Student Engagement and Writing Tasks in Science Classrooms

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In science classrooms, students have difficulty understanding the terminology and new vocabularies used in science textbooks. In addition, science concepts and facts are challenging for most students. However, informational text or science concepts are not too difficult if students are able to use science vocabulary and language in writing. Incorporating writing tasks in science content and across content area will support full student participation in science learning activities. This paper summarizes the negative effects of lack of writing literacy in science classrooms, and points out the scarcity of writing tasks in core content areas such as science. In addition, it emphasizes the positive impacts of writing tasks as it promotes student engagement in a wide variety of scientific writing activities such as taking notes following hands-on activities, writing summaries following small-group reading from the texts, using concise data in graphs, and extending newly learned science concepts. Moreover, the paper provides an example of writing task and aligns with the Common Core State Standards (CCSS), which are currently used in Oklahoma, USA. The writing task is implemented in a middle school science classroom with the collaboration of science teacher and language arts teacher. Lastly, it enables science teachers to use a writing rubric in order to analyze how students use their imagination to articulate and organize scientific ideas.

Keywords: Student engagement, writing tasks, science literacy

Introduction

Science literacy is considered as one of the most important parts of science education in terms of enabling each student to become a scientifically literate person and make informed decisions (Nam, Choi, & Hand, 2011). Students, who are scientifically literate, can communicate their ideas through writing or speaking (Krajcik & Sutherland, 2010; Norris & Phillips, 2003). To be scientifically literate individuals, students need to have a substantial background in literacy and content knowledge in order to provide solutions to scientific issues (Balgopal & Wallace, 2013). In addition, students can use scientific evidence to draw inferences to establish critical thinking skills (The National Research Council, 1996). Moreover, students can evaluate scientific evidence, make claims, understand the development of scientific knowledge, and make real life connections through extension of scientific concepts (Duschl, Schweingruber, & Shouse, 2007).

As an important part of science literacy, writing in science classrooms can effectively assist all students to understand questions, claims, scientific reasoning, evidence, and claims-evidence relationship in science (Nam et al., 2011). However, research shows that there is lack of writing tasks in science classrooms (Kamberelis, 1998). In addition, even though many states require schools to implement literacy strategies in the content courses, few schools have been implementing such strategies (Fisher & Ivey, 2005). Moreover, Duke (2000) observed 20 first-grade classrooms and claimed that there was a scarcity in writing assignments. In other research, Kamberelis (1998) conducted a study in three K-2 classrooms for four months and found that teachers were assigning fewer than 10 writing assignments in science within that time limit. Therefore, science educators need to incorporate writing tasks in their classrooms as they help students to effectively use vocabulary and develop better understanding in content area and across disciplinary content (Baker, Dreher, & Guthrie, 2000; Guillaume, 1998; Kamberelis, 1998; Purcell-Gates, Duke, & Martineau, 2007).

Integration of writing activities in science will be beneficial for students however; the need for improvement in writing skills continues to grow (National Center for Education Statistics, 2005). The lack of writing skills in elementary school years will be problematic and reflect on students' academic success in high school, and even after they transition out of secondary level (Miller & McCardle, 2011). As a result, the need for improvement of literacy skills is crucial as writing scores of students are mostly at or below basic levels on standardized tests: 67% for eighth grade and 76% for twelfth grade (Miller & McCardle, 2011).

The integration of writing into science classes also provides opportunity to students to better understand of and engage with science content (Yulea, Wolf, & Young, 2010). Mason and Boscolo (2000) investigated the impact of writing on students' content knowledge. They created two groups of students involving one with writing tasks, and another without writing tasks. They found that students using writing tasks in their classroom performed significantly better than another group on measures of short tests, conceptual understanding, open-ended questions, and transfer questions. Supporting this approach, Gunel, Hand and McDermott (2009) examined the impacts of writing-to-learn activities on different audiences and found that students implementing writing-to-learn activities performed significantly better on conceptual questions. Moreover, working on integration of science literacy at elementary schools demonstrated motives for cross disciplinary reading and writing tasks (Cervetti & Pearson, 2012).

