# WRITING INSTRUCTION IN SECONDARY CHEMISTRY CLASSROOMS

A Dissertation Presented to the
Faculty of the College of Education
University of Houston

In Partial Fulfillment
of the Requirements of the Degree

Doctor of Philosophy

by

Kayla Logan

May 2017

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## Abstract

Low ELA scores on state-mandated tests prompted efforts to incorporate writing into non-ELA classrooms through campus-wide writing initiatives. These efforts changed teachers' daily praxes and necessitated research about how teachers collaborate to improve student writing. Three research questions were posed: 1) How do chemistry teachers offer instruction in writing? 2) How do chemistry teachers value writing as an instructional tool? And, 3) How do chemistry teachers assess writing via a rubric?

The qualitative case study examined the behaviors and attitudes of three chemistry teachers as they enacted writing instruction for tenth grade chemistry students as part of a writing initiative at a high-needs high school. The researcher, an ELA teacher, collaborated with chemistry teachers for one year, collecting and analyzing data in the forms of meeting transcriptions, interviews, observations, a researcher journal, and artifacts such as writing prompts and drafts of an assessment rubric.

The study revealed that chemistry teachers shared concern for students' writing ability, but they rarely engaged in writing instruction. The collaborative development of writing prompts encouraged teachers to target chemistry learning objectives while the development of a rubric helped teachers to clarify their expectations for student writing and to identify opportunities for writing instruction. Chemistry teachers perceived that the type of writing mandated by campus administration was incompatible with their instructional goals and that more time was needed to incorporate writing into their curriculum, especially into non-advanced courses. The study contributed to a body of research regarding implementation of disciplinary writing strategies by offering an insider's view of a collaborative writing intervention at a high-needs high school.

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# Chapter I

## Introduction

This research explored how chemistry teachers incorporated writing into their classroom instruction during a campus-wide literacy initiative. The inquiry focused on the intersection of chemistry teachers' content area knowledge and their practical pedagogical knowledge about writing. The researcher provided insight about resources, support, and training that non-ELA teachers need to incorporate writing in ways that are more meaningful for gaining content area knowledge and practicing content area skills.

The days of teachers working in isolation are waning, not only because technological advancements and higher state standards have placed an emphasis on collaboration, but also because studies indicate that both teachers and students benefit when teachers collaborate to improve learning outcomes. Such collaborative teacher work, however, has not been researched thoroughly in relation to incorporating writing into non-ELA classrooms in high-needs environments. Such research is important as more educational decision-makers choose to designate time for teachers to work in professional learning communities (PLCs). How can these PLCs be used to facilitate the literacy learning, and thus the overall academic performance, of students who are at-risk and display learning gaps that impact their abilities to reason and write effectively?

### Need for the Study

Scholars have long noted the great potential for student learning through pedagogical practices that integrate writing skills development with content area knowledge acquisition; yet, decades of professional development have failed to help a majority of teachers to consistently integrate writing into non-ELA classrooms. This

study provided insight into how and why teachers choose to instruct writing in non-ELA content areas.

Because this study delved into the ways teachers implement instructional strategies for engendering thinking and writing skills among tenth grade chemistry students, it added to a body of knowledge about disciplinary literacy instruction in secondary education. The bottom-up, collaborative professional development yielded further insight into both the strengths and drawbacks of such an approach. This study supplemented previous research about teachers' implementation of literacy instruction and, particularly, their responses to campus-wide writing interventions with students who are labeled 'At-Risk' due to economic disadvantage, limited English proficiency, historically low assessment scores, and/or a variety of other factors. The study contributed to a body of scholarship about how school culture, administrative expectations, teacher collaboration, and teacher attitudes impact writing instruction. Specifically, the study yielded important insights into the role of literacy instruction in scientific disciplines and in science, technology, engineering, and mathematics (STEM) educational programs.

**Statement of the Problem**

If American educators are to meet the national demands of increasing both the equity of access and the level of science and technology knowledge and skills, they must address what Steve Graham and Dolores Perin call a "writing proficiency crisis" in American schools (2007b). The National Association of Educational Progress reported that a little over a fourth of students attain a rating of 'proficient' or higher on writing assessments; the majority of students in America write at 'basic' or 'below basic' levels

(National Center for Educational Statistics, 2012). Although state assessment and accountability standards are rising, many colleges and businesses are burdened with providing writing remediation for high school graduates who are not proficient in the types of written communication required for employment (National Commission on Writing, 2004). Unfortunately, these same literacy problems contribute to the gap between low-achievers and high-achievers and to the gap between rich and poor in America. Other contributing factors to poor writing performance in high needs schools may include teachers' orientations toward writing; a recent study found that teachers in low-income schools focus on basic skills of grammar and mechanics rather than giving their students authentic, meaningful writing opportunities like those given by their teacher counterparts at more affluent schools (McCarthey & Mkhize, 2013). Though many school districts have established STEM programs to address the growing need for skilled labor, some educators worry that these programs either downplay the important role of written literacy, or that they fail to fully integrate it into their core coursework.

Absent or inadequate writing instruction across the content curriculum could be a major reason that students are not reaching their academic potential. Especially non-ELA teachers are not prepared to combat the "crisis" in student writing proficiency for many reasons. First, non-ELA content area teachers rarely have the background and training to teach specific literacy skills. Second, non-ELA content area teachers are also responsible for students' mastery of a content knowledge and skills. Third, many non-ELA teachers do not see the relevance of literacy instruction in their curriculum. And fourth, many non-ELA teachers and administrators have negative feelings about writing initiatives and writing in general. These contributing factors among non-ELA teachers need to be

addressed directly through professional development that is sensitive to the perceived needs of non-ELA teachers. Such professional development should be delivered in teachers' content area classrooms and on their home campuses rather than in isolated, top-down professional development environments.

Witnessing the power of learning through writing is important, and the lack of these experiences may be a main reason why top-down professional development in writing instruction has not been effective for increasing the amount or the quality of writing instruction that actually happens in secondary classrooms. Though districts spend money on professional development, very few of the instructional practices promoted in these sessions make their way into teachers' routine classroom behaviors. Negative or apathetic attitudes about such professional trainings probably contribute to their ineffectiveness. In addition to negative attitudes of teachers about writing and writing professional development, students can also have negative attitudes about writing. Furthermore, students are more resistant to writing in non-ELA classrooms for they too have come to view writing as a skill relegated to a traditional ELA classroom. Students' distaste for writing in non-ELA content areas can detract from non-ELA teachers' willingness to incorporate writing instruction and writing activities into their classroom routines. Lack of instructional leadership and an emphasis on standardized tests and state accountability have been posited as reasons for the failure of writing initiatives.

This study sought solutions to these serious problems by investigating teachers' inclinations and methods for infusing writing into their chemistry classrooms as they collaborated in a bottom-up writing intervention. The intervention process included preliminary assessment of student needs, planning and implementation of targeted

writing instruction, and the development of a rubric assessing writing. Based on the findings of previous scholarship that writing instruction in secondary science classes can close achievement gaps between low- and high- achievers, and that collaboration among teachers can positively impact student outcomes, this campus case study provided a close-up snapshot of a writing initiative from the view point of three teachers of tenth-grade chemistry.

## Research Questions

This qualitative study examined three questions:

1. How do chemistry teachers offer instruction in writing?
2. How do chemistry teachers value writing as an instructional tool?
3. How do chemistry teachers assess writing via a rubric?

## Terms and Definitions

This alphabetical list of definitions includes terms used in this study. Definitions are consistent with research and theory and provided here to clarify for the audience the manner in which each is used throughout the study.

**Community of Inquiry.** COI refers to any group of individuals who work together to solve problems through collection and analysis of empirical and conceptual evidence.

**Content Area Literacy.** Sometimes abbreviated CAL, this term refers to the use of generic reading and writing strategies within both ELA and non-ELA classrooms.

**Content-Based Assessments.** CBAs are multiple choice or written tests produced by district content-area experts, or that feature portions of released State of Texas Assessments of Academic Readiness - End of Course (STAAR-EOC) exams, or that are

purchased and compiled from third parties and used to assess the specific academic progress of students within a specific course.

**Disciplinary Literacy.** Sometimes abbreviated DL, this term refers to the use of discipline-specific reading, writing, and thinking strategies, especially within English, social studies, mathematics, and science classrooms.

**Inquiry-Based Instruction.** Inquiry-based instruction refers to the systematic teaching of skills, strategies, techniques, expectations and outcomes of formulating, asking, answering, and assessing the quality of questions.

**Literacy Instruction.** Literacy instruction refers to the systematic teaching of skills, strategies, techniques, expectations and outcomes as they pertain to reading, writing, and thinking.

**Professional Learning Community.** PLC refers to a philosophical approach to teaching in which teachers engage in collaborative, ongoing inquiry and research to examine student needs and plan instruction.

**Short Answer Response**. The SAR is a written reading assessment in which students respond to an open-ended question and provide textual references to support their answers. These responses must not exceed nine lines. Short Answer Responses were removed from the STAAR-EOC in January 2017.

**STAAR-EOC**. This acronym stands for State of Texas Assessments of Academic Readiness – End of Course. Five assessments (Biology, Algebra, English I, English II, U.S. History) created by the Texas Educational Agency are used to evaluate both student and school academic performance.

**WICOR.** WICOR is an acronym for the learning model promoted by AVID (Advancement Via Individual Determination) which stands for writing, inquiry, collaboration, organization, and reading to learn.

**Writing Across the Content Areas.** WACA refers to an instructional approach that involves incorporating writing strategies in a range of classrooms; usually *content areas* applies to math, ELA, social studies, and science, but in a broader sense, it may refer to any other courses traditionally offered on secondary campuses such as business management, technology, fine arts, athletics, health, *etcetera.*

**Writing Instruction.** This term refers to the systematic teaching of skills, strategies, techniques, styles, expectations and outcomes as they pertain to composing or producing words, phrases, sentences, paragraphs, essays either with pencil/pen on paper or with a keyboard on a screen.

**Writing in the Disciplines.** WID refers to a strand of the WACA movement in which teachers engage students in literacy practice that engender disciplinary learning and products.

**Writing-to-Learn.** WTL refers to a strand of the WACA movement in which teachers engage students in writing activities that enable them to learn content.

# Chapter II

## Review of Literature

A central inquiry of this study was to determine if chemistry teachers perceived writing collaborations, created with the goal of fostering students' transfer and development of writing and thinking skills across chemistry and ELA, as beneficial to student learning. Additionally, the study probed chemistry teachers' perceptions about classroom writing and writing instruction. About 40 years of literacy scholarship informed both the intervention and research design of this study; however, little research exists on teachers' perceptions of campus-based disciplinary approaches and their effects on student writing. This review of literature addresses four main areas of scholarship: 1) writing and writing instruction; 2) perceptions of writing and professional development; 3) writing in science; and 4) interdisciplinary teacher collaboration. Subsumed within these four sections is discussion of the "crisis of writing proficiency" (Graham & Perin, 2007b), historical background on literacy and writing expectations in non-ELA classrooms, and overviews of recent studies (Tables 1-4) pertinent to promoting our national educational goals for improving both equity and STEM education.

### Writing and Writing Instruction

In her foundational article, "Writing as a Mode of Learning" (1977), Janet Emig posited that writing is, by its very nature, an act of critical and metacognitive thought, and thereby brought writing and writing instruction to the forefront of literacy research. Writing-to-learn became closely associated with the concept of Writing Across the Content Areas (WACA) in the late 1980s and gave rise to subsequent content area literacy and disciplinary literacy movements. Scholars (Stock, Schillinger, & Stock,

2014) note that Writing to Learn (WTL) and Writing in the Disciplines (WID) are two common strands of the WACA movement. Research has indicated that using writing-to-learn strategies in classrooms can increase secondary student achievement (Bangert-Drowns, Hurley & Wilkinson, 2004; Graham & Perin, 2007a, 2007b).

Bangert-Drowns, Hurley, and Wilkinson (2004) examined studies of the effectiveness of 48 writing-to-learn interventions implemented from about 1985 through 1995 and found that the interventions had "a small, positive impact on conventional measures of academic achievement" (p. 29). This meta-analysis suggested that writing-to-learn strategies are most successful for the acquisition of content area knowledge when they elicit the metacognitive processes that promote self-regulation, or a student's ability to consider multiple strategies for learning and apply them appropriately. Bangert-Drowns et al., (2004) recommended that writing in the content area classroom should be brief and exploratory. If implemented properly for a significant amount of time, writing-to-learn strategies increased student achievement by helping students to clarify their own understandings through written expression.

Two other studies (Klein & Rose, 2010; Miller, McTigue & Scott, 2015) have been particularly helpful for providing insight about quality secondary writing research design. Miller, et al. (2010) posits that good content-area writing studies include teacher-related data and case studies in addition to differentiated grouping in order to gauge the effectiveness of writing interventions for high-, mid-, or low-performing students. Klein & Rose (2010) examine the cognitive processes that accompany writing-to-learn classroom techniques, proposing that "students who are taught argument writing will be better able to use it to learn about content area concepts" (p. 435). Furthermore, Klein &

Rose (2010) used a design experiment framework which allowed them to develop theory and improve classroom instruction concurrently. These two studies, in addition to the meta-analyses of Bangert-Drowns, et al. (2004) and Graham & Perin (2007a, 2007b), are useful studies for designing both the intervention and the research design of the proposed study.

In 2007, Graham & Perin published meta-analyses that outlined the effectiveness of specific instructional writing techniques on student performance. At the forefront of this inquiry for effective writing instruction techniques were: strategy instruction, summarization, peer assistance, setting product goals, inquiry, process writing, study of models, and grammar instruction (Graham & Perin, 2007a). The authors adapted this list to include word processing, sentence combining, prewriting, and writing for content learning in *Writing Next*, their Report to Carnegie Corporation of New York (2007b). As previously mentioned, the authors declared American students to be 'in crisis' and issued a challenge to policymakers, educators, and researchers to "[help] young people to write clearly, logically, and coherently about ideas, knowledge, and views [to] expand their access to higher education, give them an edge for advancement in the workforce, and increase the likelihood they will actively participate as citizens of a literate society" (p. 28). But in order to address the 'crisis' of writing proficiency, it is important to constructively consider the non-instructional factors that threaten to perpetuate it.

Table 1 – *Key Studies about Writing and Writing Instruction*

| **Writing and Writing Instruction** | | | | |
|---|---|---|---|---|
| **Article** | **Design** | **Data collection** | **Data analysis** | **Summary of Findings** |
| Bangert-Drowns, Hurley & Wilkinson (2004) | • Meta-analysis of secondary writing-to- | • 46 studies of secondary classrooms that compared | • Coding of studies | • Writing-to-learn strategies have small effects on content learning |

| | | | | |
|---|---|---|---|---|
| "The Effects of school-based writing-to-learn interventions on Writing Achievement: A meta-analysis" | learn intervention studies | writing-to-learn with conventional instruction<br>• Educational abstracts<br>• Published dissertations<br>• Psychological abstracts<br>• Educational journals | • Calculation of effect sizes<br>• Statistical Analysis of effect sizes | • 36 of 48 studies reveals positive achievement effect (75%)<br>• Recommends metacognitive writing, shorter writings, longer interventions<br>• Possibility of feedback (rather than assessment) as a factor of effectiveness |
| Graham & Perin (2007) "A meta-analysis of writing instruction for adolescent students" | • Meta-analysis of writing intervention studies in grades 4-12 | • 123 documents with 154 effect sizes for writing quality<br>• Location and selection of studies<br>• Categorization into treatment conditions<br>• Coding of study features<br>• Calculation of effect sizes<br>• Statistical analysis of effect sizes | • T-tests, one-way ANOVA<br>• Calculation of average effect size for 11 interventions<br>• Test of homogeneity | • Many instructional procedures improve the quality of writing of adolescents<br>○ Strategy instruction (0.82)<br>○ Summarization (0.82)<br>○ Peer assistance (0.75)<br>○ Setting product goals (0.70)<br>○ Inquiry (0.32)<br>○ Process writing (0.32)<br>○ Study of models (0.25)<br>○ Grammar instruction (-0.32) |
| Klein & Rose (2010) "Teaching argument and explanation to prepare junior students for writing to learn" | • Design experiment with "theo-retically motivated design ele-ments" (436)<br>• Quantitative | • Student writing samples (formative data) "Pre-test" and "Post-Test"<br>• Student writing was assessed and numerically stated | • MANOVA | • Experimental class showed greater ability to learn during writing and more genre knowledge, etc.<br>• Highlights 3 phases of instructional intervention |
| Miller, McTigue & Scott (2015) "The quality of recent studies in content-area writing in secondary classrooms' | • Meta-analysis<br>• Mixed method<br>• Systematic literature review | • Qualitative<br>○ study of implementation<br>• Quantitative<br>• Student performance<br>• Screened 2871 articles for themes<br>• 37 final studies<br>• studies from 2000 – 2013 | • filtered by search terms<br>• excluded PD articles<br>• applied 7 methodological quality indicators (MQIs) to score each study<br>• gauged inter-rater reliability | • charts, graphs, protocols<br>• 3 trends identified<br>○ inclusion of teacher-related data to augment student-based information<br>○ differentiated groups and results based upon levels of students |

**Perceptions of Writing, Professional Development, and Literacy**

Negative attitudes about writing instruction and writing professional development seem to have been brought to the forefront by content area literacy, an approach that gained popularity in the late 1980's (O'Brien, Stewart, & Moje, 1995). Possibly stemming from the moderate success of writing-to-learn strategies, content area literacy originally promoted the integration of content reading strategies with a writing across the curriculum approach. Though some content area literacy instructional strategies, such as KWL charts, response journals, anticipation guides, and graphic organizers, incorporated some writing, these strategies did not directly address the specific writing tasks and habits of mind necessary for success in secondary academic environments. By the mid 1990's, content area literacy seemed to have lost much of the writing-to-learn emphasis (Pytash, 2012). Content area literacy, "a holistic philosophy of integrating the teaching and use of literacy processes in all secondary content classes" became associated with the phrase, 'every teacher a teacher of reading.' (O'Brien, Stewart, & Moje, 1995, p. 442) Many non-ELA content area teachers felt that the increased time spent on literacy instruction took time away from teaching the content (Gillis, 2014).

Attitudinal research related to writing revealed that some teachers have an aversion to writing from both personal and instructional perspectives. Math teachers have been documented to be the least likely to engage in writing activities, followed by science teachers (Wilcox & Jeffery, 2014). Though some teachers report valuing writing in general, many are turned off to writing in the classroom because they perceive it as time-consuming; because they perceive student writing products as of poor quality; or, because they perceive that their disciplines do not require the types of writing that are often

mandated as part of district-wide writing initiatives. Both ELA and non-ELA teachers reported that students either fail to apply their writing skills, or fail to transfer those skills from their ELA classrooms into their other courses. Probing for deeper understandings of teachers' attitudes toward writing initiatives and professional development, Cantrell, Burns, and Callaway (2008) found that most teachers did, in fact, consider themselves literacy teachers, but that their feelings of inefficacy or their limited conceptions of proficiency produced barriers to their implementation of literacy strategies in their classrooms. At least two studies (McGhee & Lew, 2007; Zane & Tucci, 2016) cited a focus on exam preparation as a deterrent to the use of authentic literacy practices in secondary schools.

**Writing in Non-ELA Classrooms.** Research indicates that teachers in non-ELA classrooms are not engaging their students meaningful writing activities that support success (Wilcox & Jeffery, 2014). A nation-wide study of content-area writing requirements in high performing schools revealed that most assignments require students to write a paragraph or less. Of those assignments, only about half are source-based tasks; that is, with the exception of some writing requirements in ELA and social studies classrooms, students are not usually expected to write about discipline-specific content (Wilcox & Jeffery, 2014). In addition to this lack of student writing, less writing on average is being expected of struggling writers and writers for whom English is a second language. The lack of classroom writing is a particular concern as it is needed for students to meet high levels of accountability set forth by state assessments such as the Common Core State Standards (CCSS) and the STAAR-EOC. Wilcox and Jeffery (2014) state that the students who need it most are producing "little of the kinds of writing that

would prepare them to successfully tackle the challenges of CCSS-aligned writing tasks and high-stakes exams" (p. 174).

**Writing Instruction in Non-ELA Classrooms.** Most content area teachers readily acknowledged that their goal should be to both help students understand texts *and* to write successfully; however, when surveyed about how they saw their roles as literacy teachers, non-ELA teachers listed reading comprehension and content specific vocabulary, not writing, as their main responsibilities for literacy instruction (Cantrell, Burns, & Calloway, 2008). Though the reading-writing connection has been well documented (Anderson & Briggs, 2011; Emig, 1977; Graham & Perin, 2007a, 2007b; Harste, Short, & Burke, 1988; Lee & Schallert, 2016), non-ELA teachers often sideline writing, treating it as a supplementary skill primarily used (if used at all) for assessment.

**Teacher Education in Writing.** Literacy coursework for aspiring educators is usually limited to one course about literacy learning. These courses are generally not discipline specific, which means that teacher candidates in most courses of study receive neither adequate time nor the professional guidance to consider: a) the specific 'habits of mind' prevalent in their disciplines, and b) the literacy practices that will best facilitate student learning and application (Fang, 2014). Furthermore, based on the limited amount of classroom writing that is occurring on average in U.S. secondary schools (Wilcox & Jeffery, 2014), it is not likely that new teachers will observe robust writing lessons upon which they can model their own practices. Campus-based teacher collaborative meetings in which writing is used as a tool for student learning and formative assessment could facilitate teacher education about writing in content area classrooms.

**Attitudes about Writing Initiatives.** Teachers do not always enjoy participating in literacy reform initiatives. In interviews about writing initiatives, teachers use words like "overwhelming," "negative," and "frustrating" to describe some of their reactions to literacy reform (Nielsen, Barry, & Staab, 2008). However, school-wide, ongoing interventions that "are responsive to teachers' perceived needs hold promise for increasing literacy instruction" (Reed, 2009, p. 1). When asked, teachers reported needing professional development opportunities that were: a) embedded in their school and classroom contexts, b) based on specific learning goals that offer deep learning opportunities, and c) supported through access to the time and resources for implementing the intervention (Nielsen, et al., 2008). In addition to these facilitating factors for effective writing initiatives and professional development, teachers commented on the importance of strong instructional leadership and a high level of knowledge and belief in the value of writing on the part of campus principals (McGhee & Lew, 2007). Regardless of recent findings on elements of effective professional development (The New Teacher Project, 2015) and successful writing initiatives (McGhee & Lew, 2007), these efforts are frequently approached in a top-down manner, leaving teachers feeling overwhelmed, frustrated, and disrespected (Nielsen, et al., 2008).

