The Florida Science Teacher

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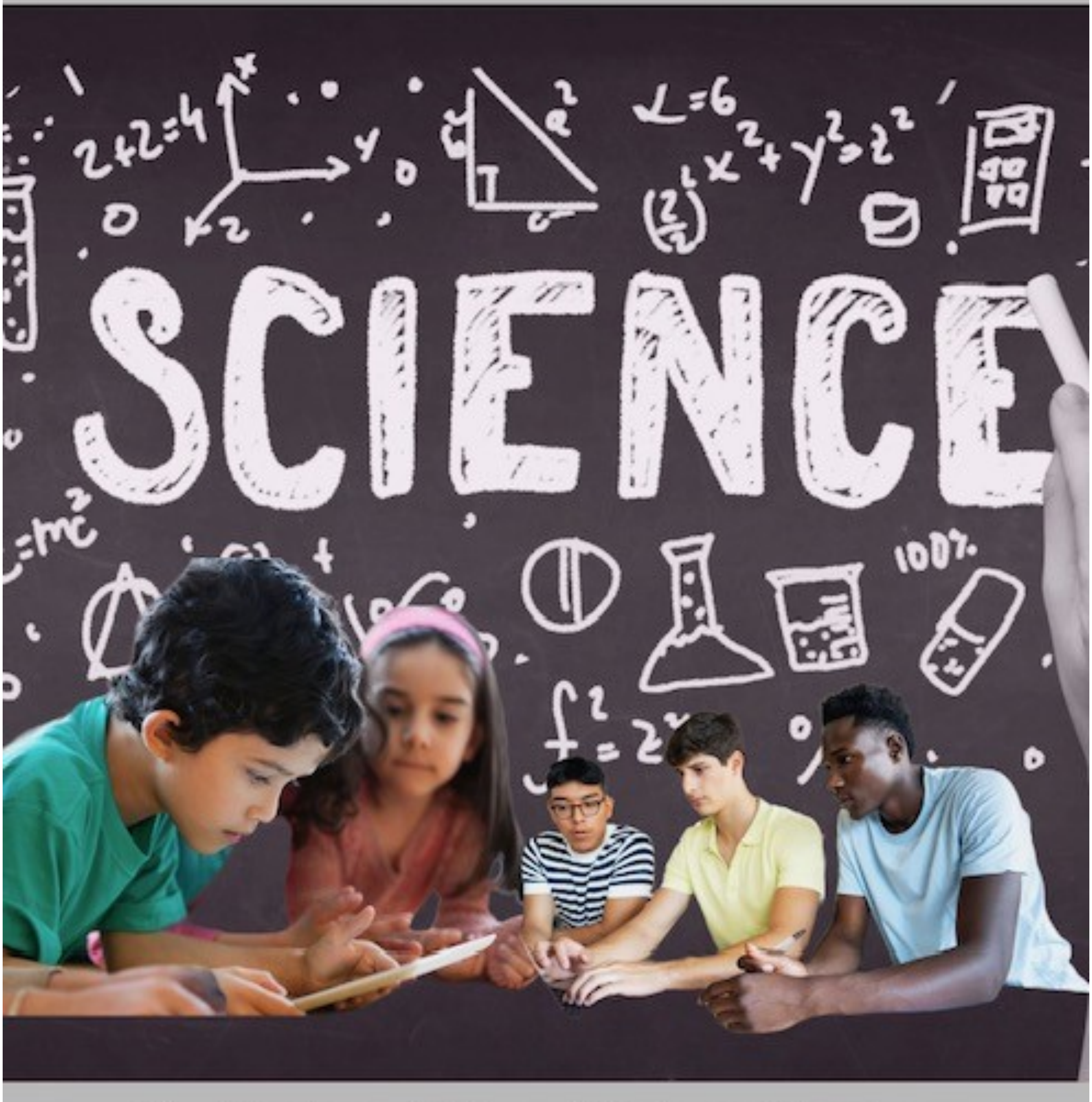

Florida Association of Science Teachers

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The Florida Association of Science Teachers (FAST) is the state's largest non-profit professional organization dedicated to improving science education at all levels, pre-school through college. The association's membership includes science teachers, science supervisors, administrators, and scientists.

Why Writing in Science?

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There is overwhelming support within the science education community for a student-centered inquiry-focused science classroom (NRC, 1996, 2000; NGSS Lead States, 2013). Within this environment, students carry out hands-on activities, while teachers encourage peer-to-peer discussion and utilize strategic questioning techniques, but what about writing? Does time provided for science instruction, as compared to reading and math, preclude the inclusion of content writing. When was the last time your students completed a writing assignment within your science classroom? Just as speaking and listening helps students make sense of what they are learning and create connections with their daily lives, so does writing. In other words, writing is thinking.

