Why was it written? What was the author's intent?
- Depending upon the group, this would be a good opportunity to contrast this genre against one they are more familiar with, such as narratives.

- Ask about its shape or basic structure. What are the parts? What does each of the parts provide?
- Take a closer look at the vocabulary that is used in the genre model. What grammar structures are seen? (In procedural recounts, the use of past tense verbs may be noted. Attention to detail in the writing could also be of note. The use of illustrations can also be mentioned.)
- Students can underline or highlight words that show time sequence, science vocabulary, and/or transition words.
- Cloze Activity: Rewrite the model text, leaving holes for missing words (preferably that address new grammatical structures of the genre). Variations on cloze activities may also be incorporated.
- Students who are more advanced, or more familiar with the genre could be asked to conclude themselves what each of the parts and purposes are for this particular genre.
- Conclusion: When students seem to have a pretty solid understanding of the genre type, review the characteristics together and make a large chart of that information. A smaller version may also be made available to student for their individual use. This will be used as reference throughout the writing cycle.

Examples of joint construction language objectives

- I can clearly introduce a topic.
- I can use formatting and illustrations to aid comprehension.
- I can use transitional words and phrases from the word bank to link ideas.
- I can use sequential words from the word bank to help specify the order of events.

- I can use precise language and science-specific vocabulary from the word bank to explain the experiment.
- I can explain what happened and state what was learned during the experiment in the conclusion.

This stage is when the writing really begins. It is also where the bulk of the scaffolding is in this writing process. Now the teacher and students work together to put the information they have about the topic (science) into a text of the genre they are learning about (procedural recounts). This is an excellent opportunity to building teamwork. Encourage students to build upon the ideas of their classmates.

Joint construction lesson ideas

- Ask for student input. "What should we write?"
- Continually re-read what is written. Does it make sense? Is it accurate? Is there a better, more scientific word that can be used?
- Reference the model texts.
- Create various word banks (transitional words, sequential words, and technical science vocabulary specific to the investigation/unit)
- Address regularly occurring grammar and spelling issues.
- Have students refer back to their notes from experiments.
- Conclusion: When students and teacher are satisfied with the product, rewrite it (as a poster) and use it as yet another model text.

Throughout this phase, student input is essential. The teacher acts as more of a facilitator or editor, asking questions and getting students to continually think more about the writing. Both the process and the product of writing are addressed in this phase. The

teacher and students are frequently re-reading what has been written and deciding if it can be improved. The meta-language mentioned during the deconstruction phases can be used in the class discussions.

Examples of independent construction language objectives

- I can write an informative text using my notes, models, and word banks.
- I can use at least three transitional words to link my ideas.
- I can use at least three sequential words to help explain the order of events.
- I can use at least eight science-specific vocabulary words to explain the experiment.
- I can explain what happened and state what was learned during the experiment in the conclusion.
- I can work with a partner to write a procedural recount of an investigation.

Independent construction lesson ideas

- This is conducted after another experiment has been completed.
- Allow students to work individually or in pairs, using their notes and the word banks.
- Remind students of the steps of the writing process. It is not perfect the first time.
- Be sure to make and save copies of these texts for future models.

Adaptations for Beginner EL Students

Students of all English levels can benefit from participating in the Teaching and Learning Cycle. First of all, every student should be involved in the science investigations on which the writing is based. If possible, have the student work with another student or educational aid who speaks the same home language.

As for the writing, there are many components to consider. Is the student a newcomer? Have they had formal schooling in the past? Here are a few suggestions that pertain to the writing process. I would also advise that you contact your school's EL teacher for additional support.

- Provide the students with a glossary of materials used as an additional reference. It can contain the picture, technical name, and a brief description of the materials. If possible, include the material's name in the student's home language as well.
- Allow students to demonstrate their learning by placing the written or picture steps of the investigation into the correct order.
- Provide a streamlined word bank for both transition and sequence words.

Note about Grouping

There are infinite possibilities for grouping students. Specifically for the Teaching and Learning Cycle, I would suggest using groups with variety of levels in the deconstruction portion. If you choose to have the students complete the independent writing portion in pairs, I suggest grouping students of similar writing levels. One strategy that can help encourage all students to participate in the writing process involves colored pencils. When working in a group, have each student use a different designated colored pencil. When collecting formative assessment information, check that each student has written a contribution to the particular draft.

