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Teaching writing to English language learners: two science teachers’ perspectives and practices

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Abstract: Writing is fundamental to science and integral to its practice. This study examined two sixth-grade science teachers’ perspectives on and practices in teaching writing to English language learners (ELLs). Both teachers were interviewed on their beliefs about and experience in teaching writing to ELLs in science. They were also each observed once per week for their writing instruction over one semester. All writing samples produced by the ELLs during the semester were collected. Qualitative analysis of the data revealed that both teachers recognized the importance of writing to science but provided few opportunities for extended writing and limited writing instruction to ELLs. The teachers cited ELLs’ disinterest in science and lack of writing proficiency, as well as their own lack of time and preparedness to teach writing, as the main reasons for not making writing a priority in their teaching practice, for having lower expectations for ELLs, and for not offering substantive language/literacy support to ELLs. These findings indicate that the lofty goal of literacy-science integration remains largely unfulfilled, despite nearly two decades of strong push for border crossing by both science and literacy educators. They suggest that a reenvisioning of the relationship between literacy and science is needed to ensure effective science instruction for ELLs and other students in need of language/literacy support.

Keywords: English language learners; science literacy; science teaching; writing instruction

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1 Introduction

Writing is essential to both the practice and the learning of science (Hand 2017; Norris and Phillips 2003). However, many students, especially those who are learning English as an additional language at the same time that they are developing content knowledge, struggle with writing, with the consequence that their science literacy development is impeded (Wilcox and Jeffery 2015; Yore et al. 2004). Because of this, science teachers have, over the past two decades, been exhorted to make writing (and literacy) an integral part of their curriculum and instruction (e.g. Saul 2004; Yore et al. 2003). Despite repeated calls for writing/literacy-science integration, it is still not clear whether science teachers have taken the message to heart. Our study investigated two science teachers’ beliefs and practices related to teaching writing to English language learners (ELLs), who now constitute roughly 10% of the student population in American public schools. The study is important in that it will shed light on ELLs’ current writing experience in the science classroom and provide nuanced insights that can inform future efforts to improve science instruction for ELLs and other students in need of language and literacy support.

2 Theoretical and empirical perspectives

Science is a discipline of principled inquiry into the universe that involves conjecture, rhetoric, and argument, as well as the empirical work of observation and experiment in natural and laboratory settings (Martin and Veel 1998; Wellington and Osborne 2001). It is primarily a form of discourse involving presentation, evaluation, and argumentation about knowledge claims using evidence from both empirical work and existing research literature. Writing/literacy is, thus, central to science. In fact, it has been argued that modern western science would not have been where it is now without writing and reading (Norris and Phillips 2003).

Not only is writing fundamental to the conception of science, it is also central to the social practice of scientists. Scientists engage in reading the work of others and writing to communicate their own views and findings. They write to keep records of observations and experiments to ensure the accuracy and reliability of their scientific activities and results; they write research articles, scientific letters, and monographs to interact with other scientists, sharing opinions, debating over scientific issues, or defending their claims; and they write books and blogs for the public to disseminate scientific knowledge to a wider audience (Yore et al. 2003). It is through these literate practices that scientists display their professional competence and contribute to scientific advancement.
Writing is also seen as a powerful epistemological tool for learning science (Hand 2017). Through writing, students have to wrestle with details, rework their initial understanding, and connect to existing knowledge in new ways, a process that leads to deeper understanding of concepts and ideas. Empirically, writing has been shown to enhance content understanding, promote inquiry and conceptual change, improve retention and learning, and cultivate scientific habits of mind for students (e.g. Cervetti et al. 2012; Chen et al. 2013; Lee et al. 2009; Thomas and Ritchie 2015). More specifically, when students write about their experiments, observations, and readings, they simultaneously reflect on and examine what they have done in greater detail and clarify and organize their thoughts better. Students who can write effectively have a deeper understanding of the content knowledge and are better at engaging in knowledge construction and knowledge sharing. In short, as Yore et al. (2004: 350) explained, “the articulation of understanding into writing provides a rich arena for cognitive activity of the learner that enhances science learning”.

Because of its importance to science and science learning, writing is seen by the science education community as a key component of science literacy (National Research Council 2012). The Next Generation of Science Standards (NGSS) (NGSS Lead State 2013) recently identified 8 core science and engineering practices for K-12 students: asking question and finding problems; developing and using models; planning and carrying out investigations; analyzing and interpreting data; using mathematics and computational thinking; constructing explanation and designing solution; engaging in argument from evidence; and obtaining, evaluating, and communicating information. These practices are “language intensive” (Lee et al. 2013), requiring students to write/read as they develop models, present ideas, offer explanations, and engage in evidence-based reasoning. Some key genres that students are expected to be able to write and read in school science are procedure, explanation, report, biography, experiment, and argument. The Common Core State Standards (CCSS) also emphasize the essential role of writing in disciplinary learning, noting that students are expected to demonstrate increasing sophistication in writing arguments to support knowledge claims and informational texts to examine/convey complex ideas clearly, accurately, and logically. To meet these goals, the CCSS recommend that students “devote significant time and effort to writing, producing numerous pieces over short and long time frames throughout the year”.

This focus on writing specifically and language/literacy in general is especially critical for ELLs, who face the double change of developing language and literacy at the same time that they are expected to build knowledge about disciplinary content in school learning (August and Shanahan 2006; Oliveira and Weinburgh 2017). Lee et al. (2013) recognized this demand, arguing that an important role of science

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teachers is to encourage and support language use and literacy development in service of science learning. They described a range of practices and strategies that science teachers can use to support ELLs as they engage in science and engineering practices and develop discipline-specific language/literacy skills. Similarly, Lyon et al. (2018) argued that to successfully engage with both conceptual demands and science/engineering practices called for by NGSS, all students need support in developing greater language and literacy proficiency. They further suggested that ELLs are “particularly in need of support” in content learning not only because of the linguistic challenges they may face but also because they are members of other groups whom schools have not traditionally served well in science instruction. In short, the message from the science education community is that science teachers bear the responsibility for supporting ELLs in science learning, and part of this support involves helping them develop the language and literacy skills needed to successfully engage with science and engineering practices.