**Content Area Literacy and Disciplinary Literacy.** In the mid-1990s, literacy researchers stated that content area literacy generally had not yielded strong results for achieving and sustaining school-wide reform (O'Brien, Stewart, & Moje, 1995), and in her 2001 report to the Office of Educational Research and Improvement, Julie Meltzer asked, "How can we bring effective content-based literacy instruction to life in the classroom in ways that will make a positive difference for students?" (p. 40). Scholars

and practitioners began to adapt content area literacy to better meet the needs of content area teachers in an approach called disciplinary literacy.

Like content area literacy, disciplinary literacy addressed the reading, writing, and thinking skills of students; however, unlike content area literacy, it did so through examination of the specific learning processes—the 'insider knowledge' and the 'habits of mind' associated with specific disciplines—and the crafting of literacy activities to address those particular cognitive processes, rather than through generic strategies applied across the curriculum (Draper, 2010; Goldman, 2012; Langer, 2011; McConachie & Petrosky, 2010; Moje, 2008; Shanahan & Shanahan, 2008). The corresponding writing movement is often referred to as Writing in the Disciplines (WID). Because disciplinary writing foregrounds the disciplines rather than subordinating them to the development of writing skills, the approach has been more palatable to non-ELA educators while it has fostered better relationships between science and literacy educators.

Neither content area literacy nor disciplinary literacy approaches have attained the same degree of documented success in meta-analyses as writing-to-learn strategies (Bangert-Drowns et al., 2004; Graham & Perin, 2007a, 2007b). Even so, scholarship on content area literacy and disciplinary literacy has been extensive and often contentious, seeming to have pitted these two approaches as rivals for application in non-ELA classrooms, professional development endeavors, and campus-wide initiatives. While some scholars have claimed that the approaches are fundamentally different and have asserted both the ineffectiveness of content area literacy and the superiority of disciplinary literacy (Shanahan & Shanahan, 2008, 2014), other scholars have claimed that a "false dichotomy" exists between content area literacy and disciplinary literacy

(Brozo, Moorman, Meyer & Stewart, 2013). Still others have maintained that struggling learners benefit more from content area literacy than from disciplinary literacy approaches (Faggella-Luby, Graner, Deschler, & Drew, 2012). A recent strand of scholarship claimed that a combination of both content area literacy and disciplinary literacy is necessary in order to provide the accelerated learning needed by low-performing secondary students (Fang & Coatoam, 2013; Brozo, et al., 2013). Likewise, scholars have called for *disciplinary CAL instruction*, a sort of hybrid method that foregrounds only those content area literacy instructional strategies that facilitate students' participation in the acts and meaning-making of the discipline (Siebert, et al., 2016). What all of these scholars have shared, however, is a conviction that writing does, indeed, have a crucial role in student learning, even beyond the ELA classroom, and especially in the scientific disciplines.

Table 2 - *Key Studies about Writing and Professional Development*

| **Perceptions of Writing and Professional Development** | | | | |
|---|---|---|---|---|
| **Article** | **Design** | **Data collection** | **Data analysis** | **Summary of Findings** |
| Cantrell, Burns & Callaway (2008) "Middle-and high-school content area teachers' perceptions about literacy teaching and learning" | • Intervention study using Content Literacy Project (CLP) | • Observations of 78 core content teachers for implementation level<br>• Interviews of 28 teachers (9 high, 10 moderate, 9 low implementation) | • Coding<br>• Independent coding<br>• Established two-level code list<br>• Calibrating and recoding<br>• Created effects matrices identified | • Mixed perceptions and feelings of efficacy<br>• Limited conceptions of specific proficiencies needed to use literacy I content areas<br>• Focus on technical skill ability of students rather than broad literacy skills<br>• Teachers found intervention worthwhile<br>• 64% reported shifts in thinking about reading and student ability |

| | | | | |
|---|---|---|---|---|
| | | | | • Almost 50% reported improved student learning |
| Cantrell & Hughes (2008) "Teacher efficacy and content literacy implementation: An exploration of the effects of extended professional development with coaching" | • Sequential mixed methods | • Quantitative: stats on efficacy from surveys and observations<br>• Qualitative: teacher efficacy survey, observation protocol, teacher interviews | • Quantitative: surveys are reverse coded, descriptive states, paired t-tests<br>• Qualitative: 2 level coding system for positive, negative, or neutral responses; coaching responses and collaboration responses | • Teachers who had higher efficacy prior to participation in PD were more likely to implement CAL<br>• Coaching and Collaboration were important factors in developing efficacy |
| Nielsen, Barry & Staab (2008) "Teachers' reflections of professional change during a literacy-reform initiative" | • Qualitative | • Semi-structured focus group interviews 41 primary grade teachers from 5 sites participated in one of six focus groups | • questions modified after first focus group<br>• transcription supplemented with filed notes<br>• constant comparative method<br>• coding for themes | • Teachers have 2 views of themselves 1) as learners, 2) as change agents<br>• Three conditions that support professional growth<br>• PD embedded in school and classroom<br>• PD focused on limited and clearly defined learning goals<br>• On demand access to time and resources<br>• Changes that occurred:<br>• Movement from curriculum-centered to student-centered<br>• Increased collaboration<br>• Requests for policy changes via teacher autonomy and advocacy for students |
| Reed (2009) "A synthesis of professional development on the implementation of literacy strategies for middle school content area teachers" | • synthesis of 4 previous studies | • 87 abstracts identified, sorted, and manually searched<br>• search with descriptors to identify 4 articles<br>• ancestral search of references | • hybrid of procedures including coding (axial) and effect size calculation | • 4 overarching categories regarding research and design of PD<br>• PD should be based on teachers' perceived needs and help them build knowledge/skills over time<br>• Contextual factors: Campus and district level administrative |

| | | | | |
|---|---|---|---|---|
| | | | | support and school-wide implementation<br>• Limited evidence supporting improved teacher and student outcomes as a result of PD targeting literacy strategies |
| Wilcox & Jeffery (2014) "Adolescents' writing in the content areas: national study results | • National survey | • student writing samples from L1 and L2 students nominated by teachers as representative of L1 or L2 writing proficiency of the campus analysis of 4485 writing samples from 66 students were from high-performing schools<br>• equal numbers of L1 and L2 students<br>• equal numbers of male and female students | • writing samples were categorized by length (as in Applebee, 1981) | • contrasts in length and type of writing by language background<br>• contrast in length and type of writing by performance history and language background<br>• contrasts in the percentage of extended writing by content area, language background, performance history and context<br>• lower-performing L1 writers and L2 writers are not writing enough or rigorously enough to be prepared for CCSS aligned writing tasks and high stakes exams |

**Writing in Science**

Studies of writing in secondary science classrooms have flourished under a disciplinary literacy approach, and in many ways it seems that disciplinary literacy brought science educators to a clearer understanding of the spirit of the writing-to-learn methods and a stronger resolve to apply them in science classrooms. Yore, Bisanz & Hand (2003) argued that because the writing-to-learn movement was oriented in a grass-roots perspective, and thus overshadowed by reductionist research approaches from the late 1970s and into the late 1980s, science education researchers were rather slow to recognize the compatibility of writing-to-learn methods and science education. Instead,

writing in science was used almost exclusively for evaluation and assessment as the fundamental sense of literacy was not (and sometimes is still not) taken seriously by scientists and science educators (Norris & Phillips, 2003; Yore, Bisanz & Hand, 2003). While the late-blooming amity between writing-to-learn methods and science education certainly does not exclude a disciplinary literacy approach, literacy scholars disagree on the viability of using content area literacy approaches in contemporary classrooms.

**Science Literacy.** In the mid 1990s the *National Science Education Standards* (1996) attempted to define scientific literacy. Though the act of writing is certainly implied, the verb 'write' is not specifically and meaningfully addressed. Rather, scientifically literate people "can ask, find, or determine answers to questions." They have "the ability to describe, explain, and predict." They can "read" and "engage in conversation"; they can "express positions"; and they can "pose and evaluate arguments" (p. 22, as cited in DeBoer, 2000). Though writing is not always specifically addressed in scholarship on science literacy, several scholars (Norris & Phillips, 2003; Osborne, 2002; Yore, Bisanz & Hand, 2003) elaborate upon the fundamental connections between science and written expression as well as the fundamental stylistic and cognitive differences in liberal arts writing and scientific writing (Bunting, 1999; Fang, 2005; Hand, et al., 2003).

**Writing-to-Learn in Science.** A significant amount of research explores writing in service of science learning. Rivard's widely cited meta-analysis (1994) concludes that writing can enhance science learning, but that many factors and attitudes about classroom teaching and learning must be in place for its effectiveness. Compelling evidence of the improvement of science learning with the combined use of writing and talking in both

secondary and post-secondary educational settings as well as in ESL classrooms confirm the usefulness of writing in science as a means of helping students to explore and clarify scientific concepts and to improve their retention of science content knowledge (Kamberelis, Gillis & Leonard, 2014; Reynolds, Thaiss, Katkin, & Thompson, 2012; Rivard & Straw, 2000; Syh-Jong, 2007). Much literature exists that explores specific techniques, activities, and philosophical approaches for incorporating writing and literacy practices into science classrooms (Creech & Hale, 2006; Draper & Adair, 2010; Grant & Fisher, 2010; Wellington & Osborne, 2001).

Several researchers (Akkus, Gunnel, & Hand, 2007; Burke, Greenbowe, & Hand, 2006; Grimberg & Hand, 2009; Hohenshell & Hand, 2006; Keys, Hand, Prain, & Collins, 1999; Poock, Burke, Greenbowe, & Hand, 2007) focus on the application of the Science Writing Heuristic (SWH), as a means for combining writing-to-learn and inquiry techniques into secondary science classrooms. Students engage in writing a lab report based on a question protocol that guides them through the cognitive processes of a laboratory experiment. Supporters of SWH believe that the written and collaborative nature of SWH methods improve engagement and emphasize the habits of mind that are integral to science learning.

Studies reveal that writing-to-learn is an effective framework for developing the cognitive pathways that lead to more sophisticated understanding of scientific concepts among both high-achieving and low-achieving students (Grimberg & Hand, 2009; Hohenshell & Hand, 2006; Klein & Rose, 2010). Grimberg & Hand (2009) used a mixed method approach including qualitative coding to trace the cognitive pathways evident in student writing; they determined that using SWH created gains in both low and high

achieving students. Hohenshell & Hand (2006) found that females benefitted more than males, showing promise for closing the gender gap in the science professions. The successful application of a writing-to-learn approach is exemplified in studies that use the Science Writing Heuristic; students in these studies increased performance on critical reasoning skills and conceptual questions while making clearer distinctions between the types of thinking that they were doing while writing (Akkus, Gunel & Hand, 2007; Hohenshell & Hand, 2006).

**Writing in Chemistry.** A significant amount of scholarship (Kovac & Sherwood, 1999; Meislich, 1987; Shibley, Milakofsky & Nicotera, 2001; Whelan & Zare, 2003) addresses writing in post-secondary chemistry courses with various degrees of emphasis on the instruction of writing. For example, Meislich (1987) argued that "Chemistry instructors do not have to teach good writing but only to recognize and not accept poor writing. Teaching good writing is best left to teachers of writing" (p. 505). Meislich did not recognize the need to provide writing instruction, though she believed that the act of writing was important to the content learning of her students. Likewise, Kovac and Sherwood (1999) argued for the use of 'microthemes' (250 words) as effective learning tools for his chemistry students, but noted the barriers of designing the assignments, grading the assignments, and students' negative attitudes, resistance, and even anger toward the assignments. In contrast to Meislich (1987), Shibley, Milakofsky & Nicotera, (2001) not only supported the use of writing within college chemistry coursework, but also supported the incorporation of writing instruction in chemistry classes by stating, "Too often student scientific writing occurs only in courses taught by the English Department" (p. 50). In most of the scholarship, and especially in that prior to the late

1990s, post-secondary instructors express the value of requiring writing, but explain very little about how they instruct or support student success in writing endeavors.

A particularly influential resource is Stoller, Horn, Grabe, & Robinson (2005) which documents the "Write Like a Chemist" course and the larger collaboration surrounding it. In this collaborative effort to improve undergraduate writing, post-secondary chemistry and applied linguistics educators in a "multiple-year effort to form valid analytic and holistic assessment instruments to be used by chemistry faculty to assess the writing performance of chemistry majors" (p. 75). The paper documented the process of collaboration including the development of prompts and rubrics, the validation writing assessment instruments, and the positive consequences of the collaborative effort. Also of relevance to this study, Stoller et al. (2005) documents the efforts to "socialize" chemistry teachers to be successful at providing information to aid in the development and scoring of writing assessments for chemistry courses.

Table 3 - *Key Studies about Writing in Science*

| **Writing in Science** | | | | |
|---|---|---|---|---|
| **Article** | **Design** | **Data collection** | **Data analysis** | **Summary of findings** |
| Akkus, Gunel & Hand (2007) "Comparing an inquiry-based approach known as the Science Writing Heuristic to traditional science teaching practices: Are there differences?" | • Mixed methods<br>• Intervention study<br>• Interpretive case study | • Qualitative: observational data of intervention, using Omar (2004) to identify level of implementation; used later as a variable in quantitative data<br>• Quantitative: baseline to deter-mine student achievement levels, Pre-Post Tests | • Qualitative: Ranking and calibration<br>• ANCOVA | • Charts and graphs<br>• SWH closes the achievement gap between low and high achievers when implemented at a high level |

| | | | | |
|---|---|---|---|---|
| Grimberg & Hand (2009) "Cognitive pathways: Analysis of students' written texts for science understanding" | • Interactive-Constructivist Theory of Learning<br>• Mixed method<br>• Intervention study of SWH for high and low achievers | • Quantitative: ITBS scores of 7th graders in Life Science<br>• Qualitative: Student writing in 4 Life Science classes with one teacher doing intervention | • Quantitative: Chi squares<br>• Qualitative: text analysis for 11 reasoning operations (observation, measurement, comparison, analysis, clarification, claims, C/E relations, induction, deduction, experimental designs, argumentation) | • Visual representation of reasoning operations and dimensionality<br>• 24 pathways for four classes, 3 lab activities, and low/high achievers<br>• Low and high achievers engage in the same processes<br>• SWH closes the achievement gap |
| Hohenshell & Hand (2006) "Writing-to-learn strategies in secondary school cell chemistry: A mixed method study" | • Mixed methods intervention<br>• 3 study groups<br>• Control<br>• SWH<br>• Peer Review | • Quantitative: Pre-Test, Post-Test with non-random sample, Objective tests to determine science achievement<br>• Qualitative: Student surveys (Gunel, Omar, Grimberg, & Hand, 2003), Semi-structured interviews of students (participants chosen by grades) | • Quantitative<br>• 1 way ANOVA<br>• ANCOVA<br>• Qualitative<br>• Open-coding<br>• Microanalysis<br>• Calibrated Peer Review (CPR) | • Assertions presented in bold and supporting evidence in italics<br>• SWH alerts students to cognitive operations and writing strategies<br>• Students in both traditional and SWH realized value in compiling and summarizing data in lab reports<br>• SWH makes writers more aware of learning in writing than traditional lab reports<br>• Writers in traditional and SWH groups believed they had control over the task<br>• Writing tasks appear to instil self-confidence in students for extended response questions on tests |
| Rivard & Straw (1999) The Effect of Talk and Writing on Learning Science: An Exploratory Study | • Quasi-experimental<br>• Process-product<br>• Embedded "naturalistic element" | • Quantitative: Pre-test/Post-test, Post-test<br>• Treatment groups stratified by gender and ability<br>• Qualitative (embedded in two, 50 min. pre-writing groups) | • ANCOVA<br>• Coding, cross case analysis, to inform possible mechanisms for effects in quantitative data | • "Analytical writing is an important tool for transforming rudimentary ideas into knowledge" (p.566)<br>• Talk with writing enhanced retention over time<br>• Gender and ability are mediating factors |

## Teacher Collaboration

Literacy research indicates that both students and teachers benefit from collaborations aimed at improving student learning (Cantrell, et al., 2008; Hughes, Parker-Katz & Balasubramanian, 2013). This assertion is in line with the scholarship regarding both teacher professional development and disciplinary literacy which posits that such practices can be most effective when they are campus-based rather than top-down, when they are collaborative efforts rather than isolated efforts, and when they maintain a disciplinary focus rather than generic literacy focus (Draper, 2010; Langer, 2011; Joyce & Showers, 2002).

Current models for the improvement of student learning emphasize collaborative efforts of teachers. Professional Learning Communities (PLCs) have gained popularity in recent years as a means for building student achievement through collective action research (DuFour & Eaker, 1998). Likewise, Communities of Inquiry (COIs), or teacher-driven research efforts, have also been viewed as a means of improving teacher and school performance as well as elevating the status of the teaching profession (Willemse, Boei, & Pillen, 2015). Both of these models, though different in some regards, are in keeping with the bottom-up rather than top-down professional development model and provide opportunities for developing interdisciplinary collaboration focused on improving students' writing and thinking skills.

**Attitudes About Collaboration.** Although teachers' attitudes sometimes form a barrier to effectively infusing writing into non-ELA classrooms, most teachers do recognize the need for coaching and collaboration as an integral part of achieving literacy reform in the content areas (Cantrell et al., 2008). But, opportunities for collaboration are

often limited and poorly structured. Teachers are not given the much-needed time and access to resources for successful preparation and implementation of new techniques, especially when trying to infuse literacy practices into non-ELA classrooms (Fang, et al., 2008; Nielsen et al., 2008; Zane & Tucci, 2016). Effective teacher collaboration, both with their content-area colleagues and with literacy teacher educators, is critical for developing writing instruction appropriate for specific non-ELA content classrooms (Fang, 2014; Stoller, et al., 2005).

**Collaboration and Change.** The emphasis on collaboration and literacy learning has created a need for professionals with classroom experiences who are able to provide support for non-ELA teachers who have not received adequate education and training to fully incorporate writing into their own classrooms. In some cases, (Fang, et al. 2008) collaborative efforts involve teachers working alongside researchers or teacher educators from post-secondary settings. These collaborations can be successful; however other researchers (Dillon, O'Brien, & Moje, 1994) argue that successful collaborations depend on in depth knowledge of *how* and *why* teachers believe in and enact literacy practices in their non-ELA classrooms. This in-depth knowledge may not be readily available to individuals who are not present in daily, ongoing interactions with teachers in real classroom environments.

One possible solution to the problem of infusing literacy practices into non-ELA classrooms is to employ literacy teacher educators (LTEs) (Fang, 2014). These individuals are literacy specialists who engage in joint planning with non-ELA teachers to both create and implement disciplinary literacy practices that will help students to simultaneously hone both their content knowledge and literacy skills. The professional

expertise of LTEs is beneficial to the enactment of campus-wide literacy reform; however, collaboration between ELA and non-ELA teachers at the same level, and who sometimes teach the same students, can also create powerful partnerships. Teachers can adopt similar terminology and strategies, or they can disambiguate the stylistic elements that distinguish science writing from ELA writing. Opening paths of communication between teachers within the two disciplines may help students to transfer and adapt their literacy skills from one class setting into the next.

Changing collaborative practices to improve writing may mean changing schedules, curriculum, campus priorities, and the general level of commitment to writing instruction among non-ELA teachers. Such changes require support on many levels, but especially that of the campus principal and other instructional leaders (McGhee & Lew, 2007). Effective interdisciplinary collaboration requires that teachers agree upon their roles and responsibilities for student achievement and are accountable for those responsibilities by assigning and keeping written student products to discuss and reflect upon during collaboration time (Fournel, 2015; Stoller, et al., 2005). Together, non-ELA teachers and literacy teacher educators, or ELA teachers, should make decisions about both the desired content area outcomes and the target literacy outcomes for student achievement. Such instructional decisions should be informed by evidence of students' progress toward set goals (Fournel, 2015; Hughes, Parker-Katz & Balasubramanian, 2013). These types of collaborations are teacher-driven and bottom-up, rather than district-mandated and top-down, which builds teachers' need for autonomy and preserves their content-area expertise. They also provide opportunities for pre-service and novice

teachers to learn about student needs, assessment strategies, and collaborative expectations.

**Collaboration Research**. Studies on collaboration (Hesjedal, Hetland & Iversen, 2015; Hughes, Parker-Katz & Balasubramanian, 2013) have frequently targeted inter-professional interactions between regular education teachers and special population professionals such as social workers, special education consultants, and heath care professionals. However, a particularly strong strand of research that will inform the proposed study involves the collaborative efforts of English as a Second Language (ESL) teachers and content area teachers. These studies (Kong, 2014; Lo, 2015) examine the challenges, tensions, and sometimes conflicting aims of teachers as they strive to improve both student content and language mastery. Often qualitative in design, the findings in these studies highlight changes in teachers' attitudes and foci, in their understandings of student needs, and in their levels of commitment and hope for the future.