Assessment and Feedback

Some reasons teachers have given for being reluctant to incorporate writing in their classrooms is the amount of time that it takes to grade it and their own lack of confidence in grading writing (Pearce, 1983). The use of checklists can greatly reduce

the workload and empower students with clear details of what is expected of their work. Specific feedback, and not too much of it, is ideal. This allows the writer insight into how to improve their writing, without overwhelming them with information (Zumbrunn & Krause, 2012).

Pre-assessment

In addition to a pre-test on the science content, have students write about a science experiment before they have been explicitly introduced to the genre of procedural recounts. This may be a simple request for the students to write down what they had observed from their experiment. It can provide valuable insight into students' current writing skills. Typically, the writing will have more of the social English vocabulary and grammatical structures. Feel free to keep these for later review.

Formative Assessment

Formative assessments can be approached in several ways. One can focus on the class as a whole to get a clearer understanding of which parts of the writing are challenging and need more support. It could lead to another class discussion on what is included in a strong conclusion. A quick walk around the room, glancing at writings and asking students questions can prove highly insightful. Perhaps a written record is more applicable for you. The following chart is one example of how a checklist can be set up to assist with formative writing assessments. I would use it to either mark a spectrum under each category (Got it!, Working, Stuck). This allows a quick glance at the page to see where additional support may be needed. It also provides more detail on each student during the writing process.

Procedural Recount Check-in form

Student Name	List of Materials	Aim	Record of events	Conclusion	Grammar/Spelling

Checklists. Students can also assess their own writing, when adequately prepared. The use of a checklist is helpful for this purpose. A checklist can be created from the chart the class puts together during the deconstruction phase. These can be adapted to the type of genre being taught and the level of students' writing.

Checklists for self-reflection and peer assessment both make the expectations of the text more clearly to students. The checklists may be used during or after the independent writing phase is completed.

Student Checklist of Questions: Procedural Recounts		
Organization		
1. Does this text have a materials list, an aim, record of events, and conclusion?	Yes	No
2. Is each section clearly labeled?	Yes	No
3. Are the sections in the correct order?	Yes	No
Cohesion		
4. Are there at least three sequential words? Circle them.	Yes	No
5. Are there at least eight science vocabulary words from the word bank? Highlight them.	Yes	No
Spelling		
6. Do you see any words that might be misspelled? Underline them.	Yes	No

The previous checklist is one that can be adapted for your classroom of writers. It may be too much information for the first time using the academic language. Keep in mind that it can be broken down into a smaller portion, used to address a specific area, or adjusted to the academic language preferred by your class.

Rubrics. These offer another way for students to be reminded of the expectations of this writing task. Likewise, these may also be used for self-assessment, peer-assessment, and post assessment. This method of assessment may be chosen for its range of scores, as opposed to the yes or no of a checklist. Below are two examples of rubrics for procedural recounts. When the rubrics are used for self-assessment or peer-assessment, it might help to reinforce some of the language used to make the rubric more interactive. For example, the rubric below asks how many sequence words from the word bank were used. The reader then circles the sequential words, highlights science specific vocabulary, and underlines any possibly misspelled words. This can help to reinforce the vocabulary

Post Assessment

The rubric on the previous page is one that would be suitable for post assessment though a simplified version would also work. Too much feedback can lead to confusion of the part of the student (Zumbrunn & Krause, 2012). Resist the urge to correct every mistake. Instead, set a clear focus and stick with it for this particular assignment.

The focus should be determined by the language objectives. These rubrics only address the language objectives. Another assessment will be needed to assess the students' grasp on the science content itself.

Rubric for Procedural Recounts

Structure	Cohesion	Vocabulary	Grammar	Spelling
The paper has an aim, a detailed record of events (with labeled illustrations), and conclusion. They are in the proper order and are clearly labeled.	The paper uses sequential and connective words correctly and with variation.	Precise, technical vocabulary is used when appropriate.	There is agreement between nouns and verbs.	All of the words are correctly spelled.
The paper has an aim, a detailed record of events, and conclusion. They are labeled and in order.	The paper uses some sequential and connective words.	Some of the words used in the text are precise. Others could be more precise.	There is mostly agreement between nouns and verbs.	Most of the words are spelled correctly.
The paper has an aim, a record of events and/or a conclusion.	The paper does not use sequential and/or connective words.	The science vocabulary words are not used in this paper.	There is some agreement between nouns and verbs.	Some of the words are spelled correctly.