Rationale

Although there is widespread consensus as to the integral nature of writing as a component for learning (Champagne & Kouba, 1999; Hand et al., 1999; Kelly & Chen, 1999), is writing used as affectively as it could in the science classroom? Some teachers may assume the students are there to learn science, not learn to write. While true, this view ignores the benefits of having students write in the content area can bring. Other teachers may believe they are including writing as their students often record procedures, data, and conclusions in their science notebooks. Still others may have students write a summary to determine what they have learnt. In higher grades writing a lab report is a common strategy for including writing, but is this all students need? While learning to write like a scientist may be important for those students anticipating science as a career, writing can offer other benefits for the more casual observer of science. While all the previously mentioned methods of writing are important skills for a science student, writing in the content can offer many more academic advantages for the student. According to Judith Langer and Arthur Applebee (1987), writing in the science classroom can also help elicit prior knowledge, help to foster new learning, and consolidate and review ideas, and reformulate and extend knowledge (p.42).

One of the most important reasons for using writing in science is to foster conceptual understanding. Research conducted by Mason and Boscolo (2000) found that students who engaged in writing to reflect, reason, and compare, developed better understandings of content as compared to students having not experienced the integration of writing. Also, the inclusion of writing into science instruction improves students' ability to produce better arguments and had better outcomes regarding conceptual change (Fellows, 1994). Hand, Prain, and Yore (2001), cite how the utilization of 'writing to explain' provides more positive academic outcomes than students who only write to record or summarize. Therefore, it is vital that students must be engaged in, not just writing about science, but writing to learn science (Owens 2001). Writing to learn helps students build their knowledge through multiple ways, to include conjecture, explanation, comparison, and reformulation.

Writing to Learn versus Learning to Write

Unlike when teaching students to write, the writing to learn framework does not require teaching the process or revising a paper until approved by the teacher. Instead, writing to learn is a way to provide students with opportunities to recall, clarify, and question what they know and how they know it. In other words, writing to learn is a way for students to express their thinking through writing (Knipper & Duggan, 2006).

Within a classroom utilizing a writing to learn approach, a teacher models and provides examples for students. Many times, the teacher does so by becoming a participant in the writing experience. The goal is to allow students to make decisions about their own writing and even make mistakes in a setting of minimal risk. The goal of writing to learn is focused on increasing students' depth of knowledge of the content, not the process of writing, though improvements of writing skills may be a by-product (Hand, Prain, & Yore, 2001). Students may question why they must write. Simply put at some point all of us will need to communicate our ideas through writing.

Writing Across Grade Levels

Writing to learn can be used as a strategy to increase student achievement at all levels. For example, kindergarteners may write using pictures and then invented spelling as they develop language skills over time. In slightly higher grades (e.g., grade 1 & 2), concept maps can be used to improve scientific thinking by providing a meaning-making experience. Concepts maps may even be utilized at higher grade levels when writing skills are more proficient.

What might be even more surprising about the effects of writing is that even ELLs can benefit from the writing to learn experience. According to Amaral, Garrison, and Klentschy (2002), ELLs not only benefit from a science experience that includes science inquiry and a plan to include writing, but after 4 years of this type of instruction can outperform their English-proficient peers on tests of writing and science. This research sends a strong message as the numbers of ELLs has increased in most areas of the country. It also provides strength to the argument to include writing to learn in conjunction with science inquiry for ALL students.

Why and How Do We Write in Science

It should come as little surprise that students are more likely and able to write when they have something interesting to write about. Within the inquiry-based science classroom, students spend time engaged in hands-on activities that can become an important part of their writing. Many times, within the science lessons, students record data, which can then be used within a writing to learn experience. Here, students make connections between the collected data and students' own lives thereby providing relevance to the lesson, which may otherwise seem abstract. A common writing prompt that is often used in science classrooms is to have students tell the story of a water molecule as it journeys through the water cycle. This process helps students make connections between places where water can be found on planet earth, states of matter, and the types of transformations (e.g., evaporation, precipitation, & condensation). Essentially, the writing assignment encourages students to create their own mental model of the water cycle.

The water cycle journey is an example of using students' own experiences and investigations to provide an opportunity for writing. A teacher's role would be to identify the potential writing prompts that relate to each lesson or concept. During the writing to learn experience, students will need scaffolding and support to be successful on writing tasks. Teachers must also model what they expect. Using the scenario of the water cycle journey, a teacher can share an example they wrote, or a student from a previous year, as an exemplar. Teachers must also keep in mind the purpose of writing to learn in the science classroom. At first, students should be allowed to use their everyday language to express their ideas, concentrating on ideas over spelling and grammar. By providing a low-stakes environment for writing, students are freer to experiment and explore the science content without the fear of failure or penalty as they complete their rough draft.