Table 4 - *Key Studies about Teacher Collaboration*

| Teacher Collaboration | | | | |
|---|---|---|---|---|
| **Article** | **Design** | **Data Collection** | **Data Analysis** | **Summary of Findings** |
| Fang et al. (2008) "Integrating reading into middle school science: What we did, found and learned" | • Mixed method<br>• Intervention study using professional development workshops, meetings, lesson planning, and a student home reading program | • Quantitative: Pre-tests/Post-tests of students' literacy abilities and content area knowledge, Student grades in science for the academic year<br>• Qualitative: Meeting minutes and notes, Observation notes, Summative reflection paper, Email com-munication, | • Quantitative: t-tests and paired t-tests Qualitative: constant comparative method; individual and group; identification of 6 | • By theme<br>• Change in teacher attitudes<br>• Teacher support includes gradual removal of scaffolds<br>• Student benefit from reading infusion<br>• Time is a big issue<br>• Successful integration requires content and reading knowledge<br>• Requires resources (for books) |

| | | | | |
|---|---|---|---|---|
| | | Student surveys, Parent surveys | | |
| Hesjedal, Hetland & Iversen (2015) "Interprofessional collaboration: self-reported successful collaboration by teacher and social workers in multidisciplinary teams" | • Qualitative intervention | • Semi-structured interviews with 5 topics about IPC<br>• Self-reported IPC<br>• 13 participants (6 teachers and 7 social workers) | • NVIVO9; QSR International | • By theme:<br>○ Personal commitment<br>○ Positive atmosphere for IPC<br>• Pulling together towards future goals |
| Hughes, Parker-Katz & Balasubramanian (2013) "Learning to teach literacy through collaborative discussions of student work" | • Intervention study | • Literacy artifacts<br>• Reflections about literacy artifacts<br>• Interviews<br>• Surveys 17 SPED teacher mentors from low-income school<br>• 43 pre-service teachers | • Constant comparison<br>• Phase one – data reviews, key findings summarized<br>• Phase two – supporting evidence found and organized<br>• Phase three – data review, categories created | • Three Themes: classroom literacy artifact selection, reason for artifact selection, prospective teachers' perceptions of the artifact discussion |
| Kong (2014) "Collaboration between content and language specialists in late immersion" | • Qualitative case study of collaborative project between ESL research and a history teacher in Hong Kong | • Student writings (assessed by teachers)<br>• Semi-structured interviews with teacher and 9 students at various levels of L2 language acquisition<br>• Researcher journal???9th grade L2 students and teachers | • Mean scores of student writing<br>• Questionnaire of students<br>• Interviews<br>• Researcher journal entries | • Project improved students' writing (text structure)<br>• Collaboration of content specialists and language specialists contributed to the success<br>• Discussion of challenges and future directions<br>• By theme:<br>○ Conflicting aims<br>○ Content language tension<br>○ Concerns about future implementation |
| Lo (2015) "A glimpse into the effectiveness of L2-content cross-curricular collaboration in content-based instruction programmes" | • Mixed method<br>• researcher as consultant | • data from 6 teacher meetings<br>• lesson observations and field notes<br>• pre-post tests of student performance<br>• only collected data from teachers with a very positive | • Quantitative Analysis of pre-post tests using descriptive statistics (independent and paired t-tests)<br>• Qualitative Transcription and coding for themes/patterns | • Statistical charts<br>• Themes<br>○ Teachers became aware of students' needs<br>○ Curriculum mapping and development<br>○ Changes in teachers' |

| | | | | |
|---|---|---|---|---|
| | | attitude toward collaboration (1 English, 2 Science, 1 Humanities)<br>• 20 months of intervention data<br>• All-girls school<br>• 3 groups: advanced, below average, average (control) | | pedagogical foci |

The literature base for this study is both wide and deep. It encompasses much more than the current ideas about student writing and writing instruction. The historical roles of literacy education in American schools and the ways that those roles have impacted teachers and their attitudes are extremely relevant to the success of contemporary writing initiatives. The need to look more closely at the inner-workings of writing and science instruction has been made more urgent by reported writing deficiencies among adolescents, and by our national quest to provide equitable opportunities for students to attain higher levels of critical thinking, innovation, and communication skills, all of which are required for the scientific and technological advancement, and perhaps for the sustainability of our world as we know it. Even beyond the scholarship on literacy, this study questioned to what degree collaboration of teachers from different disciplines can be effective in promoting student writing.

# Chapter III

## Methodology

This qualitative study examined the processes and interactions of a team of secondary teachers whose goal was to incorporate writing instruction into chemistry classes. The study was initially attempted with a team of biology teachers; however, the lead teacher and mid-level administrators aborted the study, attributing their unwillingness to participate in the study to 1.) lack of time to meet and discuss student writing, 2.) beliefs that multiple-choice assessments are superior to writing assessments for gauging student learning in biology classrooms, and 3.) pressure to either maintain or increase scores on the state-mandated biology assessment. Though biology teachers were unwilling to participate, chemistry teachers on the same campus, who are not expected to perform on state-mandated assessments were assigned to work on the project.

### Purpose and Importance of Study

The purpose of the study was to explore more deeply the ways that chemistry teachers use writing within the context of their disciplines and the realities of their daily praxes. This study was needed because teachers are increasingly being asked to provide writing instruction in their non-ELA classrooms, to teach students the differences in writing modes and purposes, and to collaborate both inside and outside of their chosen disciplines in efforts to enhance student literacy. To better provide non-ELA teachers ways to meet such expectations, the researcher posed the following research questions:

**Research Question One** - How do chemistry teachers offer instruction in writing?

**Research Question Two** - How do chemistry teachers value writing as an instructional tool?

**Research Question Three** - How do chemistry teachers assess writing via a rubric?

## Research Design

Research questions were explored using a qualitative research design. More specifically, the study was enacted through critical ethnography. Because the teachers in the study were working together with the researcher to improve instruction and student learning, the study might also be described as "collaborative action research" (Cochran-Smith & Lytle, 2009 as cited in Merriam & Tisdell, 2016). Collaborative action research seeks to improve teacher practice; it emphasizes the voices of collaborating teachers and the "unfolding knowledge and professional development" in teachers' practices (Merriam & Tisdell, 2016). The proposed study was designed to expand upon a body of knowledge regarding teachers' perceptions of writing, writing instruction, and collaborative efforts to improve student learning. Furthermore, the study hoped to bridge perceived gaps between research and practice.

A key resource for methodology was Carspecken's *Critical Ethnography in Educational Research* (1996). The researcher began by compiling primary records of writing training experience, classroom, and campus interactions of three chemistry teachers. Preliminary reconstructive analysis of data, especially of collaborative meeting transcriptions, observations, and researcher journals, provided a record of the school environment, attitudes, behaviors, and common practices of the participating teachers. Dialogic data in the forms of face-to-face, semi-structured interviews of chemistry

teachers were collected, transcribed, coded, and viewed in relation to both the primary record and the preliminary reconstructive analysis to confirm or disconfirm emergent themes. Throughout the study and prior to reporting, the emergent themes and coding were member checked by participants.

An important element of the research design was the role of researcher. Because the researcher is also a member of the faculty and works directly with the participants, an *emic*, or insider perspective, emerged. Scholars (Nolen & Putte, 2007) have noted that collaborative action research is not without its limitations, but that "such projects are valuable when conducted by skilled practitioners with established knowledge, working relationships, access, and credibility within schools" (p. 402). The common goal of both the researcher and the chemistry teachers to improve student writing created an excellent opportunity for her to access vital data first hand through direct and frequent communication with chemistry teachers. Such close interaction is necessary for success in collaborative reform agendas, which "should be based on a deep understanding of the settings and participants who will be involved in change" (Dillon, O'Brien & Moje, 1994, p. 359).

**Population and Locale**

Teacher participants had the main goal of increasing students' academic performance through a campus-wide writing initiative. The researcher guided chemistry teachers in a series of meetings in which they developed, implemented, and reflected upon their instructional writing practices. In addition to working with teachers to improve student writing, the researcher collected and analyzed data in order to answer three research questions.

The researcher and teacher participants in this study were from a suburban high school in southeast Texas. The student population was predominantly Hispanic (72%), 'At-Risk' (62%) and economically disadvantaged (70%). Specific efforts to build an academic culture had been implemented by local administration for approximately the past seven years following an 'Academically Unacceptable' rating from the Texas Education Agency in 2010. Two of the three chemistry teachers have taught at the campus, attended meetings and trainings, and participated in a variety of efforts to improve students' academic success over the course of the past twelve years. One of the chemistry teachers joined the faculty in Fall of 2013. The researcher was a seventeen-year veteran teacher, teaching tenth and twelfth-grade ELA on the same campus and serving as the level leader for the tenth-grade ELA team as well as a campus trainer in content area literacy practices.

Since the unacceptable rating in 2010, campus administrations, under the guidance of three different principals, implemented a variety of student success strategies. Most instructional campus interventions were based on the WICOR model, which promoted implementation of strategies for writing, inquiry, collaboration, organization, and reading. As part of the campus-mandate, teachers in all disciplines were expected to create and administer short answer responses (SARs) like those featured on the STAAR-EOC ELA tests. Incorporation of SARS was considered a strategy for addressing the 'W' (for writing) and the 'R' (for reading) in WICOR. In addition to various campus initiatives, the district mandated professional development based on WACA, which emphasized writing strategy instruction by all content area teachers. Although interventions to increase students' academic performance, especially on state-

mandated tests, was ongoing, frequent turnover of both campus administration (principals and academic deans) and district administration (superintendents and directors) contributed to the short-lived, disconnected, and generally unsuccessful nature of these efforts.

Though the leadership changed frequently, the low academic performance among students remained. The campus experienced growth in student performance from 2010 to 2016; however, the gains were negligible, and scores remained significantly lower in the ELA areas of reading and writing than in other content areas assessed by the state. The reading and writing scores were also significantly lower than those at other schools in the district on STAAR-EOC exams. On January 6th of 2017, the state announced the removal of SARs from the STAAR-EOC Exams in ELA I, II, and III. E-mail correspondence to district testing coordinators stated that the removal of SARs would not change the overall difficulty of the exam and that the SARs would be replaced with multiple choice questions. Results of the district benchmark (a released STAAR-EOC ELA II exam administered January 11, 2017) indicated that overall benchmark scores for the 2016-2017 cohort of sophomore students were only 3-6 percentage points lower than the other high schools in the district. The benchmark was scored by initially by individual teachers and then by the district according to rubrics and new blueprints issued by the state. It is impossible to attribute these gains to any one factor, instructional or otherwise. Furthermore, it is impossible to determine if the gains made by students on the benchmark will be reflected in the actual scores on the revised STAAR-EOC English II exam to be administered in March of 2017. This study aimed to give insight into how

non-ELA teachers navigate the practical application of required writing intervention in the shifting sands of campus, district, and state expectations.

**Study Procedure**

The procedure of the study included ongoing collection and analysis of data (see Appendix A, Table A1 for intervention overview, p. 108-110). The researcher built a primary record as a campus teacher and provider of professional development through frequent discussion of shared experiences, students, and writing goals. She also visited chemistry teachers' classrooms informally in the weeks leading up to the collaborative intervention. Preliminary reconstructive analysis began during initial meetings when the chemistry teachers and the English 2 team met to assess specific literacy needs of students and brainstorm ways to adjust instruction in the coming school year. Reconstructive analysis was ongoing based on data collected both during collaborative meetings of the chemistry team and the English 2 team (March – May, 2016) and during the meetings of the chemistry team and the researcher (August 2016 – January 2017). In the spring semester of 2016, chemistry teachers began development of prompts and a rubric to use in place of the STAAR-EOC SARs that had been mandated by campus administration. Initial interviews were administered to the three chemistry teacher participants in June (Brock and Jaimez) and August (Patel) of 2016. Copious data was collected during nine planning meetings, and dialogical data generation was ongoing until the summation of the study in January of 2017.

**Instructional Intervention.** The instructional intervention yielded data that contributed to research questions one and two: *How do chemistry teachers offer instruction in writing?* And, *how do chemistry teachers value writing as an instructional*

*tool?* The intervention to improve student writing was a collaborative effort on the part of three chemistry teachers and the researcher. The intervention was designed to meet campus mandates for classroom writing. The researcher reviewed studies regarding effective write-to-learn instruction in secondary science classrooms (Bangert-Drowns et al., 2004; Rivard, 1994; Rivard & Straw, 2000). She attempted to encourage teachers to use writing in that ways elicited metacognitive processes and that were sustained over a significant period of time. In keeping with recent findings about successful professional development, opportunities for chemistry teachers to learn and enact writing instruction strategies were embedded in classroom practice, based on specific goals, and supported by current campus administration (Nielsen, et al., 2008). Because the professional collaboration and decision-making was enacted by teachers rather than by district administrators or third parties hired by the district or campus to implement professional development, the effort was predominantly bottom-up, rather than top-down (TNTP, 2015). All teachers involved were stake-holders in the academic success of their students and the school.

**Prompt and Rubric Development.** Teachers engaged in the development of prompts and rubrics as part of the instructional intervention. These endeavors yielded data that contributed to research question three: How do chemistry teachers assess writing via a rubric? Not only did chemistry teachers collaborate to develop a rubric to guide their assessment of written responses, but they also used the assessment information to plan subsequent content and writing instruction. Teachers adapted and expanded the rubric based on students' written responses in collaborative meetings over the course of the intervention and is discussed more fully in subsequent sections.

## Data Collection

The proposed study sought answers to the research questions through two main points of entry—teachers and researcher. Data included: meeting transcriptions, classroom observations, teacher interview transcriptions, researcher journal reflections, and intervention artifacts such as prompts and rubrics.

**Meeting Transcriptions.** Fourteen meetings of chemistry teachers and the researcher were audio-recorded and transcribed (see Appendix A, Table A1 for intervention overview, p. 108-110). The goals of these meetings were to: identify content objectives, identify desired outcomes for student writing, develop writing prompts, develop and apply a rubric for assessing student writing, and discuss concerns about student writing proficiency in chemistry. The researcher hoped that these meetings would open paths of communication that would lead to improved writing instruction and student writing performance. Due to the quantity of dialogical data sources, transcription services were used (see Appendix B, Table B1 for data collection schedule, p. 115).

**Classroom Observations.** The researcher observed chemistry teachers during the twelve-month study. Using an observation protocol (see Appendix B, Fig. B5, p. 121), the researcher collected observational data in response to research question one: *How do chemistry teachers offer instruction in writing?*

**Interviews.** The researcher formally interviewed each chemistry teacher twice over the course of the study. Using semi-structured interview protocols (see Appendix B, Fig. B2 - B3, p.116-119), the researcher elicited elaboration of chemistry teachers' orientations toward writing, writing instruction, rubric development, rubric application, and the use of writing as an instructional tool for teaching chemistry. The interviews

lasted between 30 minutes and 1 hour. Interviews were analyzed not only to answer the research questions, but also to address areas of need and next steps for the writing intervention during the upcoming school year. Interviews were audio-recorded and transcribed for analysis.

**Researcher Journal**. The researcher kept a journal of her experiences and observations. Journal entries were written or recorded after each collaborative meeting and at other points in the research process. The researcher used a reflection protocol (see Appendix B, Fig. B4, p. 120) when recording her reactions to observations, interviews, and planning meetings.

**Prompts, Rubrics, and Intervention Artifacts.** Several documents, such as agendas, lesson plans, meeting notes, and student writing samples, were collected and used to either confirm or disconfirm reconstructive data analysis. Each week, teachers used the required forms for PLC and Content Unit Planning (see Appendix A, Fig. A2-A3, p. 111-112). Embedded into (almost) every team planning meeting was discussion of writing which generally fell into a cycle including: creation of a prompt, collection of student samples, analysis of student samples, and modification the rubric. The prompts and rubrics drafted by chemistry teachers in collaborative meetings emerged not only as important data, but also as ongoing measurements of teachers attitudes and beliefs about writing and writing instruction. Chemistry teachers developed four prompts:

1. Compare and contrast endothermic and exothermic processes. Provide examples of both.
2. Explain why water is a unique and important compound.

3. Pick one scientist who contributed in the discovery of subatomic particles and explain his experimental design and conclusions that were used in the development of modern atomic theory. Your answer must include the detailed information from our readings and notes.
4. Describe two types of unseen electromagnetic waves, then contrast their modern-day applications and dangers.

In addition to prompts, chemistry teachers drafted three iterations of the rubric. The rubrics below are drafts from March (Fig. 1), April (Fig. 2), and October (Fig. 3). The rubrics emerged as a measurement for teachers' perceptions of writing and writing instruction. Chemistry teachers' development of prompts and rubrics are more fully discussed in Chapter Five, Implications for Teachers.

Figure 1 – *First iteration of rubric, March 2016*

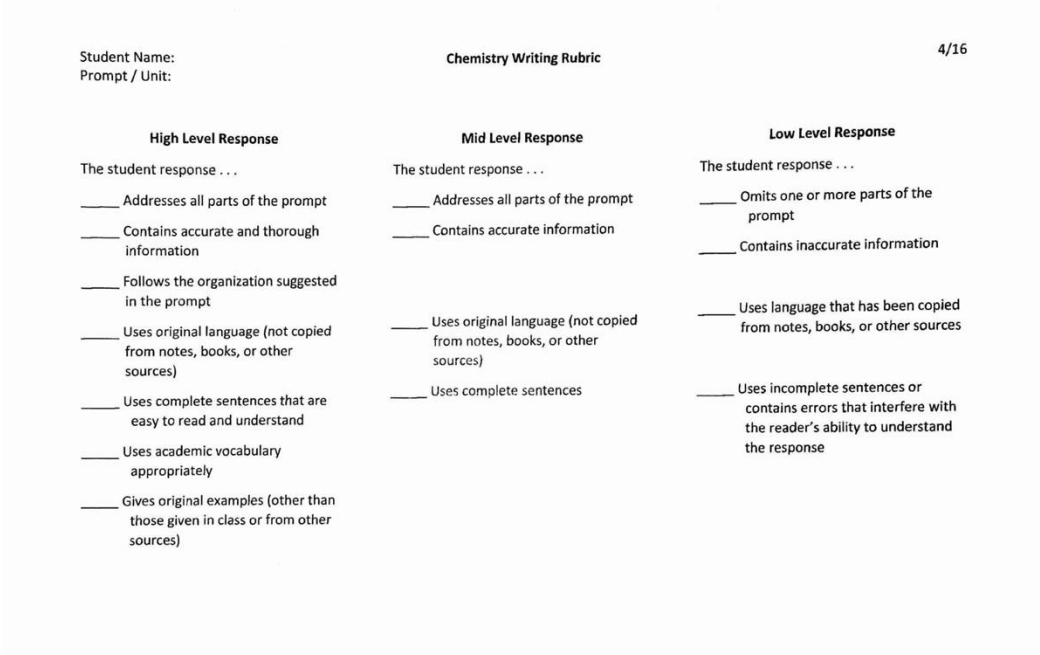
Chemistry Writing Rubric Draft
Based on meetings March 11 and 25, 2016

High Level Response – The student response . . .
- Addresses all parts of the prompt
- Contains accurate and thorough information
- Follows the organization suggested in the prompt
- Uses original language (not copied from notes, books, or other sources)
- Uses complete sentences that are easy to read and understand
- Uses academic language appropriately
- Gives original examples (other than those given in class or from other sources)

Mid-Level Response – The student response . . .
- Addresses all parts of the prompt
- Contains accurate information
- Uses original language (not copies from notes, books, or other sources)
- Uses complete sentences

Low Level Response – The student response . . .
- Omits one or more parts of the prompt
- Contains incorrect information
- Uses language that has been copied from notes, books, or other sources
- Uses incomplete sentences or contains errors that interfere with the reader's ability to understand the response

Figure 2 – *Second iteration of the rubric, April 2016*



Student Name:
Prompt / Unit:

**Chemistry Writing Rubric**

4/16

**High Level Response**

The student response . . .

_____ Addresses all parts of the prompt

_____ Contains accurate and thorough information

_____ Follows the organization suggested in the prompt

_____ Uses original language (not copied from notes, books, or other sources)

_____ Uses complete sentences that are easy to read and understand

_____ Uses academic vocabulary appropriately

_____ Gives original examples (other than those given in class or from other sources)

**Mid Level Response**

The student response . . .

_____ Addresses all parts of the prompt

_____ Contains accurate information

_____ Uses original language (not copied from notes, books, or other sources)

_____ Uses complete sentences

**Low Level Response**

The student response . . .

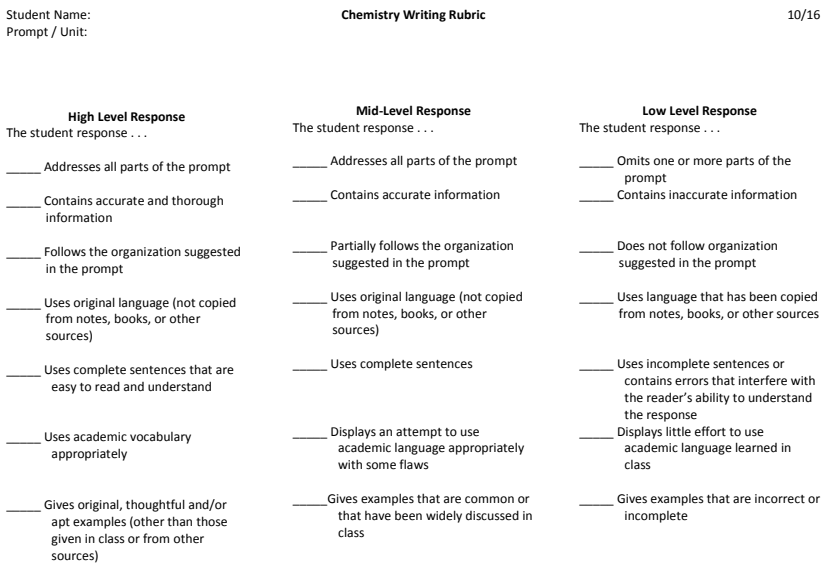
_____ Omits one or more parts of the prompt

_____ Contains inaccurate information

_____ Uses language that has been copied from notes, books, or other sources

_____ Uses incomplete sentences or contains errors that interfere with the reader's ability to understand the response

Figure 3 – *Third iteration of rubric, October 2016*



Student Name:
Prompt / Unit:

**Chemistry Writing Rubric**

10/16

**High Level Response**

The student response . . .

_____ Addresses all parts of the prompt

_____ Contains accurate and thorough information

_____ Follows the organization suggested in the prompt

_____ Uses original language (not copied from notes, books, or other sources)

_____ Uses complete sentences that are easy to read and understand

_____ Uses academic vocabulary appropriately

_____ Gives original, thoughtful and/or apt examples (other than those given in class or from other sources)

**Mid-Level Response**

The student response . . .

_____ Addresses all parts of the prompt

_____ Contains accurate information

_____ Partially follows the organization suggested in the prompt

_____ Uses original language (not copied from notes, books, or other sources)

_____ Uses complete sentences

_____ Displays an attempt to use academic language appropriately with some flaws

_____Gives examples that are common or that have been widely discussed in class

**Low Level Response**

The student response . . .