Simplified Rubric for Procedural Recounts

Structure	Cohesion	Vocabulary
The paper has an aim, a detailed record of events (with labeled illustrations), and conclusion. They are in the proper order and are clearly labeled.	The paper uses 3 different sequential from the word bank. (	At least 8 technical vocabulary words are used from the word bank.
The paper has an aim, a detailed record of events, and conclusion. They are labeled and in order.	The paper uses 1 or 2 different sequential words from the word bank.	Between 4 and 7 technical vocabulary words are used from the word bank.
The paper has an aim, a record of events and/or a conclusion.	The paper does not use sequential words from the word bank.	3 or fewer science vocabulary words are used.

Unit Design Overview

Combining academic writing and science content will help you to prepare your students for continued participation and success in the field of science. Figure 2 (below) demonstrates one basic outline of how the writing instruction can be spread out interspersed with science investigations and content. After the figure, there is the unit overview of a science unit currently taught at my school. It is from the fourth grade science curriculum. Please keep in mind that this writing instruction can be adapted to other genres and other content areas. Additionally, if can also be extended as the students grow in their writing skills. I encourage you to consult your EL teacher for additional support.

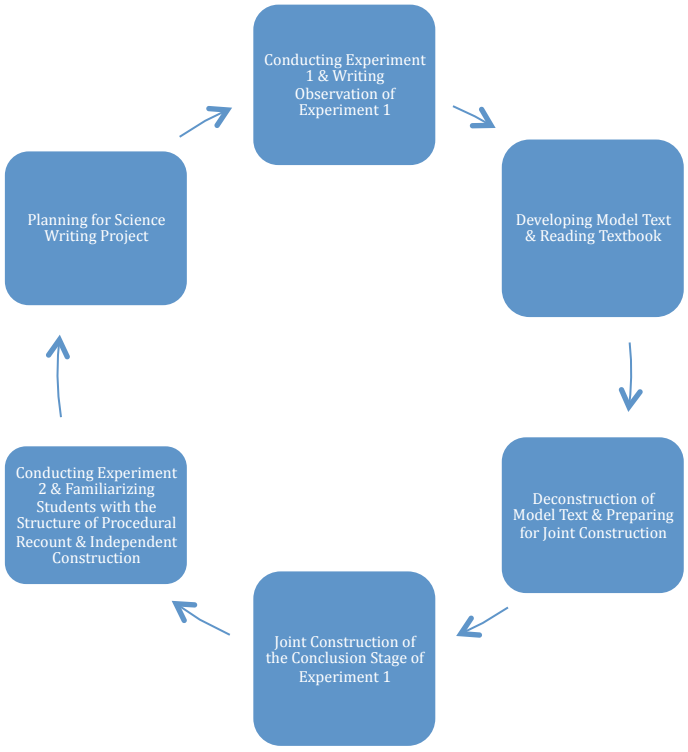

Figure 2. Modified Teaching and Learning Cycle for teaching science writing (de Oliviera & Lan, 2014 p. 29)

Sample Unit Outlines

This sample unit is not designed as a stand-alone unit. Instead, it should be used with an existing science unit. This example is to be used with the Energy and Electromagnetism Module of the FOSS kit. The purpose of this outline is to demonstrate how the Teaching and Learning Cycle can fit into an already existing science curriculum.

4th Grade: Energy and Electromagnetism Module

Week One

Day 1	Pre-test (survey), KWL chart: What do we think we know about electricity? Let students know that during this unit we will be writing about our science investigations. We will be using this genre (type of writing) that this example is to share our investigations with others.
Day 2	Conduct investigation 1 (I can build a simple light bulb circuit). Pre-Assessment: Have students take notes on the experiment and write an observation of the investigation. Formative Content Check (Which circuits would work?)
Day 3	Deconstruction: Show student a model of a procedural recount, written for science. (On a topic they studied the previous year) Ask students questions, open-ended when possible. What do you notice? What are the different parts? What kind of information is included? Why was this written, for what purpose? How can we create an outline of what is in the writing? Go over these items. Use the words aim, steps, and conclusion to discuss these pieces. Create a class list of parts. (This can be rewritten to create a rubric. Ex: Does it have an aim?)
Day 4	Build the field: Review parts of a circuit. Read: "Edison Sees the Light" p. 3-7
Day 5	Conduct investigation 2: Using a switch Joint Construction: Write a procedural recount of this investigation with class input. Invite them to revisit the outline of the genre. When completed on the board, have students copy it down, as a model of their own.