Lack of literacy activities in science classrooms can isolate the mechanics of reading and writing contents, and result in unproductive understandings about disciplinary knowledge and activities (Cervetti & Pearson, 2012). In their study, Purcell-Gates et al. (2007) investigated the impact of literacy activities in a science classroom and found that such activities predicted growth in both students' reading and writing. By obtaining necessary writing skills, students can effectively interpret, organize, analyze, and communicate ideas, which can lead to a deeper understanding of disciplinary or cross-disciplinary content (Burns, 2004; Holliday et al., 1994). In this case, the new CCSS (2010) can help science educators to incorporate the practices of reading and writing into other disciplines such as science, literature, and history. That way, science educators will be able to

use reading, writing, and language activities with content and across content specific tools in their teachings (Cervetti & Pearson, 2012).

Cervetti, Barber, Dorph, Pearson, and Goldschmidt (2012) examined efficacy of an integrated science and literacy approach at the upper-elementary level with the participation of 94 fourth grade teachers. Half of the teachers incorporated reading, writing, and scientific investigation while the other half only provided regular literacy instruction in their classrooms. Researchers found that students in science classrooms where teachers were integrating science and literacy integration, made significantly greater gains on measures of science vocabulary, science understanding, and science writing. Incorporating reading and writing assignment into science classes will support students' conceptual understandings, their ability to communicate these understandings in talking and writing, and their ability to develop crucial dimensions of literacy including reading, writing, and vocabulary knowledge (Cervetti et al., 2012).

Leading from Classroom: Writing and Effective Science Learning

In my 6th grade science class, we are working on a unit called electricity and magnetism. I present students with a question, an assessment in the form of a writing prompt with directions (see Figure 1), at the beginning of each unit. Students complete this assignment at the end of the unit. I grade this assignment as homework. I also use Bybee's 5Es (1997) pedagogy to implement my science lessons. The 5Es pedagogy includes: engage, explore, explain, elaborate, and evaluate (Bybee, 1997). In engage, a question is asked to engage students; in explore, phenomena are explored through hands-on activities; in explain, new concepts are introduced and students explain their understanding of concepts through the use of data; in elaborate, students extend and apply concepts to real-life situations; and in evaluate, the abilities and knowledge of students are assessed (Bybee, 1997). The use of Bybee's 5Es in my class does not only help students to construct meaningful knowledge in science, but it also helps students to obtain constant feedbacks from the teachers for their writing tasks as each stage of this pedagogy promotes inquiry learning.

Figure 1: Writing Tasks with Prompts

Writing the description of science phenomenon

Prompt: You are part of a team established by the U.S. Environmental Protection Agency. The agency has asked you to provide information about a system of electro magnets and how it works in cleaning heavy metals from the soil to prevent soil pollution. How does the system work? What science concepts are used to establish the system? Draw or download any available photos of the system.

Directions: Write a report, which is at least 275 words and includes the description of science concepts, data and graph results. In addition, provide a list of your references.

Writing the extension of science concepts

Prompt: Imagine you are one of the researchers who work on developing the efficiency of the system of electro magnets and are asked by a prominent newspaper to provide information about the different uses of the system of electro magnets and its usefulness for human being for the upcoming science week.

Directions: Provide written information, which is at least 300 words and includes the different and similar uses of the system of electro magnets. In addition, explain challenges that researchers encounter while using the system of electro magnets. Lastly, provide a list of your references.

My middle school is divided into teams, and each team needs to implement educational activities that align with the CCSS. In my team, I and the language arts teacher agree that she will grade the first draft of the writing assignment, and I will grade the final draft the assignment for science content. We both use the same checklist scoring guide (see Figure 2), which includes two prompts: a description of science phenomenon and an extension of learned concepts. By the middle of unit, students turn in their first draft for the language arts teacher. The language arts teacher grades

students' first draft and then returns them to students. And then, students continue to work on their final draft of the writing assignment and turn it in by the due date. Through this writing task, my students build competence in literacy skills in two curricular areas, science and language arts. In addition, doing such interdisciplinary team work demonstrates that different disciplines have similar skill sets such as helping all students to become lifelong learners. With the writing assignment, students receive more feedback and mentoring from me (about science content knowledge) and the language arts teacher (about the literacy skills).