Despite the importance of writing to science and science learning, many students, especially ELLs, face challenges in science writing. According to a recent National Assessment of Educational Progress (NAEP), only about a quarter of students in both 8th and 12th grades performed at or above the Proficiency level in writing (McFarland et al. 2018). The problem is even more acute for English language learners (ELLs), who face the double challenge of learning academic content and developing academic language/literacy at the same time (August and Shanahan 2006). Previous studies (e.g. Avalos et al. 2017; Schleppegrell 1998; Seah et al. 2015) have revealed that ELLs exhibit an array of word-level, clause-level, and discourse-level difficulties when writing in science. These include problems with basic sentence structure, inflectional endings, subject-verb agreement, relative clause for post-modification, lexical choices, verb tense, grammatical person, pronominal reference, logical connection between sentences, textual organization, and discursive flow. These difficulties prevent ELLs from producing high-quality texts that present accurate information, establish appropriate writer-reader relationships, and demonstrate scientific understandings in a logical and organized way.

One possible reason for the struggle is the lack of experience with writing and writing instruction. Lyon et al. (2018: 1290), for example, observed that secondary science teachers, perhaps more so than elementary school teachers, “generally consider themselves to be teachers of content rather than teachers of language (and literacy), despite the fact that scientific argumentation, reasoning, and communication require a multitude of specialized written and oral literacy practices”. Large-scale survey studies have found that content area teachers rarely teach writing. Applebee and Langer (2011) provided a snapshot of writing instruction in K-12 schooling within the United States. They found that students completed many more pages of brief exercises and copying than they did composing extended essays of at
least a paragraph long. Specifically, they reported that only a small amount of student work involved extended writing – 19% for elementary schools, 20.9% for middle schools, and 17.6% for high schools. In another national survey of writing instruction in American high schools, Kiyahara et al. (2009) found that writing in content areas such as language arts, social studies, and science was either entirely ignored or focused only on responding to test questions. A more recent online national survey (Drew et al. 2017) focused specifically on secondary science teachers. It found that although science teachers assigned writing to accompany the inquiry process, their most frequent assignments were restricted writing tasks that require very little composition, such as note taking, questions and answers, data recording sheets, fill-in worksheets, and graphic organizers. It also reported that science teachers seldom used evidence-based writing instructional practices and rarely made adaptations for struggling writers. Evidence-based practices such as teaching vocabulary, using writing as a tool for learning, providing students class time to write, and providing teacher or peer feedback were used only once per year or once per quarter.

These large-scale survey studies offered a bird’s eye view of the current state of writing instruction in science and other content areas. However, they lack an in-depth examination of what science teachers actually think and do in relation to writing instruction for ELLs. Our study answers this need by examining closely two middle school science teachers’ beliefs about and practices in teaching writing to ELLs. Specifically, we addressed two research questions: (a) what were the science teachers’ views on writing in science and on teaching writing to ELLs? and (b) how did the science teachers teach writing to ELLs in their classrooms? Answers to these questions will give us a frog’s eye view of ELLs’ writing experience in the science classroom and a concrete sense of the extent to which some science teachers embrace the message of literacy-science integration to meet the language and literacy needs of ELLs.

3 Methods

3.1 Setting

This qualitative case study was conducted in a public middle school (which we shall call Wetland) in Florida, a state with the fourth largest immigration population in the United States. Approximately 25% of all school-aged students in the state speak a language other than English at home. The majority of the state’s ELLs are placed in monolingual, mainstream classroom with teachers who are required to receive professional development in working with ELLs in inclusive settings. Florida is one of the few states in the U.S. that require the preparation of all teachers for ELLs. As a part of the Florida Consent Decree, Florida has implemented an ESOL (English for
Speakers of Other Languages) professional development for teachers that is organized into five areas: ESOL Methods, ESOL Curriculum and Materials Development, ESOL Assessment, Applied Linguistics, and Cross-Cultural Communication. Content area teachers in middle and high schools are required to complete 60 h of in-service professional development (or equivalent) that focuses on teaching the ESOL population.

Wetland was one of the three ESOL center schools (elementary, middle, and high) in the district. Since 1970s, the district’s ESOL program has offered intensive English instruction to students who do not speak English as a first language. Students who attended the ESOL center schools were taught in small ESOL classes for part of a day, where they received additional instruction on English grammar and the American culture. For the remainder of the day, they attended regular classes with native English-speaking peers.

Wetland served roughly 1000 students from sixth through eighth grades, with a faculty-to-student ratio of 1:17. Its demographics mirrored the racial, ethnic, and economic diversity of the local community. The percentages of White, Black, Hispanic, Asian, and Others (including American Indian, Pacific Islander, and mixed) were 42 %, 39 %, 10 %, 3 %, and 6 %, respectively. Nearly half (48 %) of the students were eligible for free or reduced-price school lunch.

3.2 Participants

Two sixth-grade science teachers from Wetland, one seasoned (Cindy, pseudonym) and the other relatively inexperienced (Helen, pseudonym), agreed to participate in our study through an informed consent process approved by our university’s Institutional Review Board. They were selected based primarily on their accessibility and willingness. The small number of participants allowed us to explore each teacher in greater depth and provide richer description of their beliefs and practices. Cindy had taught for over 31 years. She held a Master of Education degree in middle school mathematics and science and had an ESOL endorsement, which officially qualified her to work with ELLs. She taught five sections, three of which were advanced science for a magnet program and two were regular science. She had 5 ELLs in her regular science class. They came from Brazil, China, Mexico, and Puerto Rico, and had been in the U.S. for 3–24 months.

Helen had a Master of Education degree in Elementary Education. She had just started her second-year teaching science at Wetland at the time of our study. She taught five regular science sections and had 6 ELLs, who came from Mexico, China, and Saudi Arabia and had been in the U.S. for 6–24 months. Prior to working at Wetland, she had taught 8th-grade math, K-5 math, and summer school math at different schools for two years.
3.3 The sixth-grade regular science curriculum

Our study was conducted in Spring, which lasted roughly 18 weeks. During the semester, students were learning about the earth structures, earth systems and patterns, earth in space and time, and the nature of science according to the district curriculum guides. Besides developing the content knowledge, inquiry skills, and habits of mind associated with these topics, students were also expected to improve their reading and writing skills to meet the CCSS requirements. Not only were they expected to read and interpret information presented in diverse media and formats, they were also expected to write clearly and coherently, in a formal style, and using evidence and logical reasoning. The two teachers met biweekly to plan lessons together, discussing what experiments or field work to do, what worksheets and supplementary reading materials to use, what writing assignments to give, and when to administer quizzes and exams.

