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What STEM Teachers Need to Know and Do for English Language Learners (ELLs): Using Literacy to Learn

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ABSTRACT

A growing concern for STEM teachers is the responsibility of having students who do not speak English proficiently in their content area classrooms. This paper gives a background of how STEM literacy and English language learner (ELL) literacy can be used productively together as well as strategies for STEM teachers to help all students learn. Strategies for ELL literacy are good strategies for all students. We discuss specific strategies that STEM teachers can use that benefit all students in developing academic language and conceptual understanding in STEM content using a hands-on STEM experiment, “Why do I need to wear a bicycle helmet?” that incorporates Newton’s first, second, and third laws of motion.

Keywords: Academic language; Cultural and linguistic diversity; Content-specific instructional strategies; English language learners; Language minority students; STEM literacy

“How am I expected to teach the same content to every student when some kids in the class don’t even understand English? I’m a content area teacher, not a language teacher.” We hear this many times from STEM teachers.

Nationwide, student demographics reveal that the number of English language learners (ELLs, who are also known as ESL, ENL, EL, LEP, or LM students) in schools across the country continues to rise (National Center for Education Statistics, 2016). A 2015 Migration Policy Institute report indicates that 13% of the U.S. population is currently immigrants. A total of one quarter of the nation’s population is either first- or second-generation immigrants (Zong & Batalova, 2015). In the last decade, states with the largest percent growth of immigrant population were South Carolina, Tennessee, Kentucky, Alabama, and Arkansas (Zong & Batalova, 2015), none of which have traditionally had high levels of immigration. One elementary school in our southern Indiana community counts 34 languages spoken by its students, and one school district in our region totals over 100 languages. These growth patterns indicate that even teachers in regions with traditionally low immigration need to build skills in teaching content material to students who are also learning English.

Consider for a moment a demonstration that we share with teachers. We would show you a paragraph on a specific concept that is written in Arabic. The teacher would slowly read it

aloud to you, utilizing excellent teaching skills such as voice modulation, eye contact, gesturing, questioning, and wait time. Would you know what was being taught? Would you understand it even if the teacher repeated this three times? Or would you learn better from the teacher who has an understanding of your situation as an Arabic language learner and possesses specific skills that aid your comprehension? Imagining this scenario provides teachers with a sense of what ELL students experience for most of the school day, which they spend in mainstream classrooms rather than with ELL specialists or ELL-certified teachers.

Connections Between STEM Literacy and ELL Literacy

When the term *STEM* was first coined in 2001 by Judith Ramaley, the Assistant Director of the Education and Human Resources Directorate at the National Science Foundation, it referred to science, technology, engineering, and mathematics. STEM now has a broader meaning, including agriculture, environment, economics, education, computer science, and medicine (Zollman, 2011). “There is a general consensus that everyone needs to be STEM literate, but there is a difference between literacy and being literate. STEM literacy should not be viewed as a content area but as a *shifting, didactic* means (composed of skills, abilities, factual knowledge, procedures, concepts, and metacognitive capacities) to gain further learning” (Zollman, 2012, p. 12). Literacy in STEM goes beyond understanding, communicating and applying, “going beyond ‘learning to know and learning to do’ to ‘learning to live together and learning to be’” (p. 15), “from *learning for STEM literacy* to using *STEM literacy for learning*” (p. 12).

Table 1
Comparing ELL Language Needs With STEM Literacy Needs

English language learning needs	STEM literacy needs
Multiple opportunities to hear and use both social and academic English	Multiple opportunities to hear and use language to express STEM understandings
Rich contexts to help language comprehension, and the opportunity to engage and contribute to the interactive learning community	Rich contexts to help illustrate STEM concepts, and the opportunity to engage and contribute to the classroom STEM learning community
Instructional supports for written and spoken language—e.g., intentional student grouping, multiple representations, scaffolding strategies for different tiers of English vocabulary	Appropriate supports for STEM concepts—e.g., hands-on student engagement, multiple representations, scaffolding strategies for STEM-specific vocabulary
Acceptance of “flawed” language for example non-standard English grammar in earlier stages of language learning	Acceptance of “flawed” language--for example, non-scientific language

Note. This table is adapted from Riley and Figgins (2015) and is used with permission from the authors.