Figure 2: Checklist Scoring Guide

Description of science phenomenon
___Text is fully analyzed (up to 4 points).
___ Science concepts described are clear and concise (up to 4 points).
___ Description of the system shows substantial depth (up to 4 points).
___ Organization of the report is clear, focused, and unified (up to 4 points).
___Images of photos are clear and includes a description (up to 3 points).
___Data are included in the graph and scales are appropriate (up to 3 points).
___A reference list is provided (up to 3 points).
Extension of science concepts
___ Imagination is used (up to 3 points).
___Challenges in using the system are clear and concise (up to 3 points).
___Clear description for different uses of the system is available (up to 3 points).
___ Clear description for similar uses of the system is available (up to 3 points).
___A reference list is provided (up to 3 points).

Discussion
Research shows that integrating literacy strategies into content area instruction is considered to be an impactful method to improve students' content area learning (Draper, 2002; Yore & Treagust, 2006). The need for improvement of early literacy (writing) skills for children should be taken under consideration by educators because by the time children are in Kindergarten, the gap already exists in their writing skills (Miller & McCardle, 2011). Fluency in writing reflects on students' thoughts and metacognition, which helps students to understand their content knowledge (NCTM, 2000). In addition, writing skills also provide content area teachers with a view into students' understanding of content knowledge (NCTM, 2000).

The perspectives of educators comply with the idea that content literacy helps students to construct knowledge through activities that involve reading and writing tasks (Fisher & Ivey, 2005). In addition, educators believe that learning subjects such as math and science requires students to engage into reading and writing activities (Brown, Collins, & Duguid, 1989; Draper, Broomhead, & Jensen, 2010; Moje, 2008). Literacy skills support student engagement in discipline-based practices and develop better understanding of the disciplinary content (Moje, 2008). Also, literacy practices provide a useful set of instructional tools for teachers of mathematics and science so that these teachers can provide meaningful goals such as thinking, reasoning, and meaning making for students (Banilower, Cohen, Pasley, & Weiss, 2008; NCTM, 2000).
Writing across the curriculum requires students to have more quality experiences, which includes sophisticated writing strategies with informational text early in their literacy development Kletzien and Dreher (2004). Therefore it is crucial for science educators to understand that providing children with greater exposure to writing tasks in their earliest schooling experiences and through elementary school is crucial (Donovan & Smolkin, 2006). Furthermore, providing systematic instruction can help children to use meaningful language skills in scientific discourse (Wollman-Bonilla, 2000).

Conclusion

Because of these research results, this paper gives substantial insights especially to elementary and middle school science educators, about the importance of writing literacy through cross-disciplinary activities, as it is an important way of increasing students' science literacy (Hand, Wallace, & Yang, 2004; Saul, 2004; Wellington & Osborne, 2001). Writing skills also help students to make sense of and communicate about science concepts (National Research Council, 2011). In addition, they support students' understanding in evidence-supported arguments and develop students' scientific expression (Wallace, 2004). Moreover, the writing literacy is important as it plays a crucial role in carrying out daily responsibilities to keep a job, potentially gaining a promotion, and securing employment (Miller & McCardle, 2011).

References

Baker, L., Dreher, M. J., & Guthrie, J. T. (Eds.). (2000). *Engaging young readers: Promoting achievement and motivation*. Guilford Press.

Balgopal, M., & Wallace, A. (2013). Writing-to-learn, writing-to-communicate, and scientific literacy. *The American Biology Teacher*, *75*(3), 170-175.

Banilower, E., Cohen, K., Pasley, J., & Weiss, I. (2008). *Effective science instruction: What does research tell us?* Portsmouth, NH: RMC Corporation, Center on Instruction.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, *18*(1), 32–42.

Bybee, R. W. (1997). *Achieving scientific literacy*. Portsmouth, NH: Heinemann.

Cervetti, G. N., Barber, J., Dorph, R., Pearson, P. D., & Goldschmidt, P. G. (2012). The impact of an integrated approach to science and literacy in elementary school classrooms. *Journal of Research in Science Teaching*.

Cervetti, G., & Pearson, P. D. (2012). Reading, writing, and thinking like a scientist. *Journal of Adolescent & Adult Literacy 55*(7), 580–586.

Common Core State Standards Initiative (2010). *Common Core State Standards.* Washington, DC: National Governors Association and the Council of Chief State School Officers.

Donovan, C. A., & Smolkin, L. B. (2006). *Children's understanding of genre and writing development.* In: MacArthur CA, Graham S and Fitzgerald J (eds) Handbook of Writing Research. New York, NY: Guilford Press.

Draper, R.J. (2002). School mathematics reform, constructivism, and literacy: A case for literacy instruction in the reform-oriented math classroom. *Journal of Adolescent & Adult Literacy*, *45*(6), 520–529.