3.4 Data collection

To answer the study's two research questions, we collected three sets of data: teacher interviews, classroom observations, and student writing samples. All writing assignments that students completed during the semester were collected. In total, 235 pieces of writing by 11 ELLs across the two teachers were collected.

We conducted one ‘semi-structured’ interview (Seidman 2006) with each teacher at the start of the study. The interview contained a list of more or less structured questions related to the teacher’s view on and experience with science teaching and ELLs (see Appendix A). Each teacher was asked how the CCSS and the NCSS had impacted her teaching and to describe the ways writing was used and taught in her class, the challenges she faced in teaching writing, and her expectations for ELLs’ writing. Each interview lasted approximately one hour and was audio taped with a digital voice recorder. About 35 pages of transcripts were generated based on the interviews with the two teachers.

We also observed each teacher’s class once (50-min) per week for 12 weeks. In consultation with the teachers, each weekly observation was scheduled on a day when writing and/or writing instruction was most likely to occur. Science instruction in either classroom was “business-as-usual”, as we did not seek to influence their teaching in any way; and neither teacher felt pressured to deviate from their normal instructional practices. The observation focused on instructional episodes, strategies and materials, classroom activities and interactions, class assignments, and any other information related to the teaching of writing to ELLs. Field notes were recorded during the observations. A classroom observation protocol with both
descriptive and reflective columns was followed (see Appendix B). In the descriptive column, we recorded the observed instructional episodes pertaining to the teaching of writing. In the reflective column, we recorded any questions and thoughts we had regarding the observed teaching practices. The questions were discussed with the teacher shortly after each observation. Classroom artifacts such as reading materials and student worksheets were also collected.

3.5 Data analysis

Each of the three data sources were analyzed separately and then cross checked with the other two sources to discover confirming or disconfirming evidence. For the first research question on teacher perspective, we used teacher interviews as our primary data source and classroom observation and student writing samples as our secondary data sources. For the second research question on instructional practices, we used classroom observation and student writing samples as our primary data sources and teacher interviews as our secondary data source.

With the teacher interview data, we conducted thematic analysis aimed at “identifying, analyzing and reporting patterns within data” (Braun and Clarke 2006: 79). We transcribed each interview to become familiar with the data. When transcriptions were finished, we read and re-read through each data set to generate an initial list of ideas about what was important and what appeared to be interesting. We highlighted important words, phrases, or sentences and coded them on the margins of the transcriptions. We then recategorized and sorted these initial codes into potential themes. We refined these themes by re-reading and reevaluating them in light of supporting extracts from the data set. This process of refinement involved turning several potential themes into one new theme when there was too much overlap among them, recoding one potential theme into several new themes, or deleting a potential theme altogether if there were no sufficient data to support it. Once each teacher interview was coded or refined, we looked across the two data sets to identify recurring themes in teacher interviews.

Classroom observation field notes were analyzed as they were collected. The analysis started when we finished the first classroom observation with each teacher. We examined the field notes to identify initial themes relevant to writing instruction. We labeled and recorded these initial themes with supporting evidence from the data source. Then, we reread the field notes about the two teachers and compared the initial themes, reconciling, collapsing, or expanding them into more refined or accurate categories. This process was repeated until all field notes were collected and coded. Then, we examined the field notes across the two teachers to identify recurring themes related to writing instruction.
Finally, following Applebee and Langer (2011), we divided the 235 writing samples by the 11 ELLs into two groups – extended writing and non-extended writing. Extended writing was defined as an essay that is one paragraph or longer, with a paragraph being a group of related sentences that support one main idea. Non-extended writing was defined as a non-essay that involves little composing and is usually less than one paragraph in length. We further classified the extended writing samples into different science genres (e.g. report, procedure, explanation, biography, exposition, experiment) based on the work of systemic functional linguists (e.g. Christie and Derewianka 2008; Fang 2010; Veel 1997). We also sorted non-extended writing samples into different categories based on the format and purpose of each assignment.

3.6 Researcher positionality

Understanding researchers’ backgrounds is important because their preferences, biases, dispositions, and assumptions inevitably impact the conceptualization, implementation, and interpretation of research. At the time of data collection, the first author was a doctoral student and the second author a senior faculty in literacy and language education at a flagship state university (U.S.) with a nationally recognized teacher preparation program. Both researchers were multilinguals fluent in English and another language. They had extensive experience working with teachers and students in K-20 contexts in the U.S. and internationally. They believed in the centrality of language and literacy to content area learning and embraced a linguistically informed, responsive, and embedded approach to content area literacy instruction.

4 Findings

The purpose of our study was to explore two science teachers’ perspectives on and practices in teaching writing to ELLs in the science classroom. We found that both teachers recognized the importance of writing to science but did not embrace the responsibility to teach it; and consequently, offered few opportunities for extended writing and limited writing instruction to ELLs. These findings, organized around the two research questions, are elaborated below.
4.1 Perspective on writing and writing instruction

Our interviews with the two science teachers yielded five themes that reflected their beliefs about the role of writing in science teaching/learning, their role in teaching writing, their perceived challenges to integrating writing into science, their perception of ELLs’ writing abilities, and their expectations for ELLs’ writing.

4.1.1 Role of writing in science

Both teachers believed that writing is important to science and that constant practice can improve students’, especially ELLs’, writing skills. They recognized the essential role writing plays in science learning, noting that writing allowed students to deepen their conceptual understanding, reflect on their hands-on activities, and exchange their thoughts and ideas with others. For Cindy, writing is a crucial skill in science because it is needed for “communicating discoveries, findings, and results of experiments”. She elaborated,

Certainly, we want to read and write, and part of our curriculum is to include some of the reading and writing skills. And now, with the Common Core, that’s very integrated. I’ve tried to integrate the reading and writing skills. So, is it important? Absolutely! I want to test science, but you really cannot test if you don’t have the strong language skills.

Both Cindy and Helen agreed that writing deserved greater attention in their curriculum. As Helen admitted, writing “is not in it [science] a lot, and it needs to be more.” She noted the ultimate goal of cultivating scientifically literate individuals was to help her students acquire scientific knowledge and develop the ability to read/write like real scientists. In her own words,

In sixth grade, we teach them what is a lab report and what we do in a lab report. We talked about how to write lab reports, and how that even in the real world, what scientists are doing. They write down their findings and eventually they make it into a big long paper.