_____ Omits one or more parts of the prompt

_____ Contains inaccurate information

_____ Does not follow organization suggested in the prompt

_____ Uses language that has been copied from notes, books, or other sources

_____ Uses incomplete sentences or contains errors that interfere with the reader's ability to understand the response

_____ Displays little effort to use academic language learned in class

_____ Gives examples that are incorrect or incomplete

## Data Analysis

Data was analyzed to answer three research questions posed: 1) How do chemistry teachers offer instruction in writing? 2) How do chemistry teachers value

writing as an instructional tool? And, 3) How do chemistry teachers assess writing via a rubric? All recorded data was converted into text. The researcher read, reread, and contemplated data to construct a rough narrative or organizational structure for each instance of data collection (meetings and interviews). Once a general organization or narrative structure was determined, text was coded first using low level codes. Low level coding will incorporate "horizon analysis" to produce preliminary reconstruction of the data in context (Carspecken, p. 94).

Horizon analysis, or analysis that progresses laterally through objective, subjective, and normative evaluative claims, allowed the researcher to recognize "recurring patterns" and any "unusual, revealing events" (Carspecken, p. 94). As more dialogic data were analyzed, themes emerged. Themes present in multiple instances of data were foregrounded and textual data was reconstructed until a reasonable number of themes surfaced as predominant points of interest that provided answers to the questions of how teachers perceive the processes, purposes, and assessment of writing.

**Trustworthiness**

The role of researcher constituted both an advantage and a limitation to this study. The researcher took special care against bias and the use of *a priori* coding through continual peer debriefing and member checking. Teacher colleagues and fellow graduate students peer debriefed the coding of data. Participating teachers were asked to member check coding of open-ended responses, meeting transcriptions and interview data. The researcher peer-debriefed the interview protocol to avoid leading questions and to integrate consistency checks into interview questions. The researcher utilized negative case analysis to identify potential inconsistencies in the pulling of themes (Carspecken,

1996). Likewise, intervention artifacts and meeting notes were used to disconfirm emergent themes in an effort to enhance trustworthiness.

**Summary**

This section focused on the procedures that were used to provide answers to questions about how chemistry teachers instruct, value, and assess writing. Transcriptions of collaborative meetings and interviews, along with observations, a researcher journal, drafts of the rubric, and intervention artifacts were collected. The analysis of data contributes to current research and practices related to improving student writing through a writing across the curriculum approach. Specifically, the study delved into the ways that non-ELA teachers respond to writing initiatives which require them to assign, instruct, and assess writing in ways that build both students' literacy skills and content area knowledge. The study was approved by IRB in December, 2016. Letters of consent were signed by all participants (see Appendix C, Fig. C1-C2, p. 122-127).

# Chapter IV

## Findings

This chapter describes application of research methods, data, and findings in relation to the three research questions posed: 1.) How do chemistry teachers offer instruction in writing? 2.) How do chemistry teachers value writing as an instructional tool? And, 3.) How do chemistry teachers assess writing via a rubric? The chapter includes a review of the problem and purpose of the study, participant profiles, an overview of the intervention, data analysis, presentation of data from each chemistry teacher participant, and emergent themes.

The serious problem of student literacy is common among traditionally low-performing high schools with high rates of economic disadvantage and other at-risk factors. This problem frequently contributes to students' failure on state-mandated exams and decreased opportunities for success after high school. In response to the need to raise low ELA scores, some districts and campus administrations turn to teachers in non-ELA areas, requiring that these teachers adopt literacy practices designed to increase student performance on ELA assessments. Though experts agree that literacy instruction is important and valuable for student learning in all content areas, it has been noted that sometimes the methods required of non-ELA teachers do not complement the specific instructional needs for learning in their disciplines. Science teachers may struggle to incorporate classroom writing practices as mandated by campus-wide writing initiatives.

The purpose of this study was to explore how chemistry teachers addressed administrative demands to include ELA-style writing methods into their classrooms, to develop and evaluate a viable alternative to those methods if possible, and to observe the

complex factors associated with writing in chemistry classrooms, including: the teachers' predispositions toward writing and writing instruction; teachers' application of writing and writing instruction within specific units of study; and teachers' levels of comfort and expertise with instructing and assessing sophomore students' writing. In addition, the researcher and chemistry teachers shared the goal of improving student performance on both chemistry assessments and the state-mandated ELA assessment.

**Analysis and Presentation of Data**

The researcher collected and reflected upon data, reconstructed narratives, and extracted themes over the course of the study. As a close participant in both the intervention and the research, the researcher constantly sought confirmation or contradiction of inferences based on experiential data. Carspecken (1996) noted, "The more familiarity you have with the culture of your subjects, the closer your articulated meaning fields are likely to be to what actors themselves report" (p. 96). He continued, however, by reminding the researcher that "initial meaning reconstruction should be viewed as very much preliminary and subject to error" (p. 96). With this in mind, the researcher spent much time reading, rereading, and reflecting on data, oftentimes challenging preconceived notions about science teachers and their attitudes about writing. Data analysis was ongoing over the one-year duration of the study; therefore, an overview of the continuously shifting contextual landscape of the locale and its actors is needed.

**Overview of the Intervention**. The researcher was assigned to work with biology teachers in late January of 2016 (see Appendix A, Table A1 for intervention overview, p. 108-110). She began attending biology meetings and observing biology teachers in early

February. The researcher attempted to contact the assistant principal over science to discuss the collaborative effort, and spoke with the science department chair about the upcoming collaboration on two occasions. The assistant principal did not acknowledge the collaboration until after the researcher's second meeting with biology teachers on February 10. This meeting, revealed that two teachers (one being the science department chair) were unwilling to provide extended writing opportunities for students, favoring instead weekly administrations of multiple choice questions to assess student learning.

The researcher recorded feelings of frustration directly after the meeting on February 10. In her journal, she wrote:

> Writing was a warm-up question that asked students to define a term in their own words. When I asked if they thought they might think about extending the idea to comparing or a higher-level verb, Mr. Montgomery (pseudonym) said that the students weren't capable of higher order thinking and that would just cause problems. I asked if I understood him correctly that he didn't think that it was a good idea to move students beyond basic thinking skills and he agreed. Wow—that that blew my mind.

The researcher later recounted that Mr. Montgomery (pseudonym) stated that he did not have time to help the English teachers to reach their goals because he had his "own test to teach."

In the post-meeting journal entry for February 10, the researcher used words such as "negative," "bullied," and "hot-headed" in her journal to describe the interactions in the meeting of teachers on February 10. She wrote: "Basically today I asked biology [teachers] to talk about their students' writing and was told 'no' by administration. The

reason was stated as needing to prepare for standardized testing as the review for the [STAAR-EOC Biology] test is to begin in 3 weeks."

When asked by the assistant principal over science how long the biology teachers would be required to discuss student writing, the researcher estimated about 20 minutes a week. The assistant principal and science department chair rejected the possibility of dedicating 20 minutes a week to discussion of student writing because, as the assistant principal explained, the science teachers were working on completing the instruction of the entire biology curriculum by March so that they could begin reviewing the TEKS pertinent to the state assessment administered in May. Both the science department chair and the assistant principal over science believed that neither replacing nor supplementing multiple choice assessments with writing prompts would be conducive to student success on the STAAR-EOC Biology exam. After a conference call, which the researcher later recorded being "bullied into," and after private meetings of the academic dean and assistant principals over both science and ELA, the academic dean reassigned the researcher to work with the chemistry team—a team with no state mandated test requirements.

The researcher also recorded more positive interactions with three biology teachers between February 10 and February 16, 2016. On two occasions, biology teachers sought out the researcher for private conversations in which they apologized for the harsh words of the biology department chair in the meeting on February 10. In one-on-one informal conversations, three biology teachers expressed their concerns about their students' writing abilities; two of the biology teachers expressed their support for the

campus intervention, and two of the biology teachers extended invitations for the researcher to continue observing the writing that was happening within their classrooms.

The campus writing initiative was still part of the Campus Improvement Plan in January of 2016 when the campus principal retired; however, teachers were not asked to produce evidence of classroom writing for the remainder of the school year. The academic dean did support collaboration for chemistry and ELA teachers, provided that the collaborations did not interfere with other scheduled meetings. Agendas for faculty meetings and PLCs did not designate time for collaboration of chemistry and ELA teachers. Collaborative opportunities about student writing were therefore scheduled beyond the normal work time of other campus teachers during the spring semester of 2016.

It is important to note that at the onset of the study in spring 2016, the district calendar included regularly scheduled PLC days—days designated for professional collaboration—when students either arrived to school late or were released early. However, with the onset of the 2016-2017 school year, this official planning time was not included in the district schedule. Though the district PLC time was removed, campus expectations for professional collaboration expanded in August 2016 with the arrival of a new campus principal who strongly prescribed to the PLC model. The new principal continued the writing initiative from the previous year, requiring that every teacher / team would identify writing objectives and show evidence of writing in their classrooms. As part of the Campus Improvement Plan, every teacher was required to complete an SAR designed by campus administration during third period (the chemistry teachers'

conference period). After that, all campus teachers were required to design and complete an SAR with their third periods every six weeks.

Collaboration with chemistry teachers began on February 26, 2016 and continued through January of 2017. During the fall semester of 2017, the chemistry teachers shared a conference period each day from 9:05 until 9:55 AM. The teachers and researcher met regularly (with only a few exceptions) each Thursday during their scheduled conference time in order to plan. As part of the Campus Improvement Plan, the teachers were expected to address writing each week, to follow a PLC protocol, and to submit evidence of planning in 2 documents (see Appendix A, Figs. A2-A3, p. 111-112). Teachers discussed writing in some capacity during every meeting (with the exception the CBA data analysis meeting on October 27, 2016). Teachers were involved in the creation of writing prompts, evaluation of student writing samples, and calibration of assessment practices four times over the course of the study. Though some discussion of writing occurred during most meetings, a considerably larger amount of time was spent discussing how to instruct the TEKS for chemistry. Chemistry teachers adhered to the district's scope and sequence document which prescribed weekly learning objectives based on the Chemistry TEKS. Chemistry teachers determined the most relevant learning objectives (the ones to be assessed on district CBAs), and discussed logistical concerns such as who would set up the lab, whose classes would be in the lab during which class periods, and clarifying expectations for upcoming campus events or teacher duties (fire drills, assemblies, benchmark testing, grade checks, and etcetera).

**Analysis Procedures**. The researcher performed data analysis of meeting transcriptions, observation notes, and journal entries regularly using horizon analysis

(Carspecken, 1996). The process involved inferencing at low levels, and over time, reviewing those inferences multiple times to reconstruct their meanings through position-taking and consideration of the norms at work among the chemistry teachers and the ELA teacher-researcher. After analysis of final interview transcriptions and re-analysis of the body of research, the researcher identified segments of the transcripts that addressed the research questions and performed deeper analysis that revealed the emergence of nine themes. The themes were checked against the entire body of data in an effort to find data points that either contradicted or confirmed themes. Five predominant themes emerged which will be discussed more fully at the end of Chapter Four:

1. Chemistry teachers had concern for students' writing ability and often felt frustrated by student writing outcomes.
2. Chemistry teachers perceived differences and incompatibilities between writing for chemistry and writing for ELA.
3. Chemistry teachers were aware of student reactions to writing in chemistry and were more apt to engage in extended writing activities with advanced students.
4. Chemistry teachers felt that time was a factor in their difficulty integrating writing into chemistry curriculum.
5. Chemistry teachers perceived writing as a tool for assessment of chemistry learning and did not prefer the use of STAAR-EOC SARs.

**Data Presentation**. Data, mostly in the form of direct quotations, were selected by the researcher to represent larger swaths of ideas running through a majority of data and are presented in an order to aid connections between themes and three research questions posed. Data presented in the subsequent sections, entitled, Participant Profiles

and Chemistry Teacher Narratives, was collected either during Thursday morning meetings or during semi-structured interviews that were administered twice over the course of the study from September 2016 through January 2017 (see Appendix B, Table B1 for data collection schedule, p. 115). The researcher applied to the data a loose narrative structure that reflected the points of interest designated by three research questions.

**Participant Profiles**

Participant profiles in terms of age, gender, current teaching assignment, years of experience, language background, and educational background are presented in Table 5. The three chemistry teacher participants were highly qualified teachers who prepared for multiple courses to be taught daily. Teachers are presented in order of seniority within the department. Real names have been replaced with pseudonyms.

Table 5 - *Participant Background Information*

| Name | Age | Gender | Teaching Assignment | Years of Teaching Experience | Language Background | Educational Background |
|---|---|---|---|---|---|---|
| Mrs. Patel | 48 | Female | • Chemistry (General)<br>• Chemistry (Pre-AP)<br>• Chemistry (AP) | 13 | Bilingual (Hindi & English) | B.S. in Biology<br>M.S. in Chemistry<br>M.Phil. in Chemistry |
| Ms. Jaimez | 36 | Female | • Chemistry (General/ELLs)<br>• Integrated Chemistry & Physics (General/ELLs) | 12 | Bilingual (Spanish & English) | M.S. in Education,<br>B.S. in Biology (minor in Psychology) |
| Mr. Brock | 28 | Male | • Chemistry (General)<br>• Engineering Design & Problem Solving | 5 | Native English speaker | B.S. in University Studies, Science for Secondary Education (minors in English & Business) |

Collecting information on each of the chemistry teacher participants was a crucial element of constructing a primary record. Furthermore, the researcher attempted to understand each participant's feelings about writing and experiences with writing. The researcher endeavored to probe the participants' past experiences with writing as students in addition to their ongoing experiences with writing as teachers. Gaining knowledge about participants' predispositions toward writing influenced the process by which the researcher made mid- to high-level inferences through position-taking.

**Mrs. Patel.** Mrs. Patel was the chemistry team leader and taught three preparations: chemistry for general education students, chemistry for Pre-Advanced Placement sophomores, and chemistry for Advanced Placement seniors.

***Predispositions for writing and writing instruction.*** Mrs. Patel was educated primarily in English private schools in India before coming to the United States. Of the three teachers, she had attained the highest levels of education; she was trained as a college lecturer of chemistry. Mrs. Patel reported writing frequently in her educational experiences: "When I was in high school, there was nothing like multiple choice. Everything was a notebook. . . . [B]ack in India . . . you write down questions and then you write down the list of your answers."

Ms. Patel related an openness to constructive feedback of her own writing. Such feedback, she said, allowed her to improve her writing and to transition from the writing expectations in India to those in the United States. Mrs. Patel perceived writing in India to be based more on quantity—how long or developed writing was—as opposed to quality and conciseness as on assessment (THEA) that she experienced in America.

Mrs. Patel reported receiving "whatever the school provided" in terms of training on how to instruct writing. She recalled three such "school provided" trainings, including: a district-developed training delivered by campus personnel in one half-day, back-to-school session; one faculty meeting in which campus staff presented the student expectations of the STAAR-EOC short answer questions; and writing training embedded in an AP workshop.

**Ms. Jaimez.** Ms. Jaimez taught chemistry for general education students and IPC (Integrated Physics and Chemistry), a course that was offered primarily to students who did not display skills ready to enter a chemistry course, or who failed the STAAR-EOC for Biology as ninth graders. Ms. Jaimez taught a majority of the ELL and special education students at the sophomore level.

***Predispositions for writing and writing instruction.*** Ms. Jaimez reported generally positive responses to writing, particularly from her college days as an undergraduate. Ms. Jaimez recalled asking her roommate or her aunt to proofread her papers and remembers wanting harsh feedback in order to improve her writing. She stated, "I know I'm not a good writer [so] I always had someone read it for me." In terms of writing training, Ms. Jaimez mentioned the campus writing sessions presented by the researcher two years ago as well as a week-long AVID training that utilized WICOR as a basis for instruction.

**Mr. Brock.** Mr. Brock teaches chemistry to general education students and an engineering design and problem-solving course developed as a course offering related to the school's new STEM academy. At the cessation of data collection, Mr. Brock announced that he would be taking off two-weeks at a time beginning in March 2017 to

participate in a paid internship as a process technology operator at a major chemical manufacturing company.

***Predispositions for writing and writing instruction.*** Mr. Brock stated that he always did the writing required of him in high school: "I have no problem—I had no problem writing myself, but as far as instructing writing it's a different story." Mr. Brock noted that he did writing primarily in his AP courses as a high school student. In college, he took two courses that were writing intensive, requiring formal live reports and scientific article summaries. He recalled often needing a "time crunch" in order to complete his written assignments. In response to the question about the training he received regarding writing, Mr. Brock mentioned the campus training that the other two participating teachers mentioned. He also remembered taking a Reading and Writing in the Content Areas course during his undergraduate work.

When asked to describe how he felt when he was told that the chemistry team would be collaborating with English teachers to improve student writing, Mr. Brock stated, "I'm always apprehensive a little bit because [writing] is something that I'm not as knowledgeable in. I know how to write, [but] there's a huge difference between knowledge and instruction." He said he was "semi-reluctant" to engage in collaborations with English teachers regarding student writing. When asked how he would regard writing in the classroom without the campus writing initiative that mandates writing in every class, he responded, "I'd probably end up not writing as much because it's less burdensome." He continued, "I know how to work with kids who don't know how to solve a particular math problem, but whenever it's something that I'm not comfortable

with it's a different story, and so, just because of that comfort effect, I'd probably be less likely to do it."

## Chemistry Teacher Narratives

Reconstructed narratives from each of the three chemistry teachers are presented in the following sections. The researcher grouped direct quotations according to their elucidation of chemistry teachers': 1.) Predominant classroom writing procedures and practices, including data representative of teachers' most common practices for writing in their chemistry classrooms; 2.) Perceived valuation of student writing and writing instruction in chemistry, including data representative of teachers' perceptions of the value of writing and writing instruction in their chemistry classrooms; 3.) Specific concerns or frustrations with writing and writing initiatives, including data representative of common concerns or frustrations with writing and writing initiatives.; and 4.) Assessment of student writing via a rubric, including data representative of teachers' processes and valuation of the activity.

**Mrs. Patel.** Mrs. Patel was the chemistry team-leader. She taught general chemistry, Pre-Advanced Placement Chemistry, and Advanced Placement Chemistry.

***Predominant classroom writing procedures and practices.*** In her first interview, Mrs. Patel cited lab reports as the primary form of writing used in her classroom. Classroom observations revealed that Mrs. Patel frequently used writing warm-ups (or bell-ringers) in which her students wrote brief responses to questions about the previous day's learning in their notebooks. Mrs. Patel also reported asking students to write brief summaries of the day's learning as exit-tickets. These exit-tickets were often written in available space on worksheets to be turned in as students left class.

When asked to describe the writing that she was doing in class, Mrs. Patel usually turned to discussion of her AP classes rather than the lower level classes. She reported writing considerably more with her Advanced Placement students—up to three pages per assignment—as the AP Chemistry exam requires that students respond to three timed writing tasks. When asked how she integrated writing into her general chemistry class, she reported giving students "a kind of stem structure where they fill out the information which I am giving them, but with my Pre-AP and AP kids especially, I really want them to write . . . everything—labs and tests. They [need] to explain [by] writing a paragraph about the concept."

***Perceived value of student writing and writing instruction in chemistry*.** Mrs. Patel asserted that writing is very important in chemistry because "[Writing] tells me exactly what they are learning" and also because learning chemistry "is [learning] abstract concepts" that must be explained. She acknowledged that writing is sometimes the only way to gauge students' learning of the conceptual, "microscopic work" of chemistry. Writing allows her to "get the view [of if] students are understanding the concept or not." She elaborated, "Because when they write it, they actually explain what they are getting. . . . I need to know if they are receiving [it] correctly or not."

Suggesting her high value of writing in chemistry, Mrs. Patel said that writing composed 50% of a students' grade average: "Everything is graded and they write a lot." This statement, however, seems to apply only to the AP class as she later admitted, "I wish I [could] do that in Pre-AP but, I am going towards that goal." When asked to describe her classroom writing, Mrs. Patel rarely discussed writing specifically with her general education students. When asked if writing instruction was valuable in chemistry,

Mrs. Patel discussed a sense that reading and writing in chemistry is different from the "imaginary, fiction accounts" that students learn in ELA classrooms; she stated, "It's a different form of writing."

Mrs. Patel made direct connections between the level of student writing and the level of student knowledge or general intellect. For Mrs. Patel, writing reveals a student's "level of learning." She stated, "Writing takes a lot of intelligence you know? If you are not like really good at it, then you don't get products. You have to think about writing."

When asked if she would change her practices if administration did not require a writing emphasis, Mrs. Patel stated:

> No. I won't change because I totally believe that in high school, kids are spoon fed. [Teachers say,] "Okay, this is my question, answer this in multiple choice. Fill in the blank." But when you go to college, everything is expected in written form, so then it is like a drastic change. So you better expose them in ninth, tenth, eleventh grade so that they're ready to, you know, take that leap.

Mrs. Patel later continued the idea that it is hard to use writing instructionally when students lack core knowledge of chemistry:

> I don't know how to teach [writing] to the people who are on just explaining things. But if you have acquired enough knowledge, and then you can compare something . . . that could be very beneficial. But what we are doing now with regular kids, we are actually checking their knowledge, making sure that they're getting all the material in the form of a [writing] passage.

***Specific concerns or frustrations with writing and writing initiatives***. Mrs. Patel voiced concerns about the quality of student writing, the impact of technology on student

literacy, the amount of time required to use writing instructionally, and the difficulty of using writing instructionally in chemistry.

Mrs. Patel expressed concern about the quality of writing that she received from students: “I don’t know if it’s laziness . . . but I get only rare examples [of quality work]. They are kind of programmed, their brains are kind of programmed that okay, I am just going to fill in the blank.” She stated that “even when you are teaching science, you are just [sometimes] amazed. It’s like [they have] elementary writing, and they don’t understand the basic concepts. . . . It’s their level of learning.” She continued, “I don’t know how—what problems you are facing in English, but in chemistry, I just don’t get what I am expecting sometimes.” Mrs. Patel laughed lightly when she admitted, “Some of the products are really, really good. But some of them, you think, ‘I would rather not do this.’”

Mrs. Patel mentioned the use of technology and social media as a deterrent to her perceptions of good, lengthy writing. She stated, “I know technology is overpowering us. Everybody wants to type, and we want to cut and paste. But somehow we are losing the art of writing there.” She perceived that “teenagers are more into video games, texting. Old school people will read newspapers, read more books. . . . So now, if you ask them to make a power-point or something, they will be more interested than, [if you tell them], ‘Okay, write it down.’”