Draper, R. J., Broomhead, G. P., & Jensen, A. P. (2010). *(Re) imagining Content-area Literacy Instruction*. Teachers College Pr.

Duke, N. K. (2000). 3.6 minutes per day: The scarcity of informational texts in first grade. *Reading Research Quarterly*, *35*(2), 202-224.

Duschl, R. A., Schweingruber, H. A., & Shouse, A. W. (Eds.). (2007). *Taking science to school: Learning and teaching science in grades K-8*. Washington, DC: National Academy Press.

Fisher, D., & Ivey, G. (2005). Literacy and language as learning in content-area classes: A departure from "every teacher a teacher of reading." *Action in Teacher Education, 27*(2), 3–11.

Guillaume, A. M. (1998). Learning with texts in the primary grades. *The Reading Teacher 51,* 476–486.

Gunel, M., Hand, B. & McDermott, M. (2009). Writing for different audiences: Effects on high school students' conceptual understanding of biology. *Learning and Instruction, 19,* 354–367.

Hand, B., Wallace, C.W. & Yang, E.M. (2004). Using a science writing heuristic to enhance learning outcomes from laboratory activities in seventh- grade science: quantitative and qualitative aspects. *International Journal of Science Education, 26*, 131–149.

Kamberelis, G. (1998). Relations between children's literacy diets and genre development: You write what you read. *Literacy Teaching and Learning 3,* 7–53.

Kletzien, S. B., & Dreher, M. J. (2004). *Informational text in K-3 classrooms: Helping children to read and write.* Newark, DE: International Reading Association.

Krajcik, J.S., & Sutherland, L.M. (2010). Supporting students in developing literacy in science. *Science, 328,* 456–459.

Mason, L., & Boscolo, P. (2000). Writing and conceptual change: What changes? *Instructional Science, 28,* 199–226.

Miller, B., & McCardle, P. (2011). Reflections on the need for continued research on writing. *Reading and Writing*, *24*(2), 121-132.

Moje, E.B. (2008). Foregrounding the disciplines in secondary literacy teaching and learning: A call for change. *Journal of Adolescent & Adult Literacy*, *52*(2), 96–107.

Nam, J., Choi, A., & Hand, B. (2011). Implementation of the science writing heuristic (swh) approach in 8th grade science classrooms. *International Journal of Science and Mathematics Education*, *9*(5), 1111-1133.
National Center for Education Statistics. (2005). Science: The nation's report card. Retrieved October 5, 2012, from http://nces.ed.gov/nationsreportcard/Science.
National Council of Teachers of Mathematics (NCTM). (2000). *Principles and standards for school mathematics*. Reston, VA: National Council of Teachers of Mathematics.
National research council. (1996). *The National Science Education Standards*. Washington, D.C.: national academy Press.
National research council. (2011). *A New Framework for K–12 Science Education.* Washington, DC: National academies Press.
Norris, S. P., & Phillips, L. M. (2003). How literacy in its fundamental sense is central to scientific literacy. *Science Education, 87,* 224–240.
Purcell-Gates, V., Duke, N. K., & Martineau, J. A. (2007). Learning to read and write genre-specific text: Roles of authentic experience and explicit teaching. *Reading Research Quarterly*, *42*(1), 8-45.
Saul, E. W. (2004). *Crossing borders in literacy and science instruction: Perspectives on theory and practice*. Newark, DE: International Reading Association.
Wallace, C. S. (2004). Framing new research in science literacy and language use: Authenticity, multiple discourses, and the "third space." *Science Education, 88,* 901–914.
Wellington, J., & Osborne, J. (2001). *Language and literacy in science education*. Buckingham, UK: Open University Press.
Wollman-Bonilla, J. E. (2000). Teaching science writing to first graders: Genre learning and recontextualization. *Research in the Teaching of English 35,* 35–65.
Yore, L.D., & Treagust, D.F. (2006). Current realities and future possibilities: Language and science literacy—empowering research and informing instruction. *International Journal of Science Education*, *28*(2–3), 291–314.
Yulea, J. V., Wolf, W. C., & Young, N. L. (2010). Emphasizing the literacy in scientific literacy: A concise blueprint for integrating writing into biology classes. *Bioscene: Journal of College Biology Teaching*, *36*(2), 15-21.