4.1.2 Science teacher’s role in teaching writing

Even though both teachers believed in the importance of writing to science and science learning, they did not think they should shoulder the responsibility for teaching writing. Nor did they feel prepared to teach writing. They believed that teaching science content was what they were trained to do and, thus, their primary responsibility. They viewed writing instruction as the job of the Language Arts teachers, which they were not. At the time of our study, Helen just started her second year of
teaching science at Wetland. As a new teacher in the school, she did not see writing as a priority in her teaching. She was trying hard to “keep her head above water” in a new school and with an established curriculum. She said the goal of her teaching was to keep pace with the other two sixth-grade science teachers in the school. Covering as much content as expected by her school and keeping pace with the curriculum became her top concern. To her, teaching writing was something that she could wait until later when she became more well established in her new school. As she noted, “I think writing is coming to play, maybe next year. It’s definitely something that I will think about next year if I don’t do it this year”. Even then, Helen feared that her lack of knowledge about and training in teaching writing would hinder her work on writing. She was also concerned that her own writing proficiency would disqualify her from being a good teacher of writing, saying “I was not a good writer, either. So, I know, as a teacher, it makes that [teaching writing] difficult because that is not my expertise”.

Surprisingly, Cindy professed a similar lack of readiness and willingness to teach writing, even though she was a veteran teacher with an ESOL endorsement and more than 30 years of teaching experience. She insisted that “Language Arts is the class for writing, and that’s where they do their writing, their biographies, their timelines, their poetry. So, that’s where they do a lot of writing”. When asked about what science teachers can do to help improve students’ language and literacy skills, she replied, “I think reading and writing is what you can do, and they [ELLs] CERTAINLY can get that in Language Arts class”. Her prosodic stress on the word certainly betrays her conviction that reading and writing skills should be developed in the Language Arts class and that as a science teacher she should not be expected to teach writing, even though she was not ideologically opposed to having students write (as a way to demonstrate learning) in the science classroom.

### 4.1.3 Perceived challenges to writing integration

Both teachers identified student motivation as a key factor that prevented them from incorporating writing into science. They felt that “science is scaring some children” and so their job was “to motivate them, especially the ESOL kids”. Cindy said her students, especially ELLs, lacked interest in learning science. She thought that this disinterest stemmed from their struggle with science language, including vocabulary. As a result, the two teachers believed that their primary responsibility was to stimulate students’ curiosity about and interest in science and to promote conceptual understanding through hands-on activities (e.g. experiments) and the use of animations and videos, with reading and writing sidelined as optional extras. They indicated their preference for hands-on work that would allow students to “observe, touch, smell, experiment, think and ask question”. In other words, they placed a heavy emphasis on doing science and marginalized reading/writing science. As Cindy
shared, “I think that, even ESOL kids, sometimes they can DO things and then they can understand. They don’t need to understand first and then do it. So, the actual doing experiment helps them to understand”.

Similarly, Helen was heavily invested in taking her students outdoors to observe the natural phenomena and do other hands-on activities. She explained:

> We walk the students through the scientific processes, and we’re able to go outside to do a bird observation. It’s just WAY MORE exciting. It’s REALLY cool that the kids go outside, in the woods and down the street, use binoculars and all different things to observe the birds in our backyards.

With her prosodic stress on *way more* and *really*, Helen showed an emphasis on and an enthusiasm for hands-on activities in science teaching. For her, hands-on activities were an effective way of engaging students, especially ELLs, in learning science, making them become active participants, instead of passive spectators, in the learning process. Cindy articulated her rationale for prioritizing hands-on work over writing this way: “They [students] would rather do the experiment […] they’d rather do than write. They were like me too. I’d rather do it than write it, the lab reports”.

### 4.1.4 Perception of ELLs’ writing abilities

According to both teachers, most of their ELLs struggled with writing and viewed writing/reading as less enjoyable than hands-on activities. They said that their ELLs had limited language skills and used poor grammar in writing. Cindy identified the language problems that frequently occurred in her ELLs’ writing this way: “Sometimes tenses, sometimes vocabulary […] sometimes sentence structure. But mostly it’s related to the actual syntax, how they put words together in a sentence, the order of the words, those kinds of things”. She also made an interesting point about the connection between first language literacy skills and second language writing:

> I also find that kids who write well in one language write well in their second language too. If they are good writers and good readers in their native language, they will be good readers and writers in English.

Like Cindy, Helen was also concerned about her ELLs’ writing skills. She remarked that most of her ELLs were not able to write complete sentences in her class. This problem, she contended, betrayed a more fundamental issue with general writing proficiency, as it could occur when students wrote in other subjects:

> If they have difficulty writing, it’s usually not just writing in science class. The good readers are good readers in everywhere and good writers are good writers in every class. Usually, if they have troubles writing in science, that’s because they have troubles writing in everywhere. So, I don’t find that it’s specific to science. I think that is a skill that transcends the subjects.
4.1.5 Expectations for ELLs’ writing

As a result of their view of ELLs’ writing abilities, both teachers seemed to hold lower expectations for ELLs than they did for other students. Even though they expected students to improve in grammar and composition as they grew, they also recognized that they needed to adjust their expectations for ELLs. Cindy was quite explicit about keeping her expectations for ELLs different from those for the mainstream students, noting “Sure, you have to have different expectations. You have to be realistic”. She said that although she gave the same writing assignments to all students, she held different expectations for ELLs. One of the differences, she explained, has to do with quality and length. For example, she might expect 3 pages from her native English-speaking students but 2 pages from her ELLs. In terms of content, she expected her native English speakers to exhibit a mastery of content knowledge and conventional rules of writing; but for ELLs, Cindy said “I count for content, but I don’t count for grammar or anything like that for my ESOL students. This is not [language arts]. This is science, so I am really looking for content”. And even though her writing rubrics included grammar as one of her grading criteria, Cindy noted that for ELLs she usually did not take points off for language issues like grammar.

Like Cindy, Helen reiterated her focus on science content rather than the language and writing skills when grading ELLs’ writing. She was aware of the wide range of variability in her students’ writing ability. When her ELLs were pulled out to learn how to write a good five-sentence paragraph, her non-ELL students were learning how to write five-paragraph essays in their Language Arts classes. When ELLs returned to the science class, they were required to write essays. Helen did not think this was fair because her ELLs did not receive the same writing instruction and should, therefore, not be expected to complete the same writing tasks as were their non-ELL peers. She explained,

When I graded my essays, like the birds report or the ones from my last year, you have to almost just grade it on science, not on, you know, “Is there a good transition?” or “Is there a good sentence structure?” because you want to make sure there is a science part done there.