Teaching students who are learning English is intimidating for many teachers, but seems to be especially daunting to many STEM teachers who often have limited training in working with language learners. Regardless of their content area specialty, we believe that all STEM teachers—and their students—benefit greatly from knowing some basic information about teaching English

language learners. Table 1 shows a comparison of ELL students' needs and students' needs for STEM literacy. As Bennett and Ruchti (2014) assert, STEM teachers can increase student learning by integrating common practices.

In order to model what STEM teachers need to know and do, we offer the following example activity, "Why do I need to wear a bicycle helmet?" (Teaching Channel, 2016), which incorporates Newton's first, second, and third laws of motion in a real-world problem situation. In this activity, students first predict, then observe, and then experiment with placing an egg in a toy car and letting it roll down an incline plane until the car hits a brick barrier causing the egg to fly out of the car and break on the floor.

What STEM Teachers Need to Know

Using literacy to learn is a valid method for ELL students, for STEM students, and, in fact, for all students. The following are suggestions of what STEM teachers need to know about ELL students in order to facilitate learning for all students.

Students Are Learning Two Types of English to Be Successful in School

"I hear him speaking fluently with his friends out in the hall, so his lack of achievement must not be a language barrier." Complaints like this represent comments that we often hear from teachers who assume that because a student speaks English well, the student's struggle or failure to perform in class is not related to language proficiency issues. The most common misconception about language learners is that if a student can speak English, then the student knows English. However, much like learning in the STEM areas, language acquisition is not a linear process. Successful students must acquire two different types of English, social language and academic language, which Cummins (1984) referred to as "basic interpersonal communicative skills (BICS) and cognitive/academic language proficiency (CALP)" (p. 136).

BICS, or social language, is less cognitively demanding and often includes nonverbal cues and context clues to meaning; for this reason, students often become proficient in social language within 1–2 years of being in schools in the United States (Thomas & Collier, 2002). CALP, or academic language, is much more cognitively demanding and often appears in situations without many context cues (such as a nonillustrated reading passage or a lecture-style lesson without visuals or manipulatives.) This more difficult type of English encompasses general academic language that students are unlikely to hear in social situations (phrases like "select the most likely response from the following options" or "multiply by the conjugate") as well as content-area technical terms (including STEM terminology with multiple meanings; e.g., *plane* or *receptacle*). How quickly students acquire academic language varies widely due to multiple factors ranging from students' prior educational experience to the quality of teaching. However, research over the past 2 decades has indicated that students generally take 4–7 years—and sometimes up to 10 years—in U.S. schools in order to acquire academic language proficiency (Thomas & Collier, 2002). Given the complexity of the task of learning academic English, it is no surprise that students who have already acquired fluent conversational English skills often still need language support for several more years to reach grade-level expectations in the STEM content areas.

Teachers and even parents can easily mistake a student who speaks social English fluently as being proficient in English overall—even though that student may need to increase their academic

English proficiency a great deal in order to succeed in grade-level content area work. One helpful analogy for the way language acquisition works is to think of the different types of language that we all use in different social situations (*language registers*). Two students talking to one another in the hallway often use very different word choices and grammatical constructions than those same students use with their teacher in the classroom.

Teachers also may recognize a parallel between the development of social and academic language among English learners and among native speakers. Many English-only students whose spoken language is perfectly functional for social situations do not have the academic vocabulary necessary to complete grade-level tasks in Standard English—even if they speak no other language. Adults use different vocabulary, sentence structure, and discourse parameters when speaking to a supervisor, in a faculty meeting, with young children, and with close friends. Academic language is not a set of skills that English learners can “soak up” from the environment but rather is learned through scaffolding and contextual support and is facilitated through explicit teaching.

Teachers Already Have Resources on What to Expect From Students Learning English

Each U.S. state’s department of education has procedures in place to monitor and support language learning. These procedures also benefit content area teachers, but many teachers are unaware of the resources. Most states use a home language survey to indicate if a student enrolling in school speaks a language other than English; every student who indicates that they speak a language other than English is given an assessment of their proficiency in reading, writing, listening, and speaking English (Zacarian, 2012). The results of that assessment determine whether the student is considered “limited English proficient” and eligible for language support services. Under federal mandates, local education agencies must assess an identified English language learner’s (ELL) language proficiency annually until 2 years after a student has demonstrated English proficiency (Zacarian, 2012). The results of this annual language proficiency test can help STEM teachers know what students should be able to do at each level of development in reading, writing, listening, and speaking English.