Week Two

Day 6	Investigation: Using a solar cell as an energy source In pairs, write a procedural recount. Use the models that the students have to help write.
Day 7	Model how to use assess. Create a checklist from the information identified in deconstruction phase. Use a student's example, without name, to assess and make improvements to prior writings Build the field: review parts, read "Electricity" p. 8-12
Day 8	Peer-assess the procedural recounts of classmates, using the rubric.
Day 9	Investigation: Identify materials that are conductors or insulators of electricity. Independent Construction: write procedural recount
Day 10	Build the Field: new vocabulary Reading: "Energy" p. 13-21

Week 3

Day 11	Investigation: Presence of Energy, part 1
Day 12	Writing: independent
Optional activities	Investigation 2.1 Building Series Circuits Investigation 2.2 Building Parallel Circuits Reading "Series and Parallel Circuits" p. 22-27 Investigation 2.3 Solving the String-of-lights problem Investigation 2.4 Solar Cells in Series and Parallel Reading "Alternative Sources of Electricity" p. 28-33

Sample Word Banks

The following word banks are examples of what the class can create together as they progress through the science unit. Only introduce the vocabulary words as it is relevant for the investigations. For easy reference, I suggest having a separate word bank for science vocabulary specific to the unit and sequential words. These will vary based on your curriculum and your students.

Vocabulary Specific to Energy and Electromagnetism

Unit Specific Science Vocabulary	General Science Vocabulary
Battery bulb circuit component d-cell electricity electric current energy source system wire motor solar cell conductor insulator switch force interact iron magnet magnetism permanent magnet steel attract poles repel induced magnetism magnetic fields temporary magnets compass rivet coil core electromagnet electromagnetism	explain identify properties claims record observation support generate evidence construct

Science Specific Sequential Words

First To start with The first step At first	**Next** Secondly After [specific length of time] Now Additionally
Then Afterwards After	**Last** Finally In conclusion To summarize

Additional Resources for Teachers

Transition words and phrases

Words or phrases to help sequence ideas or transition between sentences or paragraphs

- first... second... third...
- in the first place... also... lastly
- after
- afterwards
- as soon as
- at first
- at last
- before
- before long
- finally
- in the meantime
- later
- meanwhile
- next
- soon
- then

Words or phrases to show location

- above
- across
- around
- behind
- beside
- between
- in back of
- in front of
- inside
- near
- outside
- over
- under

Words or phrases to show time

- while
- meanwhile
- soon
- then
- after
- second
- today
- later
- next
- tomorrow
- afterward
- as soon as
- before
- now
- next week
- about
- when suddenly
- during
- until
- yesterday
- finally

Words or phrases to indicate more information

- besides
- furthermore
- in addition
- in fact

Words or phrases to help conclude a piece of writing

- in conclusion
- finally
- lastly
- to sum up

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Scaffolding Language, Scaffolding Learning: Teaching English Language Learners in the Mainstream Classroom by Paula Gibbons

Websites

Readingrockets.org

Conclusion

In Chapter Four, I presented a brief overview of the academic writing resource guide and the guide itself. The guide includes a compressed review of academic English, an introduction to the genre of procedural recounts and how it ties into Common Core State Standards. This is followed by an in-depth look at the phases of the Teaching and Learning Cycle. Additionally, sample language objectives are listed for each of the phases, as well as ideas for addressing these objectives. Next, the guide includes checklists that may be adapted to provide feedback and several models. Finally, there are two sample unit outlines and additional resources for teachers. In Chapter Five, the final chapter, I will return to my literature review and discuss how key findings were incorporated into the completed guide. I will then discuss possible uses of the guide as well as its potential limitations. Lastly, I will discuss future research plans to gauge the guide's effectiveness and will reflect on the process of writing the guide.

CHAPTER 5
Conclusion

When I began my project I attempted to answer the question, *how can we develop and support academic writing in the science classroom?* The resource guide that was produced to address this question is shown in the previous chapter. In this chapter, I will revisit the significant findings in the literature review and explain how they were incorporated into the resource guide. Next, I will share my plans for implementation of the guide. Then, possible limitations to the resource guide's effectiveness will be considered. The chapter will conclude with a plan for future research.