During the writing to learn experience, a teacher will provide feedback to help the student improve their writing by including more accurate scientific vocabulary. The teacher will also encourage students to provide more elaboration as a means of deepening their understanding of content. Feedback is critical for emerging writers, even though some teachers may struggle to move beyond the writing (i.e., spelling and grammar) toward one that lends itself to learning of content (Owens, 2001). A teacher must also guard against vocabulary that masks understanding. For example, while many schools require teachers to post the State standards being taught, if a student includes this statement, it does not mean they understand it. With the provision of ample feedback and support, learners will become not simply better writers, but better thinkers (Spandel & Stiggins, 1990).

Writing fluency is yet another reason students need to write often to help them make meaning of content. The idea is to get students to put their ideas down on paper quickly and accurately (Fearn & Farnan, 2001). This strategy can easily be accomplished using student science journals where they are expected to write about what they learned in brief timed events. For example, the teacher may ask students to write for 3 minutes at the beginning or end of class to explain what they learned. These interludes can help students commit ideas to memory, help make sense of what was learned and provide information to the teacher about the quality of student knowledge and understanding of content. In other words, if students are not writing fluently, they may not be thinking fluently.

Conclusions

Education's current role for writing as an evidentiary expedition into a students' acquisition of knowledge is far from the goal of using writing as a learning tool. Student writing must advance beyond the replication and reproduction of science knowledge (Hand & Prain, 2006). This basis for writing as a learning tool is focused upon an interactive-constructivist approach and is essential if we expect increased academic achievement from our students (Yore et al., 2003). Unfortunately, the struggle to implement meaningful writing opportunities within the classroom has been underestimated and will need additional support in the way of pre-service and in-service training opportunities to change conceptions of science educators about the effectiveness of writing to learn (Rivard, 1994).

Though writing for many teachers is a culminating activity used to assess a student's knowledge at the end of instructional units, it is the authors' belief that writing should be placed front and center within the learning process. Students need opportunities to write often and in a low-risk environment. Students must be allowed to move beyond "the summary" if writing is to become part of the solution to improve students' reasoning ability and help them become critical thinkers about the information. To achieve this goal of transforming the writing in a science classroom is to take hold, then a concerted effort must be placed upon supporting this change by mobilizing the school administration, teachers, and other community-based stakeholders (Langer & Applebee, p 145).

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I Touched the End of the World: Science Comes Alive in Antarctica

Yvette F. Greenspan, Ph.D.

https://www.teachingscienceteachers.com

Antarctica: a place we hear about and so few of us have a chance to visit! My husband and I, along with four close friends, recently returned to Florida after cruising on a passenger ship to the Antarctica Peninsula, the Falkland Islands, and the Shetland Islands among other amazing places.

In 1959, twelve nations signed the Antarctica Treaty that preserved the area for peaceful purposes, scientific research, and collaboration. In subsequent years, the nations also agreed to preserve the wildlife, the fauna and flora, and the marine resources. Previously, many expeditions occurred in the region, with many claiming and possessing the region they discovered such as Russia, Britain, Sweden, France, and Japan. I learned about the race between Scott and Amundsen, and how Shackleton led four expeditions.

I, by no means, consider myself an expert on Antarctica; this was an eye-opening experience quite different from anything I have ever discerned. As a Floridian, I have learned all about the Everglades and taught it; I was now confronted with a totally different understanding about a part of the world I did not know.

Fortunately, there was a team of science experts on our ship who have lived, explored, and researched Antarctica. They lectured twice daily and were always available, even when we walked on deck to learn more about what we were seeing.

This is what I learned:

Antarctica, the southernmost point in the world at 60 degrees latitude and beyond, comes from the Greek word, *antarktikos*, which means “opposite to the Arctic”. In turn, Arctic comes from the Greek word *arktikos*, which means “of the bear,” in reference to the northern constellation called Osa Menor, in which is the Polar Star, marking the North Pole.

To get to Antarctica, one must cross the Drake Passage, one of the most treacherous voyages for ships due to the westerly wind and current flow that occurs counterclockwise. This area is a body of water between South America's Cape Horn, Chile, Argentina, and the South Shetland Islands. It connects the southwestern part of the Atlantic Ocean (Scotia Sea) with the southeastern part of the Pacific Ocean and extends into the Southern Ocean. Needless to say, it was indeed a rough few days but well worth the swaying of the ship, the seasickness, and the fear of not surviving!

Glaciers:

How can one talk about Antarctica without mentioning the many glaciers, ice sheets, and icebergs that can be seen easily! It was beyond remarkable! It was everything one would expect and more. We traveled into the most remote areas; bays and inlets that are considered impossible to reach. Our ship maneuvered through vast ice sheets and icebergs that you can only envisage in your imagination. All the while, day and night, we were thinking about the Titanic.