Figure 1 provides a visual representation of how knowing a student’s language proficiency levels can help teachers know what they can expect from a student. These “Can Do Descriptors” are published by WIDA, an organization that includes a consortium of 35 states that jointly use resources to comply with federal mandates for educating English language learners (WIDA, 2013). The WIDA language proficiency standards and instructional recommendations are built upon a strong research base and are a useful and recommended resource even for educators in states that are not members of the WIDA Consortium. The figure that we have included here indicates what a student at each level of English proficiency can be expected to do in the areas of listening and speaking in content area classrooms. STEM teachers can use this figure as a reference when planning lessons and modifying expectations for assignments based on the type of language students can produce and comprehend at a particular stage of English development. For example, a teacher doing the egg experiment may design assignments with the expectation that a student writing at Level 3 can be expected to produce short paragraphs but may not yet be able to state opinions orally because of a Level 2 speaking proficiency.



Can Do Descriptors: Grade Level Cluster 6-8

For the given level of English language proficiency and with visual, graphic, or interactive support through Level 4, English language learners can process or produce the language needed to:

	Level 1 Entering	Level 2 Beginning	Level 3 Developing	Level 4 Expanding	Level 5 Bridging	
LISTENING	<ul style="list-style-type: none"> Follow one-step oral commands/instructions Match social language to visual/graphic displays Identify objects, people, or places from oral statements/questions using gestures (e.g., pointing) Match instructional language with visual representation (e.g., "Use a sharpened pencil.") 	<ul style="list-style-type: none"> Follow multi-step oral commands/instructions Classify/sort content-related visuals per oral descriptions Sequence visuals per oral directions Identify information on charts or tables based on oral statements 	<ul style="list-style-type: none"> Categorize content-based examples from oral directions Match main ideas of familiar text read aloud to visuals Use learning strategies described orally Identify everyday examples of content-based concepts described orally Associate oral language with different time frames (e.g., past, present, future) 	<ul style="list-style-type: none"> Identify main ideas and details of oral discourse Complete content-related tasks or assignments based on oral discourse Apply learning strategies to new situations Role play, dramatize, or re-enact scenarios from oral reading 	<ul style="list-style-type: none"> Use oral information to accomplish grade-level tasks Evaluate intent of speech and act accordingly Make inferences from grade-level text read aloud Discriminate among multiple genres read orally 	Level 6 - Reaching
	SPEAKING	<ul style="list-style-type: none"> Answer yes/no and choice questions Begin to use general and high frequency vocabulary Repeat words, short phrases, memorized chunks Answer select WH-questions (e.g., "who," "what," "when," "where") within context of lessons or personal experiences 	<ul style="list-style-type: none"> Convey content through high frequency words/phrases State big/main ideas of classroom conversation Describe situations from modeled sentences Describe routines and everyday events Express everyday needs and wants Communicate in social situations Make requests 	<ul style="list-style-type: none"> Begin to express time through multiple tenses Retell/rephrase ideas from speech Give brief oral content-based presentations State opinions Connect ideas in discourse using transitions (e.g., "but," "then") Use different registers inside and outside of class State big/main ideas with some supporting details Ask for clarification (e.g., self-monitor) 	<ul style="list-style-type: none"> Paraphrase and summarize ideas presented orally Defend a point of view Explain outcomes Explain and compare content-based concepts Connect ideas with supporting details/evidence Substantiate opinions with reasons and evidence 	
		Level 1 Entering	Level 2 Beginning	Level 3 Developing	Level 4 Expanding	Level 5 Bridging
READING	<ul style="list-style-type: none"> Associate letters with sounds and objects Match content-related objects/pictures to words Identify common symbols, signs, and words Recognize concepts of print Find single word responses to WH- questions (e.g., "who," "what," "when," "where") related to illustrated text Use picture dictionaries/illustrated glossaries 	<ul style="list-style-type: none"> Sequence illustrated text of fictional and non-fictional events Locate main ideas in a series of simple sentences Find information from text structure (e.g., titles, graphs, glossary) Follow text read aloud (e.g., tapes, teacher, paired-readings) Sort/group