Incorporation of the Literature Review

The research that I reviewed in Chapter Two directed many of my choices on how to focus the resource guide. As a result, the resource guide achieves several goals as it is authentically tied to content, has appropriate scaffolds, and teaches a specific genre explicitly through the use of the Teaching and Learning Cycle.

First of all, research suggests that there is a marked connection between writing and learning. Hattie et al. (1996) and Weinstein and Mayer (1986) propose this occurs when the learning or meta-cognitive strategies, such as organizing, reflecting, and making sense of new information, are applied to other content areas. Students are able to practice and become more proficient with these strategies during writing, then transfer these skills to science, math, and social studies. The Teaching and Learning Cycle provides students with various opportunities to practice several writing and learning strategies including focusing and reflecting on the purpose for an investigation, accurately taking notes during

investigations, analyzing the data to form a clearly stated conclusion, and communicating the conclusion to other students. All of these skills and strategies are transferable to other content areas.

Nevertheless, these skills are not guaranteed with just any writing instruction. More precisely, the writing instruction appears to be most beneficial when it is purposeful, authentic, and frequent (Bangert-Drowns et al., 2004; Walley & Kommer, 2000). This can be addressed by pairing reading and writing themes, having students keep a journal of their understanding, or creating correspondence between students about a content topic (Brandenburg, 2002; Chen, et al., 2013; Esmaeili, 2002). The Teaching and Learning Cycle and its genre-based approach to writing instruction provides a solid connection between science investigations and writing. An audience and purpose for writing are clearly provided in the genre of procedural recount, making the writing more authentic as well.

Clearly, there is strong support for using writing to increase understanding and learning of content material (Knipper & Duggan, 2006; National Commission on Writing, 2003; Sedita, 2013). As stated previously, the skills of remembering, reflecting, and sharing are integral in both writing and academics in general. In fact, these skills are needed after school as well (Jain & Mellinger, 2015; Zumbrunn & Krause, 2012). The National Commission on Writing's 2004 report looks explicitly at the lack of basic and highly necessary writing skills of the current work force and the steps that companies and governments are taking to fill the deficit. Teaching the genre of procedural recount exposes students to a non-fiction genre, of which they often have limited exposure to in elementary (Duke & Bennett-Armistead, 2003; Klein & Kirkpatrick, 2010; Martin, 1989;

Wray & Lewis, 2000). Providing students with in-depth exposure to informational genres provides them with valuable skills, as they will be required to produce high quality academic texts and understand increasingly complex texts in the future (MacArthur et al., 2006).

In reality, writing in science is typically formal, highly structured, and dense with technical vocabulary and unique language features (Christie & Derewianka, 2008; Fang, 2005 & 2006, Fang & Schleppegrell, 2008; Keys, 1998; Zwiers, 2008). This can cause challenges for many students, though Wray and Lewis (2000) believe that this is primarily due to students' lack of experience with the scientific genres. Several researchers have concluded that non-fiction, scientific genres must be taught in schools if students with no resources for learning them on their own are to achieve academic success (Berkenkotter & Huckin, 1995; Halliday & Martin, 1993). In fact, research conducted by Purcell-Gates et al. (2007) found that explicitly teaching text structure (naming, describing, and explaining the function of genre and its features) can lead to an improvement in both reading comprehension and composition. The Teaching and Learning Cycle, which I chose to incorporate into the resource guide elegantly fits these requirements of explicit instruction of writing about science content.

Not only is there less time for teaching writing and science, as noted by Taylor and Duke (2013), but also some teachers do not feel confident teaching non-fiction writing or assume students have a more of a solid writing background than they actually do (Fradd & Lee, 1999). The resource guide addresses these issues by combining writing and science instruction, providing the important break down of the specific genre with examples, and using the Teaching and Learning Cycle, which allows students to begin

where they are. The genre of procedural recount was chosen based on the information provided by Christie and Derewianka (2008) describing it as "the prototypical experimental genre, learned in childhood and early adolescence, and remaining important throughout adolescence" (p.181).

In addition, the use of genre specific writing in science encourages students to actively transfer information, from their lab notes to the procedural recount. According to Tucknott and Yore (1999), the highest gains in student growth happened when the information was reorganized into another genre.