There are various types of glaciers: (1) glaciers that extend in continuous sheets, moving outward in all directions, (2) mountain glaciers that are confined within a path that directs the ice movement, (3) piedmont glaciers or ice shelves that spread out on level ground or on the ocean at the foot of glaciated regions.

As our expert explained in layman's terms in a visual tactile presentation, glaciers can be solid pieces of ice or, as in semi-arid areas, they can be rock glaciers mixed with rocks and debris (half ice, half rock) or another type mixed with ice, rock, and sand. The latter being a complicated structure. Each roots water in different ways and will change over time. The problem that causes glaciers to lose mass is obvious; warm air and not enough snow or rain.

Around 10% of the world's land surface is currently covered by glaciers which store around 70% of the Earth's freshwater. As glaciers retreat in size (scientists have a way of measuring the amount of snow in a glacier, which transfers to how much water is available), sea levels rise and the water supply is challenged.

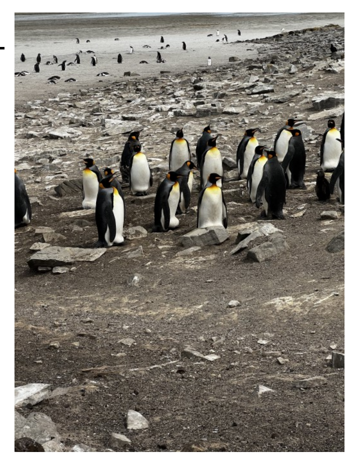
Wildlife:

Antarctica has Emperor, King, and Gentoo penguins, many species of whales, dolphins, seals, and birds. (Visit my website https://www.teachingscienceteachers.com for a complete list of the seabirds and marine mammals that were observed.) It should be noted that bears are found in the North Pole rather than the South Pole, even though both Poles have lots of ice and snow.

It was exciting to see hundreds of penguins waddle in their natural habitat! Some were learning to enter the water for the first time, fathers were warming their mates' eggs by balancing them on their feet and covering them with their pouches (for about 65 days) while females left their 'home' to enter the ocean, some for 62 days to collect food for their chicks. You must wonder how the females find their way back or how the male, during this fasting time, can feed the baby chick if it hatches before the female returns?

Sometimes the eggs of the young babies do not survive and, upon returning from the sea, the female panics because she can't find her chick. Consequently, she proceeds to find any chick and tries to take it as her own. It's not unusual to see females fighting over a chick. Some survive, others do not! Meanwhile, once the female returns, the chick is handed over to her from the male in a lengthy, difficult process (taking as much as 2 days), all the while carefully protecting the chick from the ice.

In a lecture on fur, fat, and feathers, I learned that there are window and elephant seals in Antarctica. Their thick underfur and fat acts as an insulator to repel the water from getting directly onto their skin. Also, southern right whales have a thick layer of blubber with blood vessels that help regulate their body temperature. How thrilling it was the first time to witness so many species of whales jumping in the water and, at other times, spouting water near the surface! Viewing a pod of dolphins playing in the waves created by the ship was entertaining.



Once again, I reiterate that I am not an expert on the Antarctic ecosystem. I gained a tremendous amount of knowledge about a continent around the South Pole covered with ice sheets and glaciers. I learned that this area is 5.5 million square miles and that those ice sheets and glaciers are retreating slowly, which possibly will affect us in the future and impact our daily lives. What I can conclude from my experience was that the scenery was breathtaking, and the ice sheets, glaciers, and wildlife were extraordinary!

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Onboard Antarctica Expedition Team: Dr. Shelley MacDonell, Dr. Robyn Mindy, Dr. Colin Miskelly, Alex Moffat-Wood, Camille Seaman.

https://www.google.com/search?q=ice+sheets+and+glaciers+difference

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Guidelines To Having Your Manuscript Published

The Florida Science Teacher is a peer-reviewed, practitioners' journal with an audience made up of all levels of science educators who provide support for teachers, instructors of teachers, and preservice secondary education students. The Journal is published once a year. We seek manuscripts that are inspirational and provide ideas for enhancing science teaching and learning. Journal articles are written by educators for educators. The editorial staff of The Florida Science Teacher would like to thank you for considering The Florida Association of Science Teachers (FAST) as a venue for your ideas. We look forward to your contribution to the profession.