4.2 Practice in writing instruction

Although both teachers recognized the value of writing to science learning, their practice did not seem to be aligned with what they believed. We report here three themes related to the teachers’ instructional practice involving writing: instructional routines, writing assignments, and ELL-specific writing support.
4.2.1 Instructional routines

Our classroom observations revealed that science instruction was typically delivered in a combination of whole class lecture and small group discussion. In both teachers’ classes, the instructional time devoted to writing was minimal, with much of that time spent on explaining the requirements of a specific writing assignment, discussing the structural components of the assignment, and going over the rubrics for grading the assignment. For example, when asking students to write an essay such as a scientist biography or a report on the bird experiment, Cindy and Helen prepared a writing rubric for each assignment (e.g. Figure 1 in Appendix C) and went over the grading criteria with the students in class. The rubric usually stated what was expected in terms of content, format, and grammar. Students were expected to understand what their teacher was looking for in their writing and how many points they could earn if they met certain criteria. Helen considered rubrics an effective tool for evaluating writing, noting that “we do have rubrics, which helps out so much […] it gives the kids points for what they can, as long as they have something done. That’s kind of one way to help them out in science class”.

We also noticed that both teachers occasionally modeled effective writing. For example, when discussing how to write a scientist biography, Cindy taught her students to use an “attention grabber” to capture the audience’s attention from the onset. She said that writing a good attention grabber was not an easy task, but it was an important skill to learn if they wanted to become effective writers. She then told her students that if she were to write about Neil Armstrong, the first American astronaut to land on moon, she would use this famous quote – This is one small step for a man, but one giant leap for mankind. – to grab readers’ attention.

Another instructional routine observed is that both teachers regularly used handouts to help their students gather, reflect on, select, and connect information related to the topic of writing. For example, Cindy gave several handouts to help her students complete their scientist biography essays. Her students used Scientist Fact Collection (e.g. Figure 2 in Appendix C) at the beginning of writing assignment to collect and record the most relevant information on the topic. After students had done some research on the topic, they were then given Thinking about My Reading (e.g. Figure 3 in Appendix C) to reflect on what they had read and to expand their research. When students were about to write, they used Stickperson Outline (e.g. Figure 4 in Appendix C) to help them reorganize the information they had collected, remove unnecessary information, create a more efficient flow of ideas, and consider the entirety of their writing.
4.2.2 Writing assignments

An examination of the classroom observation notes and the artifacts collected shows that there were opportunities, albeit limited, to write in both teachers’ classrooms. Students were assigned a variety of writing tasks during the Spring semester; however, the vast majority of these tasks required little or no composing. Of the total 235 pieces of writing done by the 11 ELLs during the semester (see Table 1), 11.5 % (n = 27) were extended writing, and 88.5 % (n = 208) were non-extended writing. Of the 27 extended writing pieces (see Table 2), there were 3 procedures, 3 procedural recounts, 3 reports, 3 experiment papers, 3 biographies, and 12 narrative informational texts. In procedural texts, students provided step-by-step instruction of how to conduct an observation or experiment. In procedural recounts, students retold what had been done in a scientific activity. In reports, students described the properties or attributes of an organism or organize information about an organism into classes and subclasses. In experiment papers, students presented the aim, method, results, and conclusion of an experiment. In biographies, students described the life of an important scientist of interest and evaluated his/her scientific contributions. In narrative informational texts, students presented scientific content within a story

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<th>Table 1: Total writing samples by length.</th>
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<tr>
<td>14.7 % (n = 17)</td>
</tr>
<tr>
<td>11.5 % (n = 27)</td>
</tr>
<tr>
<td>Non-extended writing</td>
</tr>
<tr>
<td>91.6 % (n = 109)</td>
</tr>
<tr>
<td>85.3 % (n = 99)</td>
</tr>
<tr>
<td>88.5 % (n = 208)</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>100 % (n = 119)</td>
</tr>
<tr>
<td>100 % (n = 116)</td>
</tr>
<tr>
<td>100 % (n = 235)</td>
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</table>

<table>
<thead>
<tr>
<th>Table 2: Extended writing samples by genre.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Genre</strong></td>
</tr>
<tr>
<td><strong>Percentage</strong></td>
</tr>
<tr>
<td>Scientific genres</td>
</tr>
<tr>
<td>55 % (n = 15)</td>
</tr>
<tr>
<td>Procedure</td>
</tr>
<tr>
<td>11 % (n = 3)</td>
</tr>
<tr>
<td>Procedural recount</td>
</tr>
<tr>
<td>11 % (n = 3)</td>
</tr>
<tr>
<td>Report</td>
</tr>
<tr>
<td>11 % (n = 3)</td>
</tr>
<tr>
<td>Experiment</td>
</tr>
<tr>
<td>11 % (n = 3)</td>
</tr>
<tr>
<td>Biography</td>
</tr>
<tr>
<td>11 % (n = 3)</td>
</tr>
<tr>
<td>Other genres</td>
</tr>
<tr>
<td>45 % (n = 12)</td>
</tr>
<tr>
<td>Narrative informational writing</td>
</tr>
<tr>
<td>45 % (n = 12)</td>
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<tr>
<td>Total</td>
</tr>
<tr>
<td>100 % (n = 27)</td>
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</table>
structure, such as “my journey through the water cycle” (see Figure 5 in Appendix C for a student sample) and “my personal story of the rock cycle” (see Figure 6 in Appendix C for a student sample). These essays were often problematic at both macro (generic structure) and micro (lexicogrammar) levels.

Of the 208 pieces of non-extended writing (see Table 3), fill-in-blank exercises (e.g. Figure 7 in Appendix C) are the most common, representing 66.3% of the subset. In these exercises, the teacher did all the composing, and students were left only to fill in missing information by supplying a word, a phrase, or a numeral that could be copied directly from the textbook, class handouts, or the teacher’s PowerPoint slides.

Completing worksheets with short answer questions was another task that students did in their classes. Of the 30 short answer worksheets collected, there were a total of 76 questions that required students to respond in phrases or no more than two complete sentences. We sorted these questions into different categories based on Bloom’s taxonomy (Bloom 1956) (see Table 4). We found that the majority of the questions (66%) were knowledge questions that asked students to recall previously learned facts, terms, or concepts. Sample questions included “Where is the Earth’s longest mountain chain?” and “Name 2 landforms that can occur because of subduction”. Another type of questions frequently used in these worksheets was comprehension question, which represented roughly one-third of the total questions.