Mrs. Patel stated that a lack of time is a concern because assigning writing results in “a lot of hard work” for the teacher. “Right now, I just have twelve AP students. What if my class was thirty? Then that would be a different thing. . . . To read everything, that would be like my own [responsibility] to do every weekend.” She acknowledged that it is

difficult to provide feedback "in a normal humanly manner," and stated that as a teacher, "You can only do so much" when it comes to writing and providing meaningful feedback. When asked about the emphasis on lack of time, Mrs. Patel admitted, "To be very honest, I never gave the whole class period [for students to complete a writing assignment]. I made it a warmup activity because . . . I do think writing is important, but I cannot incorporate it all the time." Referring to a day the researcher observed her class engaged in writing, Mrs. Patel reminded the researcher that it was the end of the grading period, her CBA was coming up, and she needed to spend time addressing material for the district assessment rather than student writing.

In addition to the time necessary for employing and instructing writing in the chemistry classroom, Mrs. Patel discussed the need for additional time to plan meaningful writing prompts: "If timing is allowed, every lesson can become a writing assignment." In addition, she noted the long-term nature of integrating writing into chemistry:

> Definitely we are using writing in our curriculum a lot. And everybody wants to. But we just need planning time ahead of time so that we can come up with, 'Okay is it going to be a good prompt?' And then see during the year, 'Okay, I think it's a good [prompt], but am I getting good results out of it?' You have the time at the beginning of the year to make [a] plan. And at the end, to reflect and say 'Okay, is it working or not?' That would be something I wish we could do.

Mrs. Patel addressed the difficulty to write during certain units of study in chemistry—a difficulty that became apparent during several of the weekly planning

meetings. When asked in her second interview if she thought that writing helped students to learn chemistry, she responded:

> Yeah. Definitely. Because if they can relate the science, which is fact-based, to real life situations, and [explain] how there are pros and cons for everything, that would be great. So, there are some topics which can be great writing topics. But sadly, second semester is more math-based. So, we cannot find—when you're doing something calculation-based, it's more that you want to see the steps rather than the paragraph.

Mrs. Patel declared that it might be advantageous to talk to the math teachers about how to use procedural writing more effectively during these 'calculation-based' units and mentioned that the science teachers are told in department meetings, "'Oh, you don't have to write a passage. Even if it's . . .a warm-up or exit ticket, that's fine.'" In a later part of the interview, Mrs. Patel summed up by stating, "You can come up with really great prompts, but not for everything. It will be vague and general. Not specific to the TEKS."

***Assessment of writing via a rubric.*** Mrs. Patel noted that "giving them the rubrics actually helps" to get better writing products. When asked if it is a chemistry teacher's job to instruct writing, Mrs. Patel asked, "What do you mean by instruct?" She talked about the teacher's job to specify expectations in the form of "dos and don'ts" for students. She said, "So the first two samples, I graded myself looking at the rubric. But the next time, I gave students the rubric. That helps a lot because then they can see what's expected." She said that it took about 3-4 minutes to assess a single writing assignment and referenced scantron tests (multiple choice) as much quicker to grade. Mrs. Patel reported feeling confident that she was consistent when grading with the rubric and

mentioned that feedback on writing assignments is more important than the actual grade. When asked, she stated that about 33% of a student's average should be based on the quality of their writing.

**Ms. Jaimez.** Ms. Jaimez teaches general chemistry and integrated physics and chemistry (IPC). She teaches the majority of ELL students at the sophomore level.

***Predominant classroom writing procedures and practices.*** Ms. Jaimez mentioned lab summaries in addition to requiring an interactive notebook as the dominant forms of writing that her students do in the classroom. In labs, she required students to write out the answers to questions about the lab procedures. Ms. Jaimez described the interactive notebook as containing "a little bit" of the writing that students do in her class and specified vocabulary, examples, and mathematic calculations as written in the notebook. She explained that students set up the notebooks so that they took notes on the right-hand side, while the left-hand side was dedicated to "practice [of] the math problems." "Every once and awhile" she has them "write out the steps to follow." She also mentioned procedural writing in which students explain the steps that they took to solve the problem, but she noted that that form of writing could be very difficult and awkward for ELL students.

In her initial interview, when asked about scoring writing, Ms. Jaimez stated, "I never give lower than a seventy unless they just wrote like a sentence when it was supposed to be a paragraph." She added, "I don't look at grammar at all because I know sometimes it's atrocious . . . but if they truly understood the topic, I'll give them 100%. When they leave something out, that's when I start taking points away." Her common

practice is to "spot check" the assignments as they are turned in—giving instant feedback or refusing to accept assignments that are not complete.

In her subsequent interview, Ms. Jaimez discussed writing with her students "at least once a month," meaning that in addition to warm-ups and writing in the interactive notebook, she would require an extended response (from 10 to 20 minutes). Also in the subsequent interview, when asked what advice she would give a new teacher being told to do writing in her chemistry classroom, she said:

> Just make sure that you're clear about what you expect from the students within their sample. And try to give them an idea. If you have samples for that, or ask another teacher that might have done the same writing assignment so that you can look at what it should look like, and let the students be able to read that.

Ms. Jaimez added that she also had success with projecting "lower end" responses and encouraging students to revise by saying, "'Okay, this person did a good job organizing, but they [should have] include[d] this information.'" Ms. Jaimez said that she doesn't really instruct writing, "It's more of me just having to read the sample, and then once I read it, I can help them."

***Perceived value of student writing and writing instruction in chemistry.*** When asked if writing is useful for learning chemistry, Ms. Jaimez replied, "Oh of course." She then began to describe the annotations that she requires students to do when reading word problems. Ms. Jaimez reported writing warm-ups as particularly valuable for knowing what concepts that the students did not master and how to reteach them. Another value for writing in chemistry (and physics) is to elicit application of what students learned. She noted, "Biology (at the high school level), it's a lot of memorization, very little

application to certain concepts. But one you get into chemistry and . . . physics, it's a lot of application. That's why students struggle with chemistry . . . and physics because they have to actually apply the content." In addition to revealing students' abilities to apply knowledge, writing "does help the students out and it lets [teachers] see whether they're truly understanding, especially when it comes to the vocab-intensive sections." Ms. Jaimez acknowledged that, "It doesn't matter what class you have . . . it's a good thing that we are writing and trying to get the students to write to be able to express their ideas because when they actually get out into the workforce, they're going to have to do that . . . . They're going to have to do some sort of writing within their job."

***Specific concerns or frustrations with writing and writing initiatives.*** Ms. Jaimez expressed concern with student attitudes toward writing, with the difficulty of producing meaningful writing opportunities for students to write about specific units, and with the time allowed for writing while maintaining time for labs and covering the TEKS.

Ms. Jaimez said that when requiring writing, she has found it important to make it worth a grade in order to get students to complete it. She smiled when she explained that on several occasions she told students that the writing portion of an assignment or test was worth anywhere from 31% to 40%, "because that's one way to get them to write." She continued, "They refuse to do the essays; they'll take the seventy [because] they don't want to do the writing." She noted that students often turned in work, saying, "'Don't read it, Miss'" either because they were apprehensive of their responses or because they knew that she often gave students instant feedback, telling them to go back and fix or add to their responses.

Ms. Jaimez admitted that it is sometimes difficult to plan meaningful writing assignments for her students; she cited units that focused on the periodic table or on mathematic calculations, such as moles and stoichiometry, as examples.

In addition to student attitudes about writing and planning meaningful writing opportunities, Ms. Jaimez lamented, "I'm always like a week—three, four days—behind everyone else because I try to incorporate [labs] with the lesson. That's what makes science fun." She said that she does the procedural writing, even with labs that don't lend themselves to writing, "but . . .especially with LEP students—to find the words to go through the steps, it is really hard for them. . . . They can *do* it, but to explain *how* they did it, they're struggling with that."

***Assessment of writing via a rubric.*** When asked about development of the writing rubric and collaboration with English 2 teachers, Ms. Jaimez stated, "I like the idea of going in and helping to create the rubric because that really helps with grading . . . and I feel that it also let us see what is expected there in the English [classroom] compared to what's expected in the science classroom." Ms. Jaimez also stated, "I think the rubric is more for the students so they know what we expect. Creating prompts that are based on chemistry TEKS seemed better to Ms. Jaimez than the previously campus-mandated STAAR-EOC short answer questions (SARs). SARs required written responses using evidence from articles about chemistry. Ms. Jaimez stated, "If you can find an article that would interest the students, I feel that it's beneficial, but if it's just like, 'I have to do it. Just read this' . . . then it's tough on the kids because it's a tough read for them [because it's not on their reading level]."

When asked about the process of developing the rubric and collaborating with an English teacher, Ms. Jaimez responded, "What I think was the most beneficial was when you were helping us to write the question to where we would be very specific. I think, honestly, that was the hardest thing for us to do. . . . We could come up with stuff, but it was very broad."

Ms. Jaimez noted that the writing rubric was versatile for various topics in chemistry and allowed her to be consistent with grading and feedback. She noted that scoring mid-range responses took longer because they require more deliberation and closer application of the rubric. Ms. Jaimez noted that the rubric increased instructional time about writing because she had a better idea of her expectations for the students. "Before [the rubric] I was like, 'Okay, you did something and it made sense. I'm just going to give you a participation grade and give a 100%.' Now I'm actually looking at the actual papers, and making comments on them, writing on them."

**Mr. Brock**. Mr. Brock teaches general chemistry and engineering design and problem solving.

***Predominant classroom writing procedures and practices.*** In the first interview, Mr. Brock reported having students write approximately once a week by writing definitions or explaining previous learning in a warm-up. He explained that he had been pushing his students in engineering design and problem-solving class to write more by adding "summary papers." When asked to discuss a writing activity that he had done with his students, he spoke about TELPAS writing samples that he did the previous year with his ELL students, and the prompts that the chemistry team developed, then said, "But

sometimes [classroom writing] turns into just a warm-up activity, 'Hey, write two or three sentences about this.' This year, it has mostly been a warm-up situation."

In the second interview, Mr. Brock explained his use of Google Classroom to post a question to which students were asked to write a "small paragraph," about "three to four sentences" with a "10-minute time limit." He discussed his realization of the importance of specifying that students should "use their notes," but that they should not "copy their notes" as their response to the question.

When meeting the previous campus expectation to complete an EOC-STAAR short answer response based on an article, Mr. Brock enthusiastically recalled his use of a "very biased piece about dihydrogen monoxide, which is water." He asked students to write whether or not they agreed with the article, and enjoyed revealing the fallacious nature of the article to the students. Other than this successful lesson involving writing, Mr. Brock stated that it was difficult to find articles that were interesting, TEKS aligned, and on an appropriate reading level for his students. He also recalled that rather than requiring a short answer response, he had required that students create a flowchart after reading a reading passage.

***Perceived value of student writing and writing instruction in chemistry.*** Mr. Brock reported that writing is important in chemistry from a professional standpoint—students need to be able to write emails and other professional writing for their futures. He noted that "There are engineers who pretty much their whole job is to write manuals for things. They tell you precisely—in short sentences—what to do."

Mr. Brock was aware of the importance of presenting one's ideas well in social media to maintain credibility, and recounted an experience in which he misspelled words

in a mass email of friends and fellow students that resulted teasing. He stated "So—that's the—the reason why I care about the grammar—because of the things that happened to me mostly." Later in the interview, Mr. Brock expressed the desire to know more about "the rules" of writing. Mr. Brock felt that writing was valuable for assessment of students' understanding of chemistry: "I think you can definitely better understand how they understood something via writing."

***Specific concerns or frustrations with writing and writing initiatives.*** Mr. Brock addressed students' lack of formality in their written assignments. He laughingly recalled, "I had one girl who turned in [a paper] that [had] LOLs and other stuff in it. . . I was like, 'This is not the kind of paper I'm looking for.'" In addition to a lack of formality with writing, Mr. Brock commented on his frustration with student apathy, not only for writing, but also for learning chemistry. He shared discussions that he had with individual students to encourage them to put in the effort since, "Chem-is-*try*." On several occasions, he emphasized the necessity for students to write complete sentences, and that sentences should be short, but not too short. Mr. Brock noted that writing in chemistry was hard for his chemistry students due to the large amount of content that was new to them, "If I had them write something that was—that they're familiar with, I'm sure it would be much more well-written."

In both interviews and in a Thursday planning meeting, Mr. Brock lamented the lack of participation in a Science Fair. He discussed the writing intensiveness of participating in science fair, and in his second interview recalled how even when he was in school, the science fair was "for the advanced kids, it was home-based thing . . . all done pretty much outside of school."

Mr. Brock seemed aware that students' writing in chemistry is different from that required in ELA courses. He commented that unlike writing in English class, writing in science should be "concise, technical writing. Very little first person." Mr. Brock noted that writing in science does not say, "'I did this'" but rather uses passive forms avoided in other styles of writing. His discussion revealed that his perceptions of writing in ELA are primarily narrative and imaginative rather than technical and factual. When asked when students should receive instruction on how to write in a technical way, he mentioned the developmental process of removing the self from one's perceptions, and thus one's writing: "I think they would need to be able to . . . set aside personal beliefs and focus only on that. The need to take themselves out of it and focus only on the information they receive to develop a conclusion."

On several occasions, Mr. Brock expressed concern about students' reactions to being asked to write, the feelings associated with writing, and the impact of negative feedback on one's writing. He reported that his current students seemed less reluctant to write than students from previous years. He hypothesized that the students' increased willingness to write was due to the increased amount of writing required in all of their classes as a result of the campus-wide focus on writing. He seemed to understand student reluctance as he noted that "sometimes, especially [with writing] you have to open up yourself. And so, it's like revealing a part of yourself and then being told that it's terrible. That hurts you inside."

Likewise, Mr. Brock noted that a teacher's emotions are engaged when expecting writing from students. When asked why teachers seemed to expect more writing from advanced students, he said, "Teachers probably do it [less with general education

students] because they get less. . . they get more positive feedback from those [advanced students], so that makes them feel better." He continued, "Emotionally-wise, if you do an assignment and you get junk back, then it makes you feel—it doesn't feel good. And so, if you do with students who you know could give you good stuff—it's almost a—like a personal thing." Further examining the admitted phenomenon of writing more with advanced students, he said, "[Teachers] spend less time setting it up and explaining expectations. . . . With a more advanced class, they understand what the expectations are."

Mr. Brock frequently expressed concern about taking class time to do writing assignments in addition to meeting the TEKS requirements for chemistry. He noted that the length of writing that he assigned would depend greatly on "Where I'm at in my instruction. . . The TEKS [come] first, and secondly, the writing portion." He addressed the need for a common planning period in addition to the 3rd period conference time. Mr. Brock noted that he perceived irony in the campus administration's emphasis on PLC, yet the failure to provide scheduled time for that collaboration to occur in non-EOC tested areas such as chemistry: "We're supposed to meet every Thursday [during] school . . . and Mrs. Patel leaves right a three o' clock every day. So, if we need [an additional] meeting, it has to be [in the fifteen minutes] right after school."

***Assessment of writing via a rubric.*** When discussing the rubric development phase of the intervention, Mr. Brock specifically recalled the sorting of student papers into low and high responses and the team's realization of the need for a mid-range category. On several occasions, Mr. Brock related a concern for students' feelings regarding the assessment of their written work: "We don't want them going, 'I'm a

failure.'" He also noted in his first interview that the rubric "was continually changing" as it was applied to increasing numbers of student samples in order to gain accuracy and completeness for subsequent use.

When asked about his application of the rubric, Mr. Brock reported providing "little to no feedback" for his students even though he acknowledged that he would have wanted to get feedback for his efforts as a student. He described his provision of feedback as "terrible," adding, "I would like to—being who I was, I like[d] to see what rubric was used to grade it and why I received the grade that I received. . . . I would [have wanted] to argue with it . . . And—I definitely didn't have the time for [my students to do] that."

Mr. Brock acknowledged the potential for increased instruction of writing in chemistry with sustained use of the rubric, "If they were taught how to use their rubric—because if we use it continually throughout the year, the same rubric, then they can be taught to do it and it could be done quickly, assuming that they do it properly." Mr. Brock then mentioned the lack of time and the need for better organization on his part for this type of writing instruction to occur. When asked about his level of confidence with providing writing instruction, he said, "I feel more confident because I have developed more of an understanding of what they should be turning in to me." He quickly noted, however, "It can be semi-frustrating in that I feel that I don't get back what they should be giving me."

**Emergent Themes**

Five themes emerged from this study. Each one will be discussed below.

**Theme One: Chemistry teachers had concern for students' writing ability and often felt frustrated by student writing outcomes.** Chemistry teachers expressed

concern for individual students as well as sophomore students as a whole. This theme emerged early in the study and was reflected in data from most meetings and interviews. Teachers shared their perceptions of students' writing abilities especially when sorting student writing samples and engaging in discussion about developing the rubric. Concerns for individual students' writing was also verbalized through short, casual interactions among teachers in the teacher's lounge, hallways, and faculty meetings. The researcher frequently documented in her journal the names of students mentioned by chemistry teachers as being successful or unsuccessful on written assignments. Though chemistry teachers addressed exemplary writing outcomes from individual students as well as improved writing outcomes from groups of students, chemistry teachers primarily expressed their concern through the emotion of frustration, commenting frequently on student apathy, lack of background knowledge, or poor writing skills. Chemistry teachers justified their concern and frustration by commenting on the future educational and professional demands for good successful writing.

**Theme Two: Chemistry teachers perceived differences and incompatibilities between writing for chemistry and writing for ELA.** In both meeting transcriptions and interview data, the researcher noted moments of resistance to eliciting student writing during units that chemistry teachers regarded as math heavy. Though teachers were aware of the possibility of eliciting procedural writing, for students to 'write the steps' out in paragraph form, most teachers seemed to prefer that students make numerated, or even bulleted lists. Ms. Jaimez noted that oftentimes the procedural writing seemed awkward for students to manage. The chemistry teachers felt that writing elicited from procedural writing was inauthentic and unbeneficial to student learning. During those periods when

writing ‘just didn’t go’ with the chemistry learning objectives, teachers continued requiring brief (3-4) minute warm-ups in which students were asked to express the previous day’s learning in 2-3 sentences. It is important to note that though the chemistry teachers were not requiring extended writing opportunities, they were, in fact, expecting that students use literacy strategies aligned with literacy in science and mathematics when students wrote calculations, definitions, lists of steps, and scientific notations.

Chemistry teachers discussed the tendency of students to use styles more suited to writing in ELA when responding to writing prompts in chemistry. For example, a student might begin a response with a rhetorical question (taught by some ELA teachers as a ‘hook’ in an essay). Mr. Brock, was aware of his students’ use of first person, while both Mr. Brock and Mrs. Patel linked ELA instruction with the writing of narratives. All of the chemistry teachers described the need for students to use language that was technical, concise, and clear when writing. In almost all instances of discussing student writing, the chemistry teachers expressed frustration at students’ failure to use original language rather than borrowed language from notes or other sources.

**Theme Three: Chemistry teachers were aware of student reactions to writing in chemistry and were more apt to engage in extended writing activities with advanced students.** Though this theme initially seemed embedded in theme one, it gradually emerged as a separate theme as it was evident in teacher talk about student apathy, resistance, or confusion about writing in chemistry. Teachers reported that students were the least likely to put effort into writing that was clearly in SAR format (on paper that resembled the STAAR-EOC SAR answer documents consisting of a question and a box of 9 lines) (See Appendix A, Fig. A4, p. 113). Chemistry teachers noted that

students were cued-in to writing tasks when teachers passed out lined paper, and that many asked if they should respond in SAR format even when the responses were not printed on SAR-formatted paper. Teachers talked about the reasons for student resistance to writing and ways that they had attempted to explain, justify, or even negotiate with students in order to encourage them to write. All three chemistry teachers told their students that English teachers may be reading their responses when expressing their expectations to students and perceived that students worked more diligently on writing that they believed would be evaluated by their ELA teachers.

Mrs. Patel and Mr. Brock displayed more enthusiasm for writing with the AP and STEM students respectively. Both of these teachers discussed that they found writing from students who were either more proficient in writing or who had a stronger command of the chemistry concepts to be easier to read and assess. Mr. Brock elaborated on the psycho-emotional needs of teachers to feel validated as instructors when they were satisfied or impressed with student writing. Ms. Jaimez did not teach advanced coursework, and her expectations for student writing were primarily warm-ups, short explanations of labs, and writing definitions in notebooks. She explained that prior to the intervention, she had not planned extended writing opportunities for her students.

**Theme Four: Chemistry teachers felt that time was a factor in the difficulty of integrating writing into chemistry curriculum.** The stress of 'having time' to write and teach chemistry was evident in virtually all data sets especially those from planning meetings. Even after deciding as a team to give students extended time for classroom writing, two of the teachers explained giving the prompt as a warm-up and one teacher began classroom instruction while a majority of students were still writing responses to

the prompt. In addition to the perception that there is not enough time for classroom writing, chemistry teachers noted a lack of time to score responses, plan prompts, and collaborate either with each other or with ELA teachers with mutual students. Chemistry teachers were constantly constrained by time and viewed time for writing as time taken away from instructing the TEKS for chemistry.

**Theme Five: Chemistry teachers perceived writing as a tool for assessment of chemistry learning and did not prefer the use of STAAR-EOC SARs.** Regardless of if the writing expectations were for students to produce quick responses (warm-ups / exit tickets) or to produce extended writing in paragraph form, chemistry teachers felt the need to assess student writing. Chemistry teachers were resistant to the idea that students could write responses that could help them to self-assess. Compelled to 'put grades' on extended writing or to give instant verbal feedback on all writing, the chemistry teachers did not feel confident about, did not fully understand, or did not find worthwhile methods associated with writing-to-learn that may have made students more aware of or accountable for their own writing and thinking.

In planning meetings and interviews, chemistry teachers demonstrated lack of enthusiasm for eliciting writing based on articles or other reading passages. With the exception of one instance—Mr. Brock's success with the biased piece about dihydrogen monoxide—chemistry teachers expressed frustration for identifying articles that: corresponded with the TEKS, were interesting to students, and that were on the students' reading levels. Additionally, chemistry teachers were put off by students' inability to manage citations taken from the article as evidence to support their answers. Chemistry

teachers seemed to sense that writing was inauthentic to scientific writing demands when students were responding in SAR format.