Manuscripts should identify a grade-level reference. Our feature articles are teacher-student focused and should provide:

- practical, timely classroom ideas and strategies that appeal to a wide audience and are accessible to the general readership;
- examples of teacher and student interactions that demonstrate that your manuscript is an authentic, classroom-tested activity; these examples might include student work, quotes from students and teachers, evaluation data, or other "snapshots" of classroom experiences;
- suggestions for managing the activity that include examples of what may have gone wrong, unexpected results, and unforeseen challenges. If you are not a classroom teacher, consider partnering with one to field test your activity and capture authentic details;
- all aspects of the learning experience from pre-assessment through summative assessment;
- safety precautions. See the NSTA Safety in the Science Classroom, Laboratory, or Field Studies (www.nsta.org/docs/SafetyInTheScienceClassroomLabAndField.pdf) to assist you;
- support for claims made in the manuscript, including research citations and personal anecdotal evidence

There are several guidelines that need to be followed. If you ignore these guidelines, your manuscript may be returned to you.

- Submit the main body of your manuscript as a Word document (.doc) or PDF format. Figures, photos, and other graphics may be embedded in your Word document, but we prefer that these elements be uploaded as separate files during the submission process
- The main body of your manuscript should be no more than 1,500 words. References, captions, sidebars, figures, and other supplementary text are not included in the word count.
- Your manuscript should be double spaced, with one-inch margins, and numbered pages. Use a single 12- point font throughout the manuscript. Avoid extra formatting of any kind.
- A 200-word abstract should accompany your submission.
- References and resources lists should be alphabetized by author and limited to current, readily available items. Cite only the most germane references. Provide a page number for any direct quote.
- Manuscripts must identify how they align with the Next Generation Science Standards. The specifics should identify disciplinary core ideas by reference number and Science and Engineering practices by direct reference, including grade band endpoints. Do not include all of the practices; rather, select those that are most germane to the activities identified in your manuscript.

The Parent Advocate

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Abstract: Do parents have the adequate understandings of the educational system to become a well-informed advocate for their child's science education? Like the professionals working within the educational system, parents too need critical information about what their child is learning, as well as how to judge the quantity and quality of instruction happing in their child's science classroom. Parents also need to become more acquainted with school communication options, how schools handle behavioral issues, as well as how their child will be academically assessed. Essentially, parents need to possess the knowledge to become advocates for their children as well as stakeholders in the educational process.

There has been much written to help teachers with regard to teaching in ways that most benefit students. A concern would be, are parents receiving the same type and amount of help in becoming an advocate for their child's science education. A document produced by the *National Science Teacher Association (NSTA)* entitled *Parent Involvement in Science Learning* (2018) provides the argument for the importance of being involved in your student's science education. While it provides a fabulous overview of what it means to be and how to be involved, such as volunteering in a classroom, these actions are limited to those parents with time on their hands often determined by socioeconomic status. What the authors feel is needed is a way for the average parent to gain the knowledge needed to learn more about the specifics of a school's science program and ways to support the change that may be necessary. Parents need to know what questions they need to be asking and what they should be looking for as evidence of a sound science educational program at their child's neighborhood school. Parents need to learn how to ask the appropriate questions about such things as, grading, student behavior, content being taught, available resources, communication (teacher to parent and school to parent), etc. By becoming a well-informed advocate, parents can become a support for and an advocate for excellence, thereby increasing the fidelity of science instruction in their neighborhood school.

Science education is a critical component of your child's overall education. Through science education your child can become scientifically literate (NRC, 1996), but why is that important? For example, the authors of the National Science Education Standards Overview (NRC, 1996) describe the importance of scientific literacy for the following reasons:

- We need scientific information to make choices in our daily lives.
- Important issues that involve science and technology require informed public debate.
- The collective decisions of an informed citizenry will determine how we manage vital natural resources such as air, water, and forests.
- There is personal fulfillment in understanding how the natural world works.
- Science contributes to vital workplace skills of decision-making, creative thinking, and problem solving.
- To compete on a global scale in the world market, we need a capable citizenry.

To become scientifically literate, students need to understand, what is science. Many consider science as a set of facts collected over the years. While partially true, this description does not capture the true essence of science and the reason students need to learn about it. Certainly, science is a body of knowledge that represents current understanding of natural systems, but it is so much more. Science also includes the process whereby the body of knowledge is constructed, as well as continually extended, refined, and revised. Both the body of knowledge and the process of science are important. One cannot develop a deep understanding of science without an understanding of both. Clearly, learning science is important for your child, the question becomes how do you as a parent support this learning and what questions should you be asking as your child's advocate?

SCIENCE CONTENT

Science is one of the most interesting and extensive subjects you can find in a school setting. It is the door to curiosity and endless inquiry. Knowing what your student is learning and what they need to succeed is important, some questions you can ask are:

- What science topics will my child learn and what skills will he/she master by the end of this year?
- How does this relate to what my child learned last year and what he or she will learn next year?
- How does it relate to what my child is learning in math, other subjects, or the world in which we live?