Table 3: Types of non-extended writing samples.

<table>
<thead>
<tr>
<th>Types of non-extended writing samples</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Fill-in-the-blank</td>
<td>66.3% (n = 138)</td>
</tr>
<tr>
<td>2. Multiple-choice</td>
<td>8.7% (n = 18)</td>
</tr>
<tr>
<td>3. Vocabulary learning</td>
<td>10.6% (n = 22)</td>
</tr>
<tr>
<td>4. Short answer questions</td>
<td>14.4% (n = 30)</td>
</tr>
<tr>
<td>Total</td>
<td>100% (n = 208)</td>
</tr>
</tbody>
</table>

Table 4: Types of short-answer questions based on Bloom’s taxonomy.

<table>
<thead>
<tr>
<th>Types of short-answer questions</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Knowledge</td>
<td>66% (n = 50)</td>
</tr>
<tr>
<td>2. Comprehension</td>
<td>32% (n = 24)</td>
</tr>
<tr>
<td>3. Application</td>
<td>1% (n = 1)</td>
</tr>
<tr>
<td>4. Evaluation</td>
<td>1% (n = 1)</td>
</tr>
<tr>
<td>Total</td>
<td>100% (n = 76)</td>
</tr>
</tbody>
</table>
asked. Comprehension questions elicited low-level thinking as students only needed to demonstrate basic understanding of previously learned knowledge. Sample questions in this category include “Explain the differences between continental crust and oceanic crust” and “How is new ocean floor created?”. In striking contrast, questions that require higher-level thinking, such as those that probe application or evaluation, were rarely asked in these worksheets. Application questions require students to use learned knowledge in a new situation, and evaluation questions require students to critically appraise something by presenting evidence to defend a claim or an argument. Even though some of the short answer questions have the potential to elicit extended writing, none of the 11 ELLs wrote more than one sentence in their responses.

Multiple choice exercise (e.g. Figure 8 in Appendix C) is another assignment that involves some kind of writing. There were a total of 18 multiple choice worksheets, which constituted just under 10% of the non-extended writing samples collected. This task was typically used as an end-of-unit quiz, and it was one of the teachers’ favorite tasks because it was an “easy, objective, and less time-consuming” way of assessing student learning. As Helen commented, “And honestly, it’s easier when you have 110 tests to grade; it’s really easier to have multiple choices”.

A fourth type of non-extended writing is vocabulary worksheet (e.g. Figure 9 in Appendix C), which presents a list of new science words for students to define. Like most science teachers, Cindy and Helen used these worksheets to facilitate student learning of new concepts and terms. A total of 22 such worksheets were collected. They were given to students at the beginning of each new unit. While students were learning the unit, they were expected to fill out a chart for each new word by finding its definition in the textbook or dictionary, copy the definition onto the worksheet, write a sentence in which the target word was used, and draw a picture representing the concept embodied in the word.

### 4.2.3 ELL-specific writing support

Neither teacher made substantive differentiation in writing instruction for ELLs and their mainstream, native English-speaking peers. Nor did they offer much support to ELLs (and other students) who were in need of language and literacy work. Recognizing that ELLs already had the pull-out support from ESOL teachers, Cindy and Helen rarely budgeted out class time to provide additional, individualized assistance to ELLs. Cindy was sometimes seen pulling her ELLs aside to explain instructions for writing. She also encouraged her ELLs to write in their native language “because that’s the way they get better in writing”. She said that if a piece of ELL writing was in a Roman language, she could figure out what it said because of her knowledge of Spanish; if the writing was in another language, she would give it to someone who
knew the language and let the person tell her what it was saying in terms of content. Cindy indicated that the purpose of allowing ELLs to write in their first language was to get them to think about content without feeling intimidated by scientific writing in English. Helen, on the other hand, made accommodations by offering English word banks of key concepts to help her ELLs in their writing. In testing situations, she would create a modified version of test questions for ELLs and also allowed them to use a dictionary during testing.

5 Discussion

Our study explored two science teachers’ (one seasoned and the other less experienced) perspectives on and practices in teaching writing to ELLs in the science classroom. It presented a frog’s eye view of ELLs’ current experience with writing in science classrooms, offering fine-grained details on teacher perspective and practice that are missing from large-scale online national surveys (e.g. Drew et al. 2017; Kiuhara et al. 2009). The rich examples and artifacts from teacher interviews and classroom observations are important in that they represent authentic voice from ‘the trenches’, giving us deeper insights into – and more nuanced understanding of – the current state of writing instruction for ELLs in sample science classrooms.

Our study found that both teachers recognized the importance of writing to science but did not make writing a priority in their actual teaching practice. Instead, they viewed content instruction as their main responsibility, offering few opportunities for extended writing and limited writing support for ELLs. These findings suggest that the task of integrating/teaching writing (or literacy) in science classrooms remains elusive for science teachers, despite many years of strong push for border crossing by scholars and policy makers from both science and literacy education communities.

This problem raises a couple of important issues regarding our efforts to integrate literacy with science. One has to do with the efficacy of the literacy-science integration message. Over the years, the message that the science and literacy education communities sent to science teachers has been that literacy is important to science because it can support science learning. This message seems to view literacy and science as two separate entities, with literacy being promoted to be in service of science (e.g. Lee et al. 2013; Pearson et al. 2010). Such a view may have had the unintended consequence of making science teachers, such as Cindy and Helen, think that literacy is subservient to science and, thus, only an ‘optional extra’ to be used when they are ready/willing or have time. In fact, both teachers appeared to view language/literacy as separate from science content, at least in their assessment practice.

It is likely that a more integrated view of literacy and science is needed if writing/literacy is to truly become a natural part of science teaching/learning. Instead of
seeing literacy and science as two separate, albeit related, entities, science and literacy educators need to view them as an integrated, unified whole: each exists within the other, and neither can survive without the other. As Norris and Phillips (2003: 226) have argued, writing and reading are not just tools for storing and transmitting science; they are “constitutive parts of science”. That is, literacy does not exist in a vacuum; and without literacy, there would be no science as we know it today. This systemic view of the relationship between literacy and science means that knowledge about literacy must, according to Patterson et al. (2018), be considered part and parcel of science content and, thus, an essential part of the professional knowledge base that every teacher of science is expected to develop.