**Limitations**

This study was limited by several factors. Specifically, the single locale and the subjectivity of the researcher limited the study in terms of reproducibility and trust-worthiness. Because the researcher was a member of the faculty, and because she had more years of service on the campus than any of the chemistry teachers, it is possible that the verbalizations of chemistry teachers, collected through meetings and interviews, failed to reflect chemistry teachers' true feelings about student writing and campus writing initiatives. The researcher developed both personal and professional relationships with teachers through years of interaction. It is possible that these relationships and the researcher's ardent desire to increase student writing influenced both the responses of her chemistry teacher peers and her interpretation of data.

Efforts to ameliorate the limitations were made by involving the chemistry teacher participants in member checking of data, including the narratives presented and the themes discussed. The researcher relied on peer debriefing through conversations with educational experts and academic peers when conducting data analysis and reconstructing narratives. Additionally, the researcher used negative case analysis, a process of reviewing both meeting and interview transcripts for any data which might contradict themes, in order to ensure a high level of trust-worthiness. The findings and themes presented in this study are not generalizable, though several elements of the study may certainly reflect attitudes and practices of chemistry teachers in other high-need secondary schools.

## Conclusion

This chapter presented data from each participant in support of five emergent themes. The researcher described data analysis procedures and careful application of Carspecken's (1996) methods for ethnographic research. Data and emergent themes suggested that guiding chemistry teachers through a cycle of planning prompts, developing rubrics, and analyzing student writing samples can be an important strategy for increasing writing instruction in chemistry classrooms. Furthermore, collaboration of chemistry teachers and ELA teachers can provide productive professional development when it is respectful of the expertise of chemistry teachers and supported by district administration.

Chapter Five will discuss the significance of the five emergent themes, their implications for further study, and their usefulness for providing answers to the three research questions central to the study.

# Chapter V

## Significance, Recommendations for Further Study, and Conclusion

This study explored the attitudes and the behaviors of chemistry teachers in a Title I high school as they implemented a writing intervention. This chapter will review researcher positionality and the five themes that impacted construction of the answers to three research questions: 1.) How do chemistry teachers offer instruction in writing? 2.) How do chemistry teachers value writing as an instructional tool? And, 3.) How do chemistry teachers assess writing via a rubric? This chapter will also explore the significance of the study as it contributes to prior research regarding the various roles of literacy approaches, bottom-up professional development, and school culture. The chapter will present implications for administrators, teachers, and future research.

### Researcher Positionality

The discussion in this chapter should be viewed with consideration of the values of the researcher as she attempted to extract meaning from her professional interactions with colleagues. The researcher was motivated by several beliefs that have developed over her 17 years of experience with teaching English Language Arts in a secondary school. The researcher has been motivated by the goal of enhancing student success in writing. She believes that students' academic success is often indicated by their ability to perform writing tasks both efficiently and effectively. Furthermore, the researcher believes that all students deserve to have rigorous writing instruction regardless of their academic level and that it is possible for teachers to offer high levels of writing instruction for all students in high-need schools. Additionally, the researcher believes that teachers deserve to have a voice in the development of the instruction they deliver and

the manner in which they deliver it. These values permeated the discussion of findings, impacted every facet of the qualitative research, and are presented here as both strengths and limitations of the study.

**Review of themes**

Five themes emerged from the research conducted.

1. Chemistry teachers had concern for students' writing ability and often felt frustrated by student writing outcomes.
2. Chemistry teachers perceived differences and incompatibilities between writing for chemistry and writing for ELA.
3. Chemistry teachers were aware of student reactions to writing in chemistry and were more likely to engage in extended writing opportunities with advanced students.
4. Chemistry teachers felt that time was a factor in their difficulty integrating writing into chemistry curriculum.
5. Chemistry teachers perceived writing as a tool for assessment of chemistry learning and did not prefer the use of STAAR-EOC Short Answer Responses.

These five themes guided the researcher in constructing answers to three research questions.

**How do chemistry teachers offer instruction in writing?**

Chemistry teachers' delivery of writing instruction was limited and partial. In great part, the absence of writing instruction was based on teachers' incomplete conception of what it means to instruct writing. Because chemistry teachers primarily viewed writing as an opportunity to assess the knowledge of their students rather than as

a viable instructional tool, writing instruction initially emerged as the mere expectation for students to sit and to write. Though providing time for students to write in class is certainly valuable, since students, to some degree, learn through practice, chemistry teachers failed to offer writing instruction, but merely read the prompt, briefly stated expectations related to required length and time. Two of the teachers provided limited one-on-one feedback when students completed and submitted the assignment, providing brief instructional guidance on how to improve the response. Toward the end of the intervention, two chemistry teachers moved somewhat closer into the realm of writing instruction by projecting the rubric and reading it to students; Mrs. Patel and Ms. Jaimez projected the prompt, projected exemplars reading, and discussed the quality of student exemplars (or non-exemplars, in the case of Ms. Jaimez).

Chemistry teachers' perceptions that writing did not contribute to student learning in certain units of study restricted efforts to instruct writing. Chemistry teachers perceived that writing was not a viable way to improve student learning during certain units, especially in stoichiometry. Teachers' awareness of their students' negative reactions to writing assignments discouraged their use of extended writing in the classroom; however, they reported that student resistance lessened somewhat and contributed this phenomenon students writing more frequently both within chemistry classrooms and in their other courses. The perceptions that writing instruction detracted from time available for instructing targeted TEKS, and the lack of writing activities specified in the district's curricular scope and sequence documents limited opportunities for instruction writing in chemistry. Chemistry teachers failed to report provision of instruction when administering the campus-mandated STAAR-EOC Short Answer

Responses, but presented the assignment, passed out paper for writing, and expected students to perform the writing task.

**How do chemistry teachers value writing as an instructional tool?**

The chemistry teachers in this study did not value writing as an instructional tool for teaching of chemistry, rather they valued writing for its role in planning instruction and assessing student learning.

Although chemistry teachers engaged in WTL strategies such as warm-ups and exit tickets, they regarded these activities as useful for providing a formative assessment of the effectiveness of instruction, not as instruction in itself. Teachers did not capitalize on the metacognitive benefits of writing, but spoke about how they could assess students' knowledge through in-class writing. Although chemistry teachers engaged in DL strategies such as lab summaries, they offered no instruction on the forms of writing that might distinguish a lab summary from an exit ticket or a book report. Chemistry teachers valued writing instruction as it is performed in ELA classrooms, they did not value writing instruction as a tool for students to actively learn chemistry content.

Chemistry teachers did report that the generation of writing prompts was an effective tool for planning instruction. The development of prompts provided an opportunity for chemistry teachers to target learning objectives that students needed to master according to district and state documents. Ms. Jaimez said that the collaborative effort of writing prompts with an ELA teacher was the most helpful part of the intervention because it made her focus on the learning objectives and how to elicit the best response from students. While reviewing student writing samples, teachers referred back to their prompts; they attempted to hone prompts to elicit the responses that would

best assess student chemistry learning. Chemistry teachers' development of prompts is more fully discussed in the subsequent section entitled, Implications for Teachers.

The study revealed that chemistry teachers regarded writing instruction as separate and secondary to chemistry instruction. Mrs. Patel and Ms. Jaimez seemed to gain slightly higher value for writing as an instructional tool when they discovered the use of both the rubric and student exemplar responses as instructional tools that could be used prior to assigning writing. The rubric became a tool for instructing students about the elements that students should consider when crafting their responses. Chemistry teachers perceived that writing instruction, offered through expressing specific expectations and providing exemplars to students, was beneficial in that it facilitated better writing products that would more accurately reveal students' attainment of chemistry learning objectives. Chemistry teachers perceived writing as a valuable tool for planning instruction and for assessing instruction, but not primarily as a tool for instruction of chemistry.

**How do chemistry teachers assess writing via a rubric?**

Chemistry teachers assessed writing via a rubric infrequently and with some resistance. However, teachers reported that the use of the rubric enabled them to score student work confidently and efficiently. Teachers felt that their scoring was consistent and that they were able to provide feedback quickly and accurately. Chemistry teachers appreciated that the rubric offered opportunities to commend students on areas in which their writing was successful and to provide constructive feedback on areas in which their writing detracted from their overall responses. Teachers reported placing value on feedback that revealed both concerns for students' writing abilities and an awareness of

students' emotional responses to writing. When working collaboratively to assess student writing, teachers enjoyed sharing responses based on the quality (good or bad) of specific student responses. Teachers also commented on both improved and disappointing performances of specific students, especially those of students who were taught by the researcher.

Teachers displayed some resistance to using the rubric, but preferred the development of their own rubric to the use of the SAR rubric. Resistance was evident in three ways: First, not all of the teachers reported providing feedback for students using the rubric. Second, not all teachers administered the writing prompt within in the time frame prescribed in the meetings and therefore did not procure their own samples for rubric development. Third, scoring calibration and rubric development meetings were often brief, occurring in the time that remained after chemistry teachers had planned their instruction of the TEKS. Regardless of resistance and difficulties, the development of their own rubric and prompts allowed chemistry teachers to address the campus writing mandate on their own terms, rather than with the use of the SAR format. This was important because chemistry teachers sensed an incompatibility between SAR writing tasks and the writing tasks that they considered appropriate for writing in chemistry.

Chemistry teachers used student writing samples to engage in discussion of the rubric on four occasions. Teachers created three iterations of the rubric based on the strengths and weaknesses that they noted in student writing. Chemistry teachers preferred the use of their own rubric to the STAAR-EOC SAR rubric because the SAR rubric required students cite textual evidence to support inferences while chemistry teachers wanted students to synthesize knowledge, putting it into their own words rather than

borrowing words from extended reading passages while chemistry teachers expected students to support their answers by synthesizing information from a variety of sources, including charts, diagrams, graphs, labs, textbooks, and videos. Chemistry teachers' development of the rubric is more fully discussed in the subsequent section entitled, Implications for Teachers.

## Approaches to Literacy, Professional Development, and School Culture

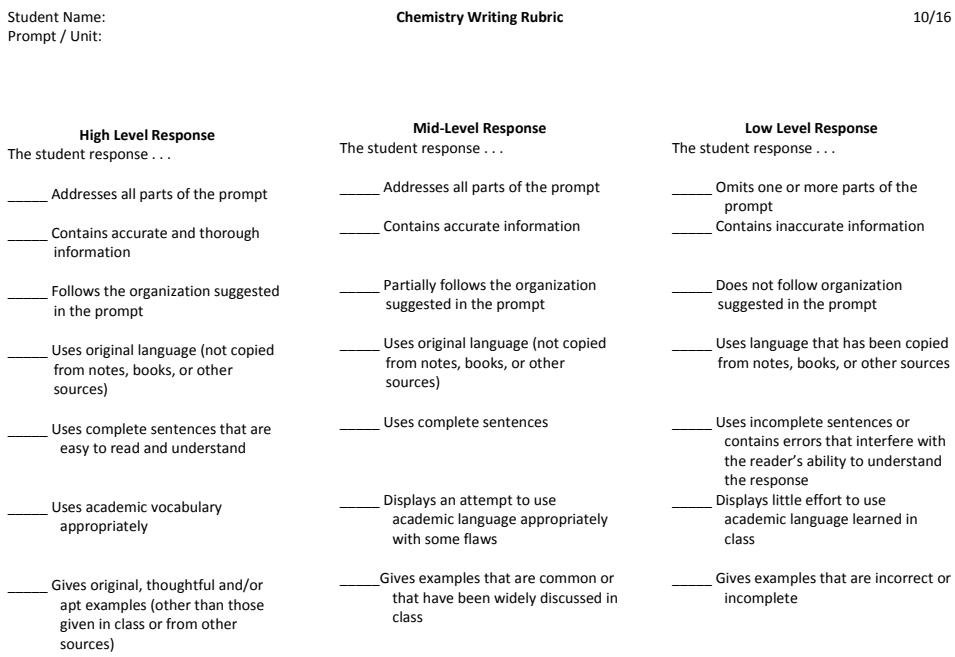
The answers to these three research questions pointed to other questions inherent in the various approaches to literacy instruction, professional development, and school culture.

**Content Area Literacy and Disciplinary Literacy.** Specifically, the study highlighted the benefits and drawbacks of CAL and DL. The school-wide initiative to complete SARs in every course, to require teachers to select articles and develop a question for students to answer in writing, was a generic strategy that was conducive to literacy learning in all areas of study. The implementation of CAL promoted a school-wide culture that valued gaining knowledge through reading regardless of the subject. Mr. Brock's dihydrogen monoxide article and corresponding SAR was an example of the applicability of a CAL approach in a science classroom. Such CAL activities can be a gateway for non-ELA teachers to engage in literacy; however, the too stringent application of CAL practices might actually hinder teachers from engaging in DL writing that would enable them to more directly address their curriculum and the specific writing demands of their courses.

The chemistry teachers' formulation of prompts and a rubric to address their specific expectations for student writing in chemistry was more akin to DL, yet closer

examination suggested that the rubric designed by the chemistry teachers did not elicit forms of writing that were overly specific to the scientific disciplines—an ELA teacher might easily use or adapt this rubric (Fig. 3) depending on the type of writing elicited:

Figure 3 – *Final iteration of rubric, October 2016*



Student Name:
Prompt / Unit:

**Chemistry Writing Rubric**

10/16

**High Level Response**
The student response . . .

_____ Addresses all parts of the prompt

_____ Contains accurate and thorough information

_____ Follows the organization suggested in the prompt

_____ Uses original language (not copied from notes, books, or other sources)

_____ Uses complete sentences that are easy to read and understand

_____ Uses academic vocabulary appropriately

_____ Gives original, thoughtful and/or apt examples (other than those given in class or from other sources)

**Mid-Level Response**
The student response . . .

_____ Addresses all parts of the prompt

_____ Contains accurate information

_____ Partially follows the organization suggested in the prompt

_____ Uses original language (not copied from notes, books, or other sources)

_____ Uses complete sentences

_____ Displays an attempt to use academic language appropriately with some flaws

_____Gives examples that are common or that have been widely discussed in class

**Low Level Response**
The student response . . .

_____ Omits one or more parts of the prompt

_____ Contains inaccurate information

_____ Does not follow organization suggested in the prompt

_____ Uses language that has been copied from notes, books, or other sources

_____ Uses incomplete sentences or contains errors that interfere with the reader's ability to understand the response

_____ Displays little effort to use academic language learned in class

_____ Gives examples that are incorrect or incomplete

Even though the rubric is not particularly chemistry-specific, giving chemistry teachers the opportunity to create a rubric that they deemed useful for writing in chemistry was more respectful of their disciplinary goals for writing. While the SAR mandate opened an avenue for establishing cross-curricular expectations and conversations between teachers and, while it helped to increase the level of urgency to facilitate literacy activities for students across the content areas, it was not necessarily effective for a DL approach.

**Bottom-Up Professional Development**. A particular interest of the researcher in the development of this study regarded the possible effectiveness of bottom-up professional development in which teachers collaborate with each other to create meaningful writing interventions rather than depending on hired outsiders such as literacy specialists or consultants to guide the implementation of classroom writing. The teacher collaboration between chemistry teachers and the ELA teacher-researcher produced an environment in which teachers shared not only the responsibility for student success but also the same environment and context. Furthermore, the professional collaboration was enacted in "real time," during the shared conference period of the teachers rather than as professional development provided outside of the regular school day.

The researcher was very careful to regard chemistry teachers as masters of both their content and of their classrooms; she consciously strived to allow chemistry teachers to guide the prompt and rubric development as well as the discussions about assessment of student work. When chemistry teachers requested guidance about what they should be doing, the researcher attempted to present the ways that ELA teachers go about the instruction of writing without suggesting that there is a set, correct way to do so. The researcher also endeavored to turn the question back to the chemistry teachers by asking them what specific elements of content and conventions that they expected in student writing. The researcher oftentimes reminded the chemistry teachers that their focus was ultimately on how students could hone their skills for comprehending and expressing chemistry concepts, not merely how to help ELA teachers to reach STAAR-EOC goals for student writing. Because the research design did not allow for a comparison group, it is not possible to declare if the bottom-up approach was more successful than a top-down

approach; however, the researcher's presence in classrooms and at meetings provided the chemistry teachers with guidance in developing prompts, creating a rubric, and assessing student work.

**School Culture**. It is the researcher's belief that the CAL elements of the intervention—the mandated SARS and the extended writing opportunities for all chemistry students—provided a gateway for meaningful collaboration that contributed to students' awareness of the unified efforts of their teachers to help them to be good writers. Chemistry teachers' use of writing in their chemistry classrooms encouraged students to transfer their skills and emphasized the importance of writing regardless of classroom content. Chemistry teachers reported making students aware that the chemistry teachers and the ELA teachers were talking about them and their writing. Though no evidence is available from this study, the researcher believes that this verbalization of shared concern for their students' ability to write well produced better products from students, making them more aware that writing is not only important in English class, but also important for learning and communicating ideas across the curriculum. Thus, the collaboration seemed to alter the culture of the school at the sophomore level, creating an environment of shared responsibility for student writing performance that students recognized and responded to with greater attention to the quality of their written work.

## Implications for Teachers and Administrators

The study revealed some implications for both and teachers and administrators of schools that are implementing or planning to implement writing interventions.

**Implications for Teachers**. Many implications for teachers and their instructional practices emerged from this study. The study highlighted ways that teachers can support

each other as well as their students to move beyond the attitudinal barriers that impede classroom writing. The study pointed to potential benefits of collaborative efforts among teachers that might improve student writing, such as the development of prompts, the application of a rubric, the planning and implementation of instruction.

***Moving Beyond Attitudinal Barriers to Writing***. Collaborative meetings of ELA and chemistry teachers provided a platform for real talk about the challenges presented by campus mandates to engage students in classroom writing. Teachers were able to acknowledge when and why getting students to write was difficult. They were able to voice concerns about instructional time and administrative demands. Attitudinal barriers to writing surfaced from both teachers and students, but the intervention was possible because the chemistry teacher participants were willing to incorporate opportunities for extended writing into their chemistry curriculum. Chemistry teachers' recognition of the need for students to be better writers was made evident by failing scores on the STAAR-EOC English II exam; however, if the chemistry teachers did not perceive deficiencies in students' writing skills to be *their* problem (as well as the problem of ELA teachers), then increased levels of resistance may have thwarted the intervention. In large part, it seemed that a campus culture of sharing responsibility for students' overall success as learners drove the intervention with chemistry teachers. Interactions that were respectful of the expertise that each teacher brought to the meetings produced an environment in which teachers could acknowledge attitudinal barriers to classroom writing and attempt to move beyond them.

***Developing Prompts***. The development of prompts provided an opportunity for teachers to engage in dialogue about the learning objectives that students needed to

master. Chemistry teachers relied heavily on district and state documents in planning instruction, and they were quick to recognize areas in which writing could be beneficial for assessing their students' learning as opposed to objectives that they perceived did not lend themselves to writing. For example, the researcher noted that TEKS with verbs such as, *calculate, identify, use, know, name, perform, collect,* and *define,* were unlikely fits for preparing a writing prompt, while TEKS with verbs such as *analyze, compare, describe, distinguish,* and *explain,* yielded prompts that chemistry teachers regarded as more meaningful to their ultimate goal of student learning. Chemistry teachers used four prompts:

1. Compare and contrast endothermic and exothermic processes. Provide examples of both.
2. Explain why water is a unique and important compound.

3b. Pick one scientist who contributed in the discovery of subatomic particles and explain his experimental design and conclusions that were used in the development of modern atomic theory. Your answer must include the detailed information from our readings and notes.

4. Describe two types of unseen electromagnetic waves, then contrast their modern-day applications and dangers.

Prompts that targeted specific learning objectives provided a common formative assessment by which teachers could assess their own instruction. At first, chemistry teachers developed a tri-prong prompt, *compare, contrast,* and *provide examples* (Prompt 1). Chemistry teachers were frustrated when the students did not provide explicit discussion of comparison (students tended to imply the similarities when writing about

the contrasts). Upon looking at the responses, the chemistry teachers realized that they preferred for students to give original examples rather than those presented in class; however, this preference was not specifically stated in the prompt. Discussion of student responses enabled teachers to improve the prompts and yielded insight to possible opportunities for instruction.

The researcher noted that chemistry teachers attempted to ameliorate problem areas caused by the wording of the prompts. For example, after creating the three-pronged prompt, chemistry teachers shifted to a prompt that elicited only one verb, *explain,* but elicited two explanations—how water is both unique and important (Prompt 2). Chemistry teachers wanted for subsequent prompts to be even more specific; they added specifications to Prompt 3 (Table 6). Using notes from a planning meeting, the researcher drafted Prompt 3a; however, before administration, chemistry teachers revised the prompt to include even more specific requirements in an effort to elicit the more specific responses.

Table 6 - *Comparison of Prompt 3a and Prompt 3b from September 2016*

| Prompt 3a | Prompt 3b |
|---|---|
| *Which scientist do you think had the most significant impact on the discovery of subatomic particles? Explain your answer using detailed information from our readings and notes.* | *Pick one scientist who contributed in the discovery of subatomic particles and explain his experimental design and conclusions that were used in the development of modern atomic theory. Your answer must include the detailed information from our readings and notes.* |

Though the prompts generally elicited main two verbs, the chemistry teachers often presented the two verbs along with multiple ideas for students to manage and their writing. For example, Prompt 4 elicited only two verbs (*describe* and *contrast*), however, the task was to describe two types of waves and then contrast them, which increased the complexity of the task.

Chemistry teachers generally desired more complex tasks for student writing than those elicited from the two-pronged SAR prompts using the verbs *infer* and *support*. They also disliked displaying the prompts on SAR formatted paper (see Appendix A, Fig. A4, p. 113) which provided space for students to plan or pre-write their responses; rather, chemistry teachers preferred that students respond either on notebook paper or on copy paper printed with lines to look like notebook paper (see Appendix A, Fig. A5, p. 114). The chemistry teachers expected students to respond to the prompt in first drafts that were also final drafts. However, judging the complexity of the prompts, the students may have benefited from being encouraged to plan or prewrite their responses.