- Will there be science homework and what will it look like? (NSTA, 2018)
- Does my student need any special clothing or materials?

INSTRUCTIONAL QUALITY AND QUANTITY

As many parents already know, it is the disciplines of math and ELA that take priority in the elementary grades, with science typically receiving minimal and sometimes no time during the school day. As a parent, ask your school about instructional time given to science.

Even if science is being taught in the classroom, is the quality of the instruction purposeful and meaningful? NSTA (2018) provided some thoughtful questions that are important to the quality of the instruction being taught:

- How is science taught in your classroom?
- What are the methods or activities used?
- Are there sample lessons I can review?

It is important to know how the child is learning, especially since students have different learning types (visual, auditory, kinesthetic, tactile). Is my child learning via reading a textbook, watching videos, doing worksheets, or actual inquiry-based hands-on activities? Is my child learning in a way that best fits their needs and learning styles? Often, students thrive in inquiry-based learning due to construction of one's own knowledge that it can stimulate. Inquiry also allows for collaboration that brings on many different key life skills such as communication.

STUDENT BEHAVIOR

As student behavior plays a part in a student's success, it is important to know how their behavior affects it, what support systems are in place, and how you as a parent can help your child if they are having any difficulties. Schools are a wonderful place to learn and grown with their peers, but some students will have trouble for various reasons, and it might come at a time when you do not expect it. The following are questions you may want to ask the teacher or the administration:

- Can I be of any help if my child is being bullied/being a bully?
- Who will contact me if my child is disruptive?
- How does behavior affect grades and in what ways?
- What are some supports offered at or by the school to help manage my child's behavior?
- Many schools offer a program called Positive Behavior Intervention Support, does yours?

STUDENT GRADES

Grades are another large concern of parents, so it is critical to have communication about the sources of grades so the parent can better judge the academic gains of the child. It is important for parents to find out how students are being provided with grades. For example, questions a parent can ask a teacher are as follows:

- Are grades based solely on tests?

- Do grades include class work and if so, how is it weighted towards the overall grade?
- Are grades based on mastery where a child can fix their work to earn a higher grade?
- What happens when my child struggles with the coursework? Are there helpful resources?
- What happens when school is missed due to illness? Are there alternative assignments?
- What type of grading scale are you using?
- Is participation counted toward a grade and if so, how much?
- Is extra credit available to improve a grade?
- How many tests will be given each week, quarter, year?
- Are alternative forms of assessment offered based on students' needs?
- Are students able to make up a test if missed or retake if they do not get a good grade?

COMMUNICATION

Russell and Airasian (2012), describe the importance of receiving more than a report card to paint a clearer picture of student performance. Not surprisingly, communication is key in forming a relationship between parents/guardians and a teacher. Quality communication that occurs more than once every nine weeks or when a student misbehaves will act as a bridge between the classroom and home life. This communication needs to work both ways. Teachers can have up to twenty-five students and may find it difficult to be in contact with the parents of every student on a regular basis, especially if they are having to contact each child's parent separately. This leads to parents feeling as if a teacher only contacts them if their child is struggling or misbehaving. This problem can be exacerbated when it is hard for the parents and teachers to connect; this can be due to language barriers, parent work schedules, a family's lack of access to technology, etc. None of these barriers are the fault of either the parents or the teacher but it may cause roadblocks in the frequency of communication and minimize the support a student receives.

While the teacher and school should be sending information home to parents in the form of newsletters and agendas, that should not be the extent of parent/teacher communication. Some schools have programs like Class Dojo, where teachers and schools can keep track of behavior, events, "points" that were awarded to specific students or their entire class, a feed similar to Facebook so you can see what different classes in the school are up to, and a direct messaging component to communicate with any teacher your child has or administrators. Kickboard is another similar program that some schools have integrated school-wide with similar features. However, not all schools have these types of programs. If your school does not, feel free to ask what the teacher uses.

CONCLUSIONS

All parents want what is best for their children, but all too often they are not equipped to participate. By utilizing this article as a guide, the hope is for the parent to advocate for their children to ensure they are provided the best science education possible. Schools have the same desires for every student and appreciate parent involvement in the school and acting as an advocate for their child. Teachers too want parents to be involved in their child's education. According to the American Institute for Research (n.d.) when stakeholders work together, student performance increases. Students miss school less frequently, dropout rates decrease, and students are more motivated to learn, all indicators of academic success.

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Multicultural Science Education for the English Language Learner

Tony De Souza, Ed.D.