A related issue that may explain the resistance of both veteran (Cindy) and relatively new (Helen) science teachers to prioritize writing in science instruction is their lack of knowledge about how to teach writing in science. Traditionally, science teachers, like other content area teachers, were required to take one literacy methods course as part of their licensure program (Fang 2024; Romine et al. 1996). This course was taught by literacy faculty, typically focused on reading, and was often too generic to be of much utility to science teachers. As a result, they typically came to the profession with surface understandings of writing and a weak sense of their own writing self-efficacy (Morgan and Pytash 2014). Most lacked a solid understanding of the writing process and writing pedagogy, especially as they relate to ELLs; and many did not have sufficient linguistic and literacy expertise to plan and teach engaging units and lessons that promote ELLs’ writing development in the context of science learning (Accurso 2020; Schleppegrell 2004).

Alternatives to the traditional way of preparing science teachers to teach literacy have been suggested. Lyon et al. (2018) advocated integrating literacy into core science methods courses, instead of having teachers learn about literacy in a course separate from content. They suggested that this new approach is more effective in helping teachers engineer a simultaneous focus on literacy and science instruction for ELLs. The approach appears to be consistent with the integrated view of literacy and science and holds promise for improving the science teaching of ELLs. Lee and Buxton (2013) recommended that professional development work for science teachers focus on identifying a proper balance between literacy and science, engaging teachers in active learning of how to infuse literacy with science practices, connecting the NGSS with the CCSS, and forging partnership with a wide range of in- and out-of-school stakeholders.

It is not surprising that the two science teachers in our study viewed writing as a potentially powerful vehicle for enhancing students’ understanding of what they were learning in science. This positive view of writing is likely the result of repeated exposures, through inservice workshops and/or preservice coursework, to the message that writing is fundamental to science and integral to its practice. For many
years, the science education community has emphasized the centrality of literacy to the enterprise of scientific inquiry and to the teaching and learning of science. This emphasis is evident in recent scholarship on science literacy (e.g. Fang 2024; Fang et al. 2008; Hand 2017; Yore et al. 2004) and in the national and state science education standards (e.g. CCSS, NGSS).

Despite their ideological commitment, both science teachers did not practice what they believed in. Like other content area teachers reported in the general research literature two decades ago (O’Brien et al. 1995), neither Cindy nor Helen considered writing instruction to be within the purview of their primary responsibilities. They believed instead that teaching writing is the job of language arts teachers. They rejected the responsibility for writing/literacy instruction in part because of their deeply engrained belief that science is primarily a practical subject involving hand-on work of experiment and observation. For them, writing or literacy is separate from, rather than integral to, science content; it is a luxury that can wait to be included in the curriculum until they have time and feel prepared or comfortable to teach it. This inconsistency between beliefs and practice is not uncommon among teachers, as many factors – personal and contextual – can constrain their ability to attend to their beliefs and to provide instruction that aligns with their beliefs (Patrick and Fang 2022; Semetana et al. 2020). O’Brien et al. (1995: 447) attributed the difficulty of integrating literacy in content areas like science to “the complexities of secondary schooling”, noting that compartmentalized curricula, content primacy, pedagogies of control and telling, the organizational and reward structures of school, and classroom realities (e.g. overburdened teachers, disengaged students, prescriptive standards) are all antithetical to the literacy-content integration effort.

Our findings that ELLs had limited experience with extended writing and received little support in writing corroborate those reported in large scale studies of writing instruction reviewed earlier. In our study, the ELLs rarely engaged in writing as a way to learn, construe, consolidate, and communicate scientific understandings. Instead, the majority of the writing they produced was non-extended writing, a type of writing best described as “writing without composing” (Applebee and Langer 2011: 5) – usually short answer tasks, fill-in-the-blank exercises, or copying from the board – where the resulting text is completely structured by the teacher or textbook. Our classroom observations confirm that ELLs were rarely given tasks that required them to compose texts of adequate length or complexity. Most often, they were asked to take notes of teacher presentations, locate and copy vocabulary definitions, complete worksheets with fill-in-the-blank exercises, outlines, and questions that elicited brief responses. While these brief writing tasks enabled teachers to quickly assess students’ content learning, they deprived students of the opportunity to use writing to sharpen and transform their conceptual understanding. Even though some of the assignments provided opportunities for extended writing, most ELLs
wrote only 1–2 sentences in response or did not complete the assignments. Their teachers neither pushed them to compose longer answers nor provided support that helped them complete essay-type responses. As a consequence, these students engaged in very little extended writing that requires composing.

Several factors likely contribute to the predominance of brief writing in the two science classes. The sheer number of students that each teacher had to deal with is an obstacle to using extended writing. Cindy and Helen each taught 5 sections, with roughly 25 students per section. This translates into some 125 essays to grade per assignment for either teacher. Using brief writing tasks such as multiple choice and fill-in blanks became an easier and more efficient (and, thus, preferred) way of assessing learning. Time constraint and pressure for content coverage also placed a limit on the teachers’ use of extended writing. The pacing guide that Cindy and Helen used mapped out a variety of concepts and ideas that they must teach and specified the number of days to be devoted to each topic. Both teachers had to abide by the pacing guide to stay on track and to ensure that certain concepts/units were covered by a certain date so that their students were prepared for statewide assessments. The bulk of instructional time was thus used to cover content and prepare students for tests, with little attention to the language/literacy needs of ELLs. This left little time for extended writing and writing instruction. Students did not have the opportunity to analyze, compose, share, reflect on, and revise their writing, a process essential to improving writing proficiency (Weaver 2010). Students’ less-than-positive attitude toward and lack of proficiency in writing further discouraged the teachers from assigning (extended) writing during instruction.