***Developing and using a rubric***. The rubric emerged as an instrument for teacher dialogue. The creation of the rubric did not result in a significant increase in classroom writing, nor did it increase enthusiasm for the use of extended writing with chemistry students. However, development of the rubric did provide a starting point from which chemistry teachers could think deeply about literacy expectations in chemistry class. Teachers began by independently sorting student responses to Prompt 1 into two stacks, high and low. The researcher recorded characteristics of high-level responses as each teacher shared and discussed the examples they pulled. The researcher also recorded the characteristics of low-level responses as described by the teachers. When assessing

responses, chemistry teachers concluded that the SAR format encouraged students to copy evidence, while they preferred for students to synthesize information from a variety of student-generated forms, including class notes, charts, and graphic organizers. They agreed to specify that students use original examples in the first draft of the rubric created in March, 2016 (Fig. 1). Also, chemistry teachers quickly recognized the need for a mid-level response, and the researcher attempted to record the distinctions that they made during their discussion of student writing samples.

Figure 1 – *First Iteration of Rubric, March 2016*

Chemistry Writing Rubric Draft
Based on meetings March 11 and 25, 2016

High Level Response – The student response . . .
- Addresses all parts of the prompt
- Contains accurate and thorough information
- Follows the organization suggested in the prompt
- Uses original language (not copied from notes, books, or other sources)
- Uses complete sentences that are easy to read and understand
- Uses academic language appropriately
- Gives original examples (other than those given in class or from other sources)

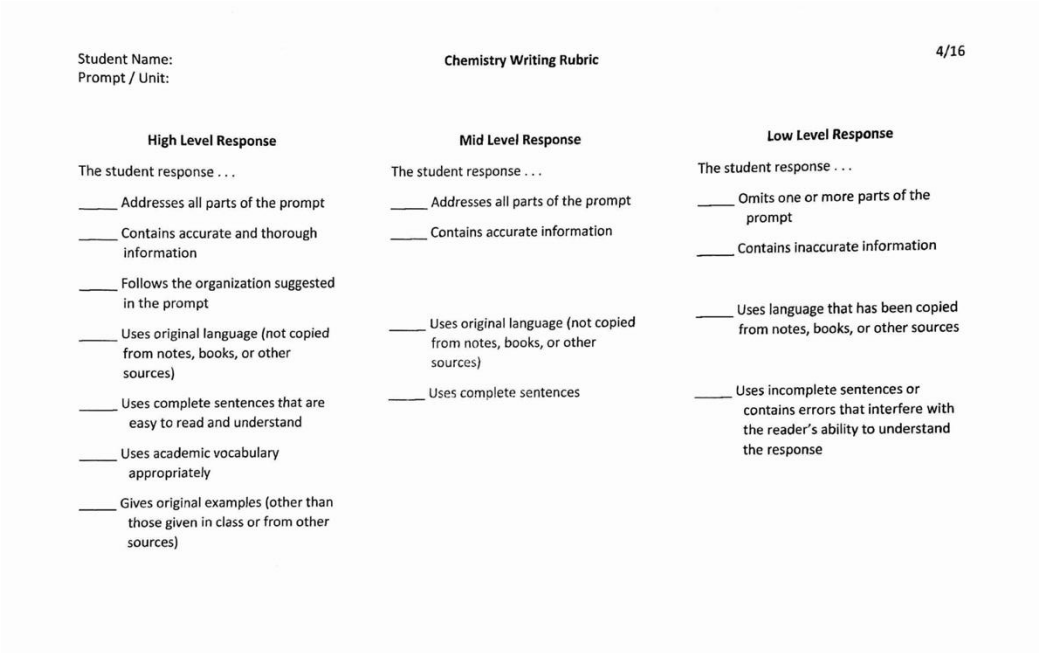
Mid-Level Response – The student response . . .
- Addresses all parts of the prompt
- Contains accurate information
- Uses original language (not copies from notes, books, or other sources)
- Uses complete sentences

Low Level Response – The student response . . .
- Omits one or more parts of the prompt
- Contains incorrect information
- Uses language that has been copied from notes, books, or other sources
- Uses incomplete sentences or contains errors that interfere with the reader's ability to understand the response

This first draft of the rubric was used to assess responses to Prompt 2, and teachers began to flesh out the rubric to include leveled descriptors for each element specified in the first rubric. The researcher formatted the rubric with a landscape orientation and included blanks for teachers to place checks as a means for quickly providing students with feedback. The second draft of the rubric from April, 2016 (Fig. 2) highlighted points for

further discussion at subsequent meetings such as how they might expect students to "follow the organization suggested in the prompt," "use academic vocabulary" and "give original examples."

Figure 2 – *Second Iteration of the Rubric, April 2016*



Student Name:
Prompt / Unit:

**Chemistry Writing Rubric**

4/16

**High Level Response**

The student response . . .

_____ Addresses all parts of the prompt

_____ Contains accurate and thorough information

_____ Follows the organization suggested in the prompt

_____ Uses original language (not copied from notes, books, or other sources)

_____ Uses complete sentences that are easy to read and understand

_____ Uses academic vocabulary appropriately

_____ Gives original examples (other than those given in class or from other sources)

**Mid Level Response**

The student response . . .

_____ Addresses all parts of the prompt

_____ Contains accurate information

_____ Uses original language (not copied from notes, books, or other sources)

_____ Uses complete sentences

**Low Level Response**

The student response . . .

_____ Omits one or more parts of the prompt

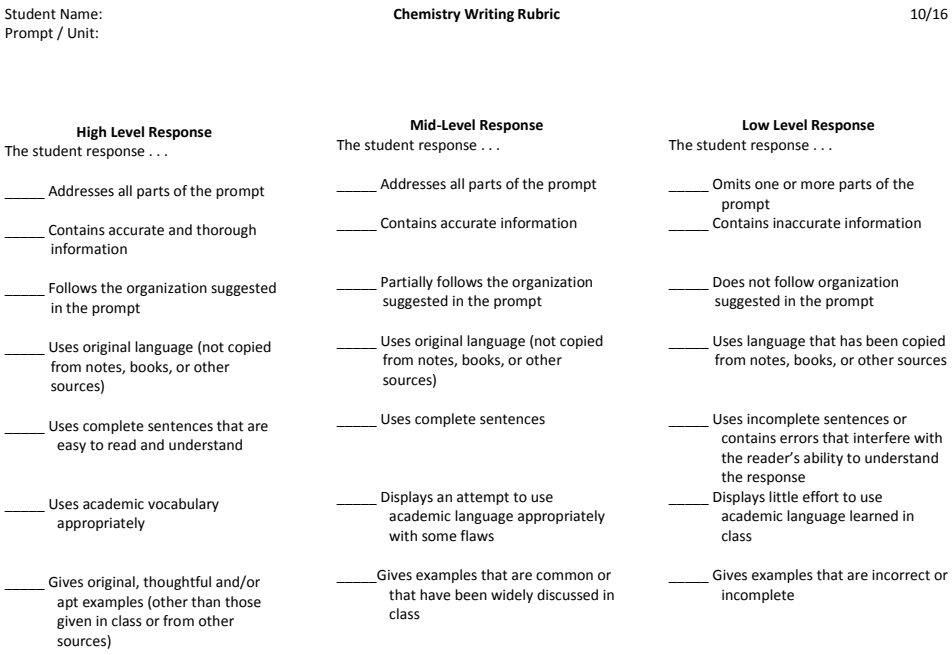
_____ Contains inaccurate information

_____ Uses language that has been copied from notes, books, or other sources

_____ Uses incomplete sentences or contains errors that interfere with the reader's ability to understand the response

Development of the rubric over time necessitated that the chemistry teachers analyzed both the student responses and the prompts. Using the rubric to assess student work provided teachers opportunities to consider how students managed the thought processes specified by the verbs used in the TEKS. When evaluating student responses with the rubric, chemistry teachers regarded the quality of the responses as reflective of the quality of their classroom instruction. The process of using the rubric to assess student responses encouraged teachers to take a closer look at how their classroom practices impacted students' abilities to provide written responses that could be used to assess chemistry learning. The final rubric from October, 2016 (Fig. 3) was regarded by teachers as a final form, and they used this rubric to calibrate scoring for the duration of the intervention.

Figure 3 – *Final iteration of rubric, October 2016*



Student Name:
Prompt / Unit:

**Chemistry Writing Rubric**

10/16

| **High Level Response**<br>The student response . . . | **Mid-Level Response**<br>The student response . . . | **Low Level Response**<br>The student response . . . |
|---|---|---|
| _____ Addresses all parts of the prompt | _____ Addresses all parts of the prompt | _____ Omits one or more parts of the prompt |
| _____ Contains accurate and thorough information | _____ Contains accurate information | _____ Contains inaccurate information |
| _____ Follows the organization suggested in the prompt | _____ Partially follows the organization suggested in the prompt | _____ Does not follow organization suggested in the prompt |
| _____ Uses original language (not copied from notes, books, or other sources) | _____ Uses original language (not copied from notes, books, or other sources) | _____ Uses language that has been copied from notes, books, or other sources |
| _____ Uses complete sentences that are easy to read and understand | _____ Uses complete sentences | _____ Uses incomplete sentences or contains errors that interfere with the reader's ability to understand the response |
| _____ Uses academic vocabulary appropriately | _____ Displays an attempt to use academic language appropriately with some flaws | _____ Displays little effort to use academic language learned in class |
| _____ Gives original, thoughtful and/or apt examples (other than those given in class or from other sources) | _____Gives examples that are common or that have been widely discussed in class | _____ Gives examples that are incorrect or incomplete |

***Understanding Students' Transfer of Writing Instruction***. Collaborations among chemistry and ELA teachers enhanced teachers' awareness of the differences in writing expectations for their mutual students, and cross-curricular efforts seemed promising for helping both teachers and students to understand the different expectations for writing in different areas of study. For example, when looking over student writing samples, the researcher noticed the ways that students wrote based on their ELA instruction; oftentimes these elements of student writing did not coincide with the expectations of chemistry teachers for student writing. Prior to these discussions, chemistry teachers did not recognize that students were attempting to transfer their writing skills from ELA into chemistry. This realization opened new opportunities for writing instruction in chemistry class such as: how to avoid the use of personal pronouns and active voice; how to organize ideas into charts or bulleted lists using parallel structure; how to use transitional

words and phrases; and how to follow the specifications for the organization designated in complex prompts.

***Planning and Implementing Writing Instruction***. Writing collaborations that draw from either Write-To-Learn or Disciplinary Literacy approaches have potential to increase the planning and implementation of writing instruction.

The chemistry teachers in this study embraced the types of writing aligned with a Writing-To-Learn approach; however, they did not embrace the spirit of the approach. Both ELA and chemistry teachers might benefit from training on how to move beyond merely requiring students to write warm-up and exit tickets to explicitly teaching students strategies for engaging in metacognitive processes. For example, teachers might instruct students to both recall past learning and to target new learning through rereading, revising, or editing their short responses for inclusion of specific content area knowledge, specific syntactical or grammatical constructions, or specific errors in writing conventions. These brief instructional moments could enhance students' metacognition while promoting both content area knowledge and writing skills. When enacted in both chemistry and ELA classrooms, the practice could facilitate students' transfer of learning. In order to hone teachers' skills for this type of instruction and to unify instruction across classrooms, collaborative meeting time could be dedicated to the modeling of such strategies through teacher role-playing or through reviewing and critiquing videos of teachers engaging in the instructional practices. These opportunities would constitute bottom-up professional development in real time—a type of professional development that has been known to be more likely to transfer into teachers' usual instructional practices.

Engaging in dialogue increased teachers' understanding of the instructional approach of disciplinary literacy. Meetings in which chemistry and ELA teachers shared their reactions to student responses increased their awareness of stylistic and conventional differences in writing for specific disciplines. ELA teachers noted that students were transferring knowledge, but that transfer did not fit with the ideal forms of writing that chemistry teachers envisioned. The teachers were able to go back into their classrooms and address these disciplinary distinctions so that students could learn how to better present information to their disciplinary-specific audiences.

**Implications for Administrators**. This study revealed the important roles of administrators when promoting writing instruction across the curriculum. Administrators face the challenge to lessen the resistance to writing often displayed by both teachers and students. If teachers are only expected to follow state and district documents (which often do not specifically recommend writing as viable activities for student content learning), then writing is easily disregarded in non-ELA coursework. On the other hand, imposing ELA–style writing (such as SARs) onto non-ELA curriculum may increase non-ELA teachers' resistance to writing. It is the responsibility of administrators to mandate writing instruction in ways that foster a school culture of shared responsibility for student success.

Both campus and district administrators have the responsibility to carefully and critically review district scope and sequence documents to ensure that ample opportunities for literacy practices are embedded. Likewise, it may be helpful to observe the wording of state-mandated curriculum (in this case, the TEKS for chemistry) to ensure that students are being asked to engage in meaningful writing, to develop realistic

expectations for classroom writing, and to provide training for how to integrate writing if those opportunities are not readily visible or specifically prescribed in state curricular documents.

Administrators can advocate that teachers get the time necessary for engaging in dialogue about writing. This study suggested that merely requiring students to write may not be sufficient for realizing improvements in student writing, but that teachers may not have the know-how about how to make more of the writing opportunities that they are creating in their non-ELA classrooms. Teachers are unaware of how their instruction may be impacting student writing ability in classes other than their own if they are not provided time to share and discuss their classroom writing practices.

If administrators are to prescribe CAL strategies, then they should strive to be explicit about the purposes for mandating that intervention (to improve the academic culture of the school), and they should also be considerate of the feelings of teachers who are being asked to go outside of their comfort zones to provide literacy instruction. Mr. Brock's "semi-reluctance" to instruct writing and his frank statement that if he was not required to write with his students, then he probably would not due to the burdensome nature of classroom writing was a key example of teacher resistance to writing. This resistance underscored the need for administrators to not only mandate writing, but to also be aware of potential negative feelings that such mandates may elicit. Administrators could strive for a balance of CAL and DL that could alleviate tensions surfacing from writing mandates and enhance school culture. Supplementing CAL with DL can serve to empower non-ELA teachers to explore what it really means to write for a discipline-

specific audience and help teachers to create more meaningful, discipline-specific writing opportunities.

**Recommendations for Further Study**

This study created new questions about teacher resistance to writing. Interviews of resistant science teachers might serve to further illuminate both the roots of resistance and ways to build a school culture that more willingly shares responsibility for students' writing abilities. Studies involving surveys of non-ELA teachers involved in campus-wide writing interventions may serve to define and quantify resistance, revealing potential effective means for addressing it. More research is needed on the social-emotional impacts of teacher collaboration on students and their writing products. It may be helpful to examine the writing practices of students at schools without writing collaborations versus schools with writing collaborations. Additionally, further analysis of student writing products may contribute to evidence about the levels of effectiveness of cross-curricular teacher collaboration on student writing.

**Conclusion**

Curricular and administrative decision-makers would be wise to hear the voices of individual classroom teachers—to listen carefully, closely, and critically. The researcher's feeling that collaborative interactions among teachers are important for addressing students' instructional writing needs has been affirmed though this research as has her belief that collaborative teacher action is essential for cultivating positive attitudes about writing among all stakeholders, but especially among students, teachers, and administrators. Such positive attitudes provide a key to improving the writing

instruction that teachers provide and to increasing the likelihood that students will learn to write well.

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# Appendix A

## Intervention Artifacts

**Table A1** - Chart containing dates, location, attendees, and brief descriptions of the meetings from Feb 2016 through January 2017. The chart was compiled from meeting minutes, audio transcriptions, and researcher reflections.

| Date / Time | Location | Attendees | Narrative of Meeting | Notes / Next Steps |
|---|---|---|---|---|
| Feb. 3, 2016<br>8th period | Page's room | Biology team | Planning for student success on CBA | Researcher observed |
| Feb. 10, 2016<br>8th period | Gold's room | Biology team | Planning for student success on CBA; researcher introduced writing initiative | Biology team leader rejected use of writing as part of their planned curriculum |
| | | | | 2/11/16 – Administration blocked writing initiative with biology team |
| | | | | 2/16/16 – Researcher assigned to work with chemistry team |
| Feb. 26, 2016<br>1:30 – 2:15<br>PLC Friday | Logan's room | Logan<br>Brock<br>Jaimez<br>Patel | Introductions and purpose of collaborative effort, development of prompt 1, clarification of prompt administration | Teachers will complete prompt with chemistry students prior to March 11<br><u>Prompt 1</u>: *Compare and contrast endothermic and exothermic processes. Provide examples of both.* |
| Mar. 11, 2016<br>1:30 – 2:15<br>PLC Friday<br>(spring break) | Logan's room | Logan<br>Brock<br>Jaimez<br>Patel | Teachers sort writing samples, discuss elements to put on rubric, develop prompt 2 | Teachers will complete new prompt with chemistry students prior to March 25<br><u>Prompt 2:</u> *Explain why water is a unique and important compound.* |
| Mar. 25, 2016<br>1:30 – 2:15<br>PLC Friday | Logan's room | Logan<br>Brock<br>Jaimez<br>Patel | Teachers sort writing samples, discuss revision of rubric | Logan will revise rubric for next meeting |
| Apr. 8, 2016<br>1:30 – 2:15<br>PLC Friday | Logan's room | Logan<br>Brock<br>Jaimez<br>Patel | Continuation of 3/25; brief discussion of options for next prompt | -- |
| Apr. 22, 2016 | -- | -- | -- | No meeting due to extended faculty meeting including STAAR-EOC training, AP Exam proctor meeting, and discussion of master schedule for 2016-2017 school year |
| Apr. 27, 2016<br>2:30 – 3:00 | Logan's room | Logan<br>Brock<br>Jaimez<br>Patel<br>English 2 team | English teachers pair up with chemistry teachers to discuss samples and rubric | Teachers interacted in positive ways, expressed interest in further collaborative discussion of student writing |
| May 27, 2016 | -- | -- | -- | Teachers released early by campus administration. Meeting cancelled. |

| | | | | |
|---|---|---|---|---|
| Sept. 2, 2016<br>3rd period | Patel's room | Logan<br>Brock<br>Jaimez<br>Patel | Teachers plan chemistry instruction and discuss writing goals and language objectives | Logan will resend/print copies of rubric |
| Sept. 15, 2016<br>3rd period | Patel's room | Logan<br>Brock<br>Jaimez<br>Patel | Teachers plan chemistry instruction and develop prompt 3 | Logan will write and copy prompt<br>Prompt 3a: *Which scientist do you think had the most significant impact on the discovery of subatomic particles? Explain your answer using detailed information from our readings and notes.*<br>Prompt 3b: *Pick one scientist who contributed in the discovery of subatomic particles and explain his experimental design and conclusions that were used in the development of modern atomic theory. Your answer must include the detailed information from our readings and notes.* |
| Sept. 22, 2016<br>3rd period | Patel's room | Logan<br>Brock<br>Jaimez<br>Patel | Teachers plan chemistry instruction, discuss ACE strategy for SARs | Chemistry teachers reject SAR format. Logan will procure new paper format and make copies. |
| Oct. 10, 2016 | -- | -- | -- | Campus meeting agenda did appropriate time for writing collaboration |
| Oct. 13, 2016<br>3rd period | Patel's room | Logan<br>Brock<br>Jaimez<br>Patel | Teachers plan chemistry instruction, discuss writing samples and rubric, critique prompt, discuss ACE strategy for SARs, discuss student reactions to writing | Logan will provide revised copies of rubric. Teachers will contact Logan regarding observations. |
| Oct. 20, 2016 | -- | -- | -- | Patel cancelled meeting; Jaimez in ARD |
| Oct. 27, 2016<br>3rd period | Patel's room | Logan<br>Brock<br>Jaimez<br>Patel<br>Science Instructional Specialists | CBA data analysis | -- |
| Nov. 3, 2016<br>3rd period | Patel's room | Logan<br>Brock<br>Jaimez<br>Patel | Teachers planned chemistry instruction and developed prompt 4 | Logan will create prompt, copy and distribute to chemistry teachers; Patel will pilot prompt with Pre-AP students |

| | | | | |
|---|---|---|---|---|
| | | | | Prompt 4: *Describe two types of unseen electromagnetic waves, then contrast their modern-day applications and dangers.* |
| Nov. 10, 2016 | -- | -- | -- | Patel cancelled meeting |
| Nov. 17, 2016<br>3rd period | Patel's room | Logan<br>Brock<br>Jaimez<br>Patel | Teachers plan chemistry instruction, discuss student reactions to writing prompt | Teachers like the lined paper rather than SAR formatted paper. |
| Dec. 1, 2016<br>3rd period | Patel's room | Logan<br>Brock<br>Jaimez<br>Patel | Teachers plan chemistry instruction, discuss writing samples, discuss possibilities for next prompt | -- |
| Jan. 5, 2017<br>3rd period | Patel's room | Logan<br>Brock<br>Jaimez<br>Patel | Teachers discuss PLC paperwork expectations, plan for chemistry instruction, decide to shift to procedural writing | Teachers will use brief warm-ups and exit tickets to satisfy campus writing requirement |

**Figure A2** - PLC planning document required for planning meeting

PLC ---Planning Agenda

Team Leader: Click here to enter text. Date: Click here to enter a date.

Team Members: Click here to enter text.

Team Norms:

**DuFour's Questions for PLC's**

What do we want our students to learn?

How will we know they have learned it?

How will be respond when a student experiences difficulty?