As for the assessment of writing, the resource guide uses both checklists and direct rubrics, so as not to overwhelm the teacher or the student (Pearce, 1983; as cited in Zumbrunn & Krause, 2012).

Ultimately, this resource guide was constructed on a foundation of decades of writing instruction research. As a result, my hope is that the resource guide will be effective in its goal to empower teachers to teach genre specific writing during science class and students to confidently write about science content.

Implementation

The resource guide is designed for mainstream teachers to be used in combination with a science curriculum. It can be used at any time during the school year. However, I would recommend it towards the beginning of the year. This will allow for the class to practice and improve their writing in this genre in other units as well. It would also be possible for other genres to be taught at a later date, using the teaching and learning cycle.

The units could have been laid out in greater detail. However, upon closer inspection the science curriculum in our district is due to be replaced in the next couple of years. I wanted the resource guide to serve a purpose beyond that time.

Without question, there are many improvements and additions that can be made to this resource guide. It could be more finely attuned to the grade level or to the content material. It could be expanded and used to develop the academic writing of students in other content area as well. My recommendations for future study would focus on identifying the suitable academic genres of the various content areas and building upon them over the course of a student's elementary and middle school career. I would highly recommend that professional development be made available in the district on the Teaching and Learning Cycle in addition to the resource guide.

A Broad Audience for the Guide

The resource guide is not limited to those working with EL students. In fact, Fradd and Lee (1999) found that it was common for teachers to mistakenly assume that their students have foundational skills in place, when in reality some were lacking those basic skills. Additionally, Schleppegrell (2012) notes that explicit writing instruction is beneficial to both EL and non-EL students alike. The guide is addressed to teachers with diverse classrooms. I have also included several adaptations that can be made to this resource explicitly for use with beginner EL students.

Limitations to Resource Guide Effectiveness

There are several potential limitations to the resource guide's effectiveness. The Teaching and Learning Cycle can be employed with a variety of age groups, content areas, and genres. However, the scope of this resource guide is restricted to upper

elementary classrooms, science, and procedural recounts. The resource guide is simply a starting point. There are so many other places that academic writing instruction could take place.

Another possible limitation is that of time and flexibility. As mentioned in the introduction, in numerous schools, science is being short-shifted in favor of contents on high stakes tests. As a result, the time available for teaching science has shrunk or disappeared. This resource guide seeks to combine literacy and science learning. Teachers should review both their science and literacy outlines to choose which unit(s)/month(s) would be the best fit for the academic writing in science.

Future Research Plans

I plan to implement my academic writing resource guide this coming year in order to gauge its effectiveness. While academic research is severely restricted in my school district, I hope to collect data typical for measuring student growth. This will include completing a science experiment as a class and then writing a procedural recount text, before learning what that entails as a pre-assessment. Then, I will collect student writing samples during both the joint and independent construction phases. Lastly, I will keep a final copy of their procedural recount text for their writing portfolio and have the students compare their first and current attempts at writing in this genre. Sizeable student growth at the end of the data cycle could lead to greater interest from classroom teachers and school administrators.

Presenting the Resource Guide to Others

I will be presenting this resource guide to my team members, three fourth and three fifth grade classroom teachers in the fall of 2016. My plan is to co-teach at least one

science unit in each class, using the teaching and learning cycle for academic writing. Based on the feedback and student data, I would like to expand the writing instruction to science in third and sixth grades in the future.

Conclusion

It is an understatement that this project was a learning experience. It challenged me to consider how I can positively impact on the writing skills of all of my students, both EL and native English speakers, even when I am not in the classroom. I cannot do it all. This feeling of insufficiency of meeting all of the needs of my students led me to ask the question: *How can we develop and support the academic writing of our students in the science classroom?* My literature review helped inform me of the extensive discussion that has taken place in the area of writing in content areas, effective writing instruction, and research specifically on the writing needs of EL students. This research led me to create this resource guide that is grounded in what current literature establishes as best practice in explicit genre-specific academic writing instruction. I hope that this guide will be effective and efficient in helping teachers teach academic writing skills during science class. I have the incorporation of the literature review in the resource guide, ideas for implementation, limitations of the resource guide, and future plans for study. Ultimately, I can say that I feel more prepared to teach and to assist my colleagues in meeting the academic writing needs of our EL and native English speaking students. As a result, the students will continue to love science and feel confident in their ability to write about it.

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