Another factor that encouraged the use of non-extended writing may have to do with a lack of alignment between standards and assessments. Beginning in 2003, a state-wide science assessment was administered annually in Grades 5, 8, and 10. This high-stakes test included a large percentage of multiple-choice questions, some gridded responses, and a few short-response and extended-response tasks. Even in extended-response tasks, where longer and more detailed answers were expected, students were not required to compose paragraph-long texts. Starting in 2013, a new version of the high-stakes science test was administered to students in Grades 5 and 8. The revised test consisted of multiple-choice test items only, requiring literally no writing with composing. This change in test format likely further de-incentivized teachers to incorporate writing and writing instruction in their teaching. It also reinforced the misconception that many science teachers, including Cindy and Helen, had long held regarding the role of writing in science learning. That is, science teachers tend to view writing instruction as an optional extra that can take their precious instructional time away from teaching what they consider to be the more important part of science – content.
It is also noteworthy that almost half of the extended writing pieces by ELLs were narrative informational texts and that key school-based science genres such as explanation and exposition were missing from the writing corpus collected. Creative narrative writing tasks, such as *My Personal Story of the Rock Cycle* and *Journey Through the Water Cycle*, were used by Cindy and Helen, who seemed to view writing as a generic literacy skill that can be applied unproblematically across content areas (e.g. science, literature) or genres (e.g. story, report). The narrative-informational texts written by the ELLs invariably used playful and emotive language that made their stories interesting and enjoyable to read. While narrative-informational texts may be a potent vehicle for students to demonstrate their understanding of science to teachers, an overemphasis on this hybrid genre can desensitize students to the linguistic registers that are functional and more effective for construing scientific principles, processes, and understandings, making them further alienated from the language that has co-evolved with science over the past century to classify, decompose, explain, and theorize natural phenomena and their relationships in the universe. As Halliday and Martin (1993: 219) cautioned, “narrative itself is a tremendously inefficient way of exploring the ways in which science interprets the world and positively detracts students from building up scientific understandings”. They exhorted teachers and students to work towards developing a much clearer grasp of the linguistic resources that are more powerful for building up a scientific, rather than commonsense, picture of the world. Christie and Derewianka (2008: 149) called for a similar emphasis on expanding students’ repertoire of language resources for scientific meaning making in writing, noting that school science involves not only initiating students into “an understanding of scientific knowledge and scientific methods” but also “learning a technical language and a set of written text types or genres which encode scientific principles and procedures”. In other words, ELLs need to develop language resources that enable them to write science genres and communicate scientific meanings in ways that are consistent with how scientists perceive and construe the natural world.

### 6 Conclusion

Our study examined two inservice science teachers’ beliefs and practices related to teaching writing to ELLs over the course of one regular semester. Our qualitative findings complement and enrich the largely quantitative findings reported in large-scale national surveys. Taken together, these studies – from both a bird’s eye view and a frog’s eye view – indicate that despite repeated calls for literacy-science integration over the past two decades, writing remains on the peripheral of science
teachers’ instructional practices and science teachers today do not seem more willing or prepared to incorporate writing in their classroom than did their predecessors. As noted science education scholar Larry Yore (2004: 90) lamented,

In more than 30 years of working with language and science, my most difficult task has been – and continues to be – to convince science educators and other teachers of the importance of language in science and the importance of language-oriented tasks (such as reading and writing) in inquiry science instruction.

This is indeed a troubling revelation that provides one plausible explanation for why many ELLs (and other students) continue to struggle with writing in science. It suggests that there is still much more work to be done in (a) convincing science teachers of the centrality of literacy to science learning and teaching, (b) establishing a school culture that promotes cross-disciplinary collaboration and integration, (c) creating conditions that facilitate literacy-science integration, (d) developing teacher expertise in science and literacy, (e) showing teachers how to design and implement units of instruction that serve disciplinary goals and address the language/literacy needs of ELLs, and (f) studying the effect of the integration on ELLs’ learning outcomes.

Preparing teachers to provide effective science instruction for ELLs and others in need of language and literacy support is one of the most pressing issues facing the science education community today (Lee and Buxton 2013; Oliveira and Weinsburgh 2017). Given what is now known about the role of writing in science learning and the current state of writing instruction in science classrooms, it is imperative that we respond methodically to the calls from both science and literacy educators to re-conceptualize science teacher education curriculum (Lyon et al. 2018; Patterson et al. 2018) and professional development models for science teachers (e.g. Lee and Buxton 2013; Luft and Hewson 2014; Patrick and Fang 2022). At the heart of this reenvisioning should be a shift in thinking about the relationship between literacy and science, such that literacy is no longer seen as merely a handmaiden in service of science but rather an inalienable part of science. Only until literacy is accepted as a constitutive part of the content of science can we truly usher in a new era of science teaching that meets the language and literacy needs of ELLs and other students.

**Appendices**

**Appendix A: Teacher interview guide**

Interviewer: ________________________
Date/Time: __________________________
Interviewee: ________________________
1. Could you talk a bit about your ELL students, such as their academic proficiency, language backgrounds, and writing performance (when compared to that of your native English-speaking students)?
2. Could you tell me about your experience working with ELL students in science class?
3. What are the challenging aspects of being a secondary science teacher?
4. What role do you think writing has in a secondary science class?
5. Do you teach writing in your science class? If you do, how do you teach it?
6. When you give a writing assignment to students, what do you expect to see in their writing?
7. What issues, if any, do you notice in your ELL students' writing?
8. What writing skills do you think ELL students need to develop in order to reach the level they are expected to reach?
9. The Common Core State Standards set standards for Grades 6–12 literacy in History/Social Studies, Science & Technical subjects. They also specify writing standards for secondary students. As our state is implementing the Standards, to what extent do you think the Standards will affect your instruction, especially in connection with writing instruction?
10. Based on the writing students have produced so far, what do you think can be done for ELL students to improve their writing in science?

Appendix B: Classroom observation guide

Name of teacher: ___________________
Class & Grade: ___________________
Date & Time of observation: __________________
Name of observer: ___________________

<table>
<thead>
<tr>
<th>Observation Field Notes</th>
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<tr>
<td>How content is delivered</td>
</tr>
<tr>
<td>– Hands-on</td>
</tr>
<tr>
<td>– Reading</td>
</tr>
<tr>
<td>– Writing</td>
</tr>
<tr>
<td>– Combination?</td>
</tr>
<tr>
<td>Writing activity</td>
</tr>
<tr>
<td>– Purpose of writing activity</td>
</tr>
<tr>
<td>– Materials used</td>
</tr>
<tr>
<td>– Strategies used</td>
</tr>
<tr>
<td>– Teacher and student behavior</td>
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<table>
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</thead>
<tbody>
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<td>Descriptive</td>
<td>Reflective</td>
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</table>
Appendix C: Figures of samples

For figures of samples, please visit: https://www.researchgate.net/publication/374083094_AppendixCofJWL-2023-0016.

References