How will we respond when a student already knows it?

| **Topic for Discussion** | **Who** | **Minutes/Outcomes/Product** |
|---|---|---|
| Good News/Victories: | | |
| TEKS--Scope & Sequence/Planning: | | |
| Skills to be mastered: | | |
| WICOR Strategies: | | |
| Data Review: | | |
| Common Formative Assessments: | | |
| Common Summative Assessments: | | |

**Figure A3** - Content Unit Plan, planning document required for planning units.

## Content Unit Plan

| | | |
|---|---|---|
| **TEKS** | **Verb:** | **Translate : (Restate in your own words)** |
| **Example: (What would that look like in your classroom?)** | | **Costa's Level of Questioning:** |
| **Key Understandings:** | **Performance Indicator: (What are students going to do?)** | **Misconceptions:** |
| **Core Questions, Guided Questions or Formative Assessments**<br><br>**1-3 Questions** | **1.**<br><br>**2.**<br><br>**3.** | |
| **Suggested Resources:**<br>**Curriculum Guide**<br>**EduSmart**<br>**StemScopes**<br>**United Streaming**<br>**Or**<br>**Other lessons/activities that align to TEKS** | | |
| **WICOR Strategies for Student Engagement & Success:** | | **Don't Forget to:** |

**Figure A4** - SAR template adapted from the State of Texas STAAR-EOC ELA exam.

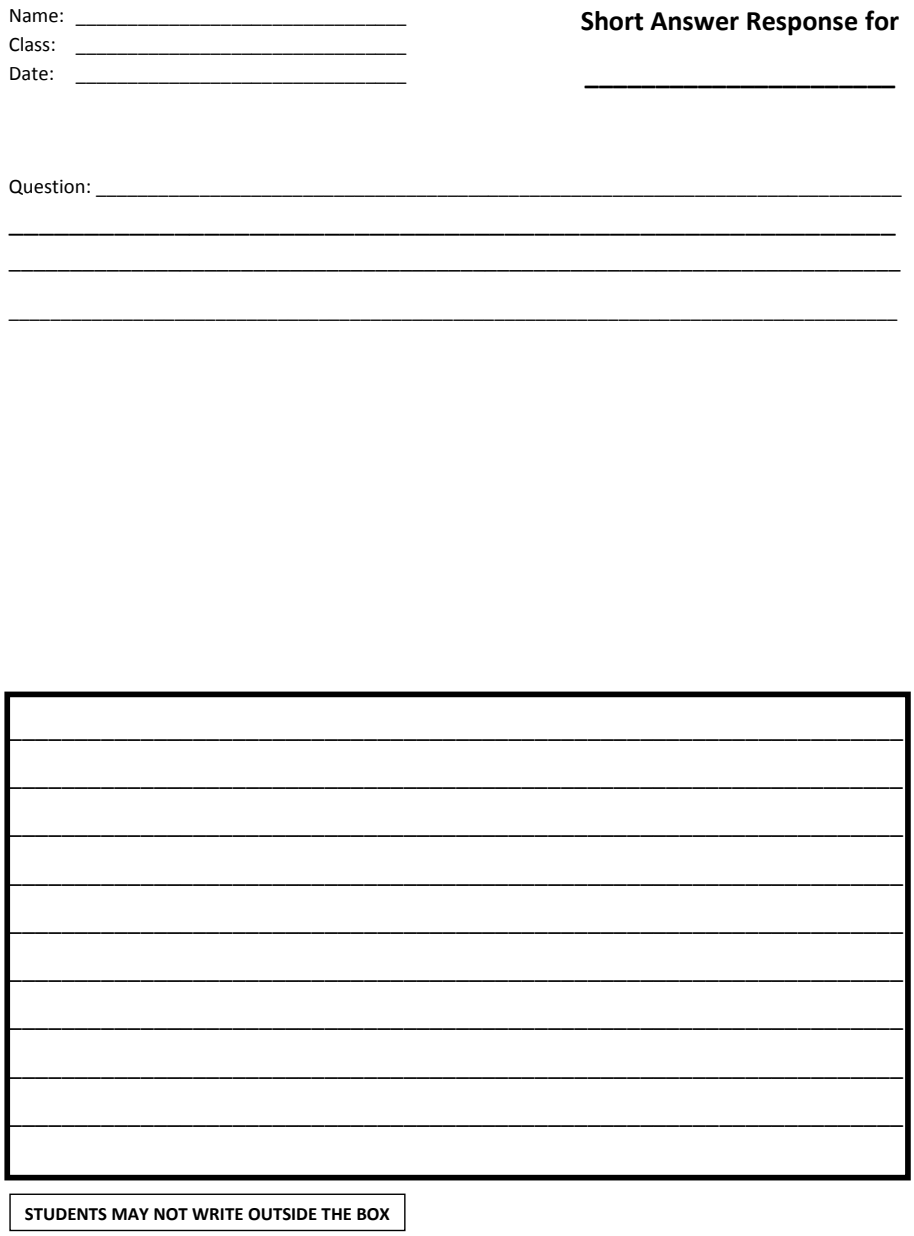
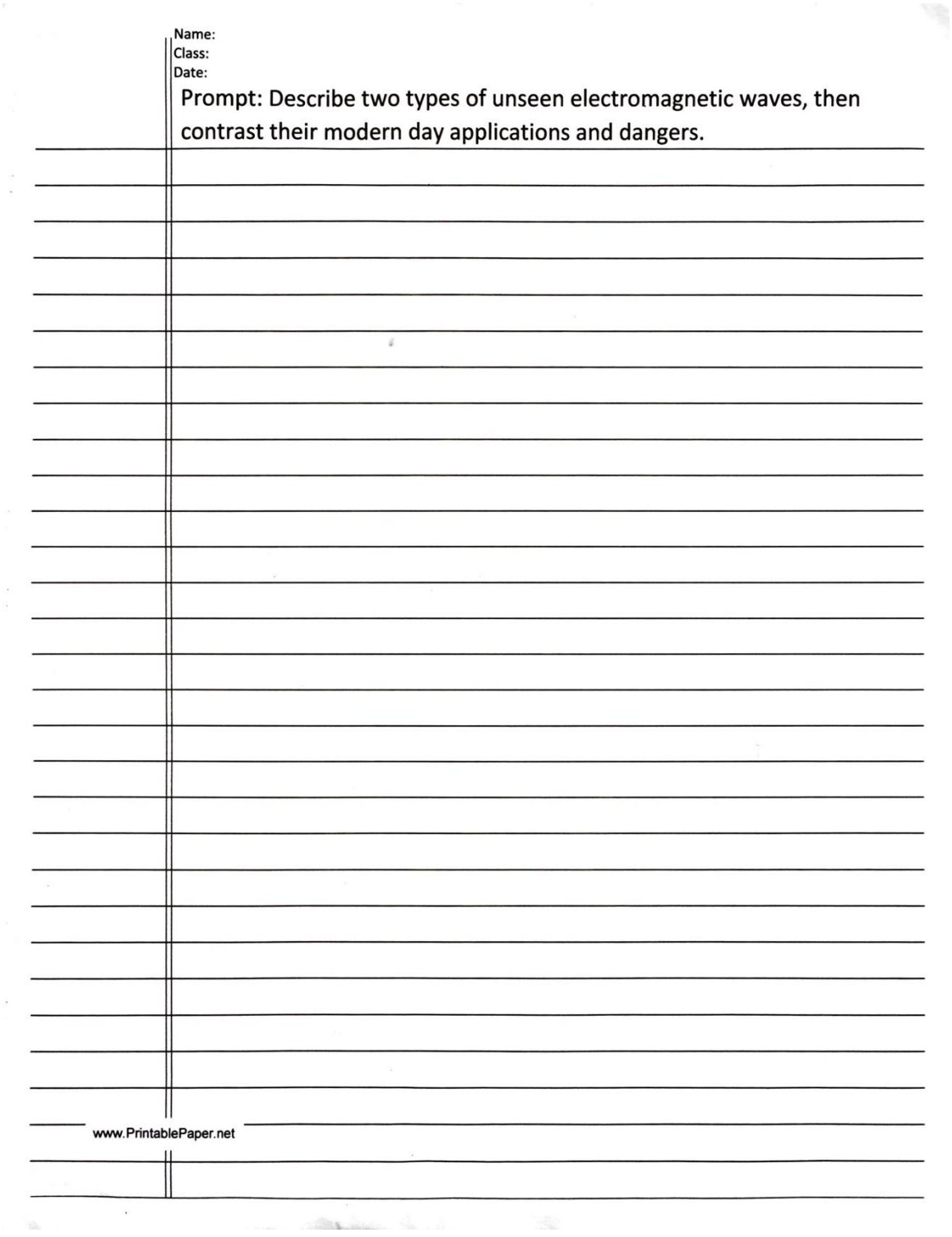


**Figure A5** – Prompt 4 on copy paper formatted to appear like notebook paper



# Appendix B

## Research Schedule and Protocols

**Table B1** – Data collection schedule.

DATA COLLECTION SCHEDULE

| Data Type | Collection Dates |
|---|---|
| Collaborative Meetings | Feb. 26th, 2016<br>Mar. 11th, 25th, 2016<br>Apr. 8th, 27th, 2016<br>Sept. 2nd, 15th, 22nd, 2016<br>Oct. 13th, 27th, 2016<br>Nov. 3rd, 17th, 2016<br>Dec. 1st, 2016<br>Jan. 5th, 2017 |
| Interviews<br>with Mr. Brock<br>with Ms. Jaimez<br>with Mrs. Patel<br>*all names are pseudonyms | <br>June 13th 2016 / Jan. 18th 2017<br>June 3rd 2016 / Jan. 19th 2017<br>Sept. 16th 2016 / Jan. 17th 2017 |
| Classroom Observations | Feb. 2016 – Jan. 2017 |
| Researcher Reflections | Feb. 2016 – Jan. 2017 |

**Figure B2** – Interview Protocol 1

**Topic Domain 1: Teacher experience and predispositions toward writing**

**Covert Categories**

- Teacher's attitudes about writing and writing instruction
- Teacher's level of familiarity with strategies for writing instruction
- Teacher's self-efficacy for writing and writing instruction

**Lead-off Question:** What courses and/or student populations did you teach this year?

**Follow Up Questions:**
How many years have you been teaching?
How many years have you been teaching sophomores?
About how often do you use writing in your classroom?
How much writing did you do in high school? In ELA? In science?
How much writing did you do in your college coursework?
How *do* you, or how would you *like to*, use writing in your classroom?
How much training for professional development have you had in writing instruction?

**Topic Domain 2: Teacher perception of purpose and process of writing**

**Covert Categories**

- Teacher's perception of the purpose of writing in ELA/chemistry
- Teacher's ideas about the characteristics of good writing in his/her subject area
- Teacher's perception of writing as a process
- Teacher's perception of similarities and differences between writing in ELA/chemistry

**Lead-off Question:** Describe a writing activity that you did with your students this year.

**Follow Up Questions:**
How would you characterize the style of writing appropriate in [ELA/chemistry]?
Did you learn anything from collaborating with [ELA/chemistry] teachers? If so, what?
In your mind, what is the purpose for writing in [ELA/chemistry]?
Writing has been described as a process. What does that mean in your mind?
If our school didn't have a writing initiative, would your writing instruction change? If so, how?

**Topic Domain 3: Teacher perception of writing assessment**

**Covert Categories**

- Teacher's current practice for assessing student writing
- Teacher's beliefs about providing feedback for student writing

- Teacher's perceptions of the connection between student writing and quality of instruction
- Teacher's perceptions of the collaborative meeting of ELA and chemistry teachers

**Lead-off Question:** Walk me through the process of developing a writing rubric for chemistry. Or, describe your experience discussing the student writing samples and chemistry rubric.

**Follow Up Questions:**

How important is it to assign grades to student writing?

How would you describe the quality of your students' writing this year?

Describe how you provide feedback to students about their writing.

Would you share any experiences that you've had with receiving feedback on your own writing?

To what degree do you feel that you adjust instruction based on student writing?

**Interviewer's Reflection**

- Overall perception of interview
- What went especially well? Why?
- What did not go well? Why?
- What could have been done differently?
- Suggestions for future interviews or for improving interview protocol

**Figure B3** – Interview Protocol 2

**Topic Domain 1: How do chemistry teachers offer instruction in writing?**

**Covert Categories**

- Teacher's self-efficacy for writing and writing instruction
- Teacher's level of familiarity with strategies for writing instruction

**Lead-off Question:** I enjoyed observing your class. Would you walk me through what you did that day to offer writing instruction?

**Follow Up Questions:**

Describe the writing training that you've had.

What advice would you offer a new teacher who is asked to provide writing instruction in her new chemistry class?

How confident do you feel when offering writing instruction in your chemistry classes? What makes you feel that way?

**Topic Domain 2: How do chemistry teachers value writing as an instructional tool?**

**Covert Categories**

- Teacher's attitudes about writing and writing instruction
- Teacher's perception of the purpose of writing in chemistry
- Teachers' beliefs about the relationship between writing instruction and student performance

**Lead-off Question:** How *do* you, or how would you *like to*, use writing in your classroom?

**Follow Up Questions:**

When you assess your students' writing, do you think back to the instruction that students got before they wrote the response?

[If yes]

What elements of the instruction do you think about?

Do you think that the instruction that the students got impacts the quality of their writing? How?

Does your memory of the way you delivered instruction impact your assessment of a student's work? [If yes, how?]

How often do you adjust instruction based on student writing?

[If never or rarely]

What prevents you from adjusting instruction based on student writing?

[If sometimes or frequently]

Please give an example of a time that you adjusted instruction based on student writing.

**Topic Domain 3: How do chemistry teachers assess writing via a rubric?**

**Covert Categories**

- Teacher's practices for assessing student writing
- Teacher's beliefs about providing feedback for student writing
- Teacher's perceptions of the connection between student writing and quality of instruction
- Teacher's ideas about the characteristics of good writing in chemistry

**Lead-off Question:** When you use the rubric to assess your students' writing, how do you do it?

**Follow Up Questions:**

How much time would you estimate that you spend assessing a single response?
How much time would you estimate that you spend assessing writing each week?
How consistent do you feel that you are when using a rubric to assess student work?
That seems [time-consuming / pretty quick]. Would you like to comment on how you feel about spending this amount of time?
How would you describe the quality of your students' writing this year?
Do you provide any feedback for your students? If so, how? (written/verbal)
What sort of things do you [write/say]?
How important is it to assign numerical grades to student writing?
What percentage of a student's 6-weeks average should be based on the quality of their written responses? Why?

**Interviewer's Reflection**

- Overall perception of interview
- What went especially well? Why?
- What did not go well? Why?
- What could have been done differently?
- Suggestions for future interviews or for improving interview protocol

**Figure B4** - Researcher Reflection Protocol

- Overall perception of meeting
- What went especially well? Why?
- What did not go well? Why?
- What could have been done differently?
- Suggestions for improved facilitation of future meetings.
- What specifically needs to be done to prepare for the next meeting?
- What specifically needs to be done to support teachers before the next meeting?
- After reviewing notes from the meeting, what additional literature, documents, artifacts, or research needs to be collected?
- What transcriptions, coding, analysis can be done at this time?
- What new questions have emerged?

**Figure B5** - Observation Protocol and Reflection

Name of Observer:
Date of Observation:
Location of Observation:
Teacher Observed:
Class Observed:

**Research Question: How do chemistry teachers offer instruction in writing?**

DURING OBSERVATION:
Describe the classroom environment.

Describe the teacher behaviors.

Describe the student behaviors.

Additional Notes:

AFTER OBSERVATION:

**Research Question: How do chemistry teachers offer instruction in writing?**

Recommendations and Next Steps:

New Questions:

# Appendix C

## Human Subjects Research Approval

**Figure C1** – Confirmation of IRB Approval through the University of Houston ICON system.

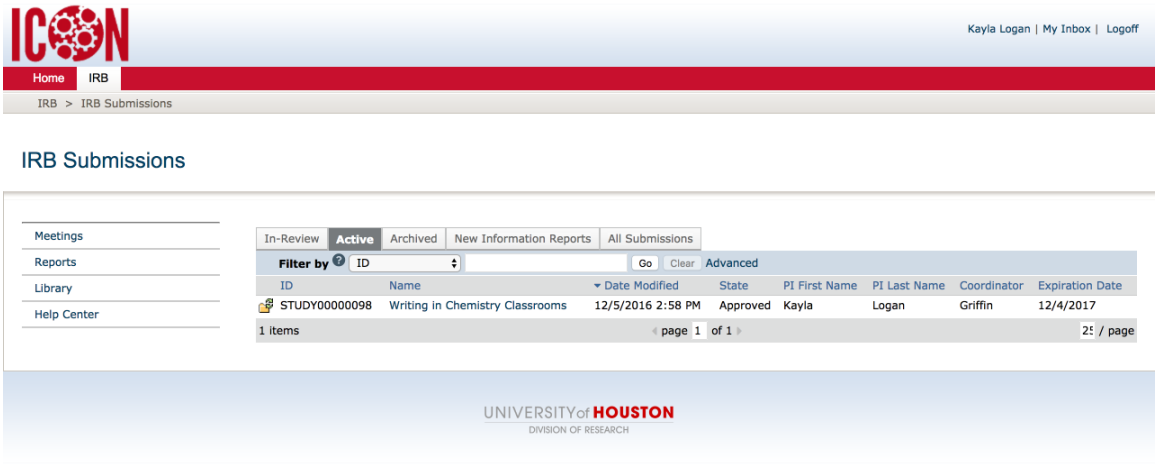


**Figure C2** – Consent document signed by all participants

UNIVERSITY of HOUSTON
A CARNEGIE-DESIGNATED TIER ONE PUBLIC RESEARCH UNIVERSITY

## Consent to Take Part in a Human Research Study

***Title of research study:***

WRITING INSTRUCTION IN SECONDARY CHEMISTRY CLASSROOMS

Investigator: Kayla Logan is conducting this study as part of a dissertation for fulfillment of a Ph.D. in Curriculum and Instruction at the University of Houston under the supervision of Dr. Lee Mountain.

You are being invited to take part in this study because of your role as a chemistry teacher at a Title One high school that is undergoing a writing initiative to increase student college-readiness and to raise student performance on state-mandated standardized tests.

You should know that your participation in this study is completely voluntary. Please understand the following:

1. Kayla Logan will explain this research study to you.
2. Whether or not you take part is up to you.
3. You can choose not to take part.
4. You can agree to take part and later change your mind.
5. Your decision will not be held against you.
6. You can ask all the questions you want before you decide, and you can ask questions at any time during the study.

***Why is this research being done?***

The difficulty of infusing writing into science curriculum has been noted in previous scholarship; however, the benefits of using writing as an instructional tool in both secondary and post-secondary science classrooms has also been well established in research literature. Furthermore, the benefits of a literacy-rich science curriculum has been cited as instrumental in closing the achievement gaps between students in high income areas and students who are economically disadvantaged. This qualitative study will examine three questions:

1. How do chemistry teachers offer instruction in writing?
2. How do chemistry teachers value writing as an instructional tool?
3. How do chemistry teachers assess writing via a rubric?

***How long will the research last?***

This research will build on the collaborative work that you have already done with Kayla Logan beginning in the spring semester of 2016 and will continue to the end of the fall semester, 2016. You will be in this research study for approximately three months after you sign the consent form. Agreeing to participate in the study will commit you to participating in weekly planning meetings during your

regularly scheduled conference period. In these meetings you will not only plan chemistry lessons, but you will also discuss the logistics and challenges of infusing writing into your chemistry curriculum. Should you consent to participation in the study, you will agree to be observed by Kayla Davenport Logan while leading writing instruction in your classroom. You also consent to engage in a face-to-face interview lasting between 30 minutes to an hour at the end of the fall semester 2016.

The time commitment from the time of your consent will not exceed 10 hours. This includes ten 45 minute weekly planning meetings (7.5 hours), one classroom observation (not to exceed 45 minutes), a culminating interview (not to exceed 1 hour), and an additional 45 minutes to cover any additional meeting time that may be requested by participants, researcher, or campus administration to clarify, assess, or discuss the writing intervention.

It is expected that three people will participate in this research study.

If you consent to participate in this research, you will:

- Interact with the researcher and other chemistry teacher participants and team members during meetings, observation, interview
- Participate in about 10 weekly planning meetings held on the high school campus (not to exceed 45 minutes each)
- Be observed engaging in writing instruction in one chemistry class of your choice
- Engage in 1 face-to-face interview about your experience with incorporating writing into your chemistry classroom instruction (not to exceed 1 hour)
- Agree to being audio-recorded during meetings, the observation, and the face-to-face interview with the understanding that all name identifiers will be deleted from the audio transcriptions

This research study includes audio recordings of participants. **Please read and check the statements that describe your consent:**

- ❑ I agree to be audio recorded during the research study.
  - ❑ I agree that the audio recording can be used in publication/presentations.
  - ❑ I do not agree that the audio recording can be used in publication/presentations.
- ❑ I do not agree to be audio recorded during the research study.

If you do not consent to being audio recorded, you will not be eligible to participate in this study. However, if you do not agree that the audio recordings can be used in publication/presentations, you are still eligible to participate in the study.

***What happens if I choose not to participate?***

You can choose not to take part in the research and it will not be held against you. Choosing not to take part will involve no penalty or loss of benefit to which you are otherwise entitled.

***What happens if I say yes, but I change my mind later?***

You can leave the research at any time it will not be held against you. The data that has been collected up to the point of your withdrawal may still be used in data analysis. If you stop participating in the research, already collected data will not be removed from the study record. All name identifiers will be removed from the research.

## Consent to Take Part in a Human Research Study

***Is there any way being in this study could be bad for me?***

There are no significant foreseeable risks related to the procedures conducted as part of this study. However, it is possible that some participants may feel psychological discomfort at being audio recorded or observed. This discomfort is not an intended outcome of the study, and the researcher will take every precaution to ensure the psychological comfort of participants. If you choose to participate and undergo a negative event that you feel is related to the study, please inform the researcher or the research supervisor.

***Will I get anything for being in this study?***

You will not receive financial compensation for participating in this study.

***Will being in this study help me in any way?***

The researcher cannot promise any benefits to you or others from your taking part in this research. However, possible benefits include increased student performance and professional development as a result of engaging in collaborative discussions regarding writing.

***What happens to the information collected for the research?***

Efforts will be made to limit the use and disclosure of your personal information, including research study and name identifiers to people who have a need to review this information. Each subject's name will be paired with a pseudonym which will appear on all written study materials. The list pairing the subject's name to the assigned pseudonym will be kept separate from these materials. The researcher cannot promise complete secrecy. Organizations that may inspect and copy your information include the IRB and other representatives of this organization, as well as collaborating institutions and federal agencies that oversee human subjects research.

The researcher may publish the results of this research. However, the researcher will keep your name and other identifying information confidential.

## *Who can I talk to?*

If you have questions, concerns, or complaints, or think the research has hurt you, you should talk to the researcher or the research supervisor: Kayla Davenport Logan, 713.240.6230, kdlogan@uh.edu. Dr. Lee Mountain, 713-743-4964, LMountain@central.uh.edu.

This research has been reviewed and approved by the University of Houston Institutional Review Board (IRB). You may also talk to them at (713) 743-9204 or cphs@central.uh.edu if:

- Your questions, concerns, or complaints are not being answered by the research team.
- You cannot reach the research team.
- You want to talk to someone besides the research team.
- You have questions about your rights as a research subject.
- You want to get information or provide input about this research.