Abstract

It has become evident that as our society becomes more and more pluralistic, so have the English language learners (ELLs) in our K-12 classrooms today. The metamorphosis within our schools, especially in urban areas, presents a multitude of challenges for content-area teachers in science and STEM education. Science instruction is a great platform that provides intriguing lesson context for English proficiency development in ELLs while learning meaningful academic content. To secure effective instruction that will promote higher academic achievement for English language learners, teachers should integrate science content and language into daily instruction. This will ensure that ELLs will have the opportunity for academic literacy development. As the ELL is learning a second language (L_2), they are in their acquisition phase of English and require opportunities for success in school. Visual models when used during science instruction are a great example of language support in a multicultural classroom to provide vocabulary opportunities that are vital for students' reading education and mastery.

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American society has become increasingly more culturally diverse, resulting in our classrooms also seeing a lot of growth with K-12 students from different cultures. No longer are we able to only speak of a monoculture as the personification of all things *"American."* Additionally, the values, lifestyles, and traditions are manifested among the different children representing families beginning with the Native Americans to Mexico, Africa, the Indian subcontinent, Southeast Asia, Central America, Europe, and so many other different homelands. It has become evident that as our society becomes more and more pluralistic, so have the English language learners (ELLs) in our K-12 classrooms today (Lee & Buxton, 2013). In 2017, The U.S. Census Bureau reported that the percentage of the American population of children aged 5 and older speaking a language other than English at home was 21.6 percent in 2016 (U.S. Census Bureau, 2017). In addition, the report also indicated that new language data showed Spanish was the most predominantly non-English language spoken at home in 2016 by 40.5 million people, or 13.3 percent of the population aged 5 and older. This was followed by approximately 3.4 million Chinese speakers at home, with 1.7 million speaking Tagalog.

Integrating Science for the ELL

The metamorphosis within our schools, especially in urban areas, presents a multitude of challenges for content-area teachers in science and STEM education (Amaral, Garrison & Klentschy, 2002; Fradd & Lee, 1999; Nóvoa, 2019; Palacios & Kibler, 2016; Santau et al., 2010; Trainor & Robertson, 2022). Notwithstanding the increasing expectations that science teachers should help all students achieve higher academic standards, science instruction for ELLs remains essential to have classrooms that would foster cultural understanding and sensitivity for immigrant students and others belonging to non-dominant groups within our society (Castaneda & Baustista, 2011; Lee & Luykx, 2005). In as much, K-12 classrooms in the United States continue to be fast-changing and more linguistically diverse over the past several decades. The previous disposition in public schools has traditionally been conceptualized as separate areas of instruction for ELLs resulting in a lack of equality for those students. To counter this and secure effective instruction that will promote higher academic achievement for English language learners, science and STEM teachers should integrate science content and language into daily instruction (Barr, Eslami & Joshi, 2012; Groves, F. H. (2016). In science education, research on instructional pedagogy that promotes science and helps ELLs reach English proficiency has also been emerging in recent years (Besterman, Williams & Ernst, 2018: Lee & Buxton, 2013; Okhee, 2005; Tan, 2011). However, to ground emerging research literature into instructional strategies in the classroom, teachers' preparation in multicultural education must include content integration to help ELLs achieve English proficiency (Krashen et al., 1979; Kuhl, 2004). Equal access to content-area instruction should be implemented right from the beginning through the practical aspects of modeling situations the learner can apply and utilize in class. This will ensure that ELLs will have the opportunity for academic literacy development (Perez & Holmes, 2010). We must also be aware not to confuse the limitations of language with limitations of cognition. When an ELL enters the science classroom, it is necessary to assess the student's English proficiency level because this will vary. Having a working knowledge of the ELL's English proficiency level will help the teacher make an informed decision on how to create the accommodations needed for learning (Arnold et al., 2012; De Anda, Ellis & Mejia, 2022; Dolapcioglu, 2019).

Visual Modeling

Science is a broad content area because it represents a complex system (e.g., earth, life, natural, physical, etc.), which are all different scopes in the curriculum teachers cover in the mainstream science classroom. Furthermore, due to the intricacy of these science lessons, especially when reviewing different systems with ELLs (e.g., the water cycle), visual models are a great tool to help the second language (L_2) learners understand the component complexities, the sequence transformations, and relationship occurrence within the water cycle lesson (Ben-Zvi Assaraf & Orion, 2005, 2010; Kali, Orion & Eylon, 2003). As the ELL is learning a second language (L_2), they are in their acquisition phase of English and require opportunities for success in school. Visual models during science instruction also provide vocabulary opportunities that are vital for their reading education and mastery (Freay & Fisher, 2012; Geva & Farnia, 2012; Lee & Gail, 2018). Therefore, teachers will need to make instructional decisions when preparing lessons that would integrate science and English proficiency content for the ELL with strategies in teaching the content through literacy, language support, and discourse. If the student's language skills in English during instruction are not proficient enough for them to become academically successful, teachers should also provide non-academic opportunities for success in the classroom and outside. Lee and Gail (2018) similarly advocated that teachers need skills for knowing how to identify the relevant components of images and visual representations of models used during instruction. This will invariably help ELLs understand the lesson being communicated better, and help teachers become aware of how their students interpret and conceptualize the visual model examples used during instruction (Diaz, Cochran & Karlin, 2016; Echevarría & Vogt, 2011; Granena & Long, 2013).

Even though the difference is significant among the second language (L_2) student population in our schools today, there remain some universal characteristics that could help teachers have a better understanding of their ELLs regardless of the child's home language (L_1). First, most L_2 students will progress at a different pace as they independently move towards language acquisition that contains fewer reading comprehension errors (with teacher guidance) during classroom instruction. For example, Life Science teachers could determine the impact of how they're providing their instruction (e.g., a plant life cycle lesson) and observe how the ELL masters concepts and vocabulary (Ferreira, 2011). As the ELL considers the stages of seed, sprout, small plant, and adult plant, many L_2 learners may *"pick up"* such features relatively early during the language acquisition phase (Grossberg, 2015; Gweon, et al., 2012; Helman & Burns, 2008), while the ability to fully comprehend and make inferences may require longer exposure to the L_2 language with additional fine-tuning from the teacher (Olulade et al., 2020; Richardson, 2000; Schachter, 2017). Second, in older ELLs, the L_2 acquisition structure will be relatively independent of their home language structure because of the natural learning sequence tied to the child's first language. This is possible because the ELL facilitates the learning process of lesson content and can translate the information (cognitively) into their L_1 home language to make the connections (Ahmad, Khan & Saeed, 2022; Au et al., 2008). In other words, the ELL progresses from emergent language development to the language stabilization stage connecting speech, reading, and writing (Anton, Gould & Borowsky, 2014; Cheng, Wang & Perfetti, 2011).

Language Support for the ELL

Science and STEM teachers working with multicultural students should attempt to plan, create, and teach curricula that will prepare and develop their students to communicate in their new L_2 language. The overall long-term objective is to move the ELL towards communication competence in English (De Anda et al., 2022; Jeon & Yamashita, 2014). Science instruction is a great platform that provides intriguing lesson context for English proficiency development while learning meaningful academic content (Jez & Wassmer, 2015; Okhee, 2005). Therefore, science teachers should consider the use of language support strategies because they will be specific to the needs of ELLs and will help enhance their comprehension of academic content to develop the English proficiency needed. Keeping in mind that there is nothing a teacher can do to rush the ELL's English language acquisition phase, however, teachers do play a critical role and can help increase the learner's L_2 language production through peer interaction in the classroom (Herrara, et al., 2010; Honnert & Bozab, 2005). The key is to provide the ELL with time and practice opportunities each week. This language support strategy is specific, measurable, and if applied 2-3 times each week during instruction, will help the student verbally demonstrate their L_2 speaking ability. Furthermore, if the science activities are structured to provide peer or small group interaction, it will naturally create the opportunity for the ELL to explain concepts and contribute towards the assignments. This will invariably also give the teacher an opportunity to monitor the student and gauge what the child has learned in demonstrating progress in English language development (Ambridge & Lieven, 2011; DeKeyser et al., 2010; Fuligni et al., 2012). Furthermore, teachers could build on the background knowledge of the ELL as that would help them increase comprehension. This could be done by eliciting their background knowledge in the content area through a variety of activities for example through using graphic organizers and asking the ELL questions about the lesson (Louwerse & Ventura, 2005; Noorman & Bylund, 2016).

Learning something new is a catalyst for stacking building blocks for the learner—the more they build, the higher they can go (Zhukova, 2021). In as much, it is not always evident which exact building blocks an ELL would bring to school from their individual background knowledge learned through their L_1 experiences due to language barriers. At times an ELL may be unable to make a connection between their previous experiences with given lesson content with the current lesson being taught. This is where the skills of the teacher drawing on the student's background knowledge become so central. Here's where teachers will have the opportunity to creatively elicit the ELL's background knowledge (McCullough, 2013; Meng, 2020) on the lesson topic and in doing so will increase the learner's comprehension of the material. Utilizing a "K/W/L" (Know, Want to Know, Learner) chart is a great and simple strategy to accomplish this. The ELL will be able to share their knowledge and see how it connects to the new information being taught (Montessori, 1964; Zieher & Armstrong, 2016). These language development strategies are just a few practical examples of how teachers could use them in science and STEM multicultural classrooms with English language learners (NICHHD, 2000; Pianta & Stuhlman, 2004; Ratcliffe & Harts, 2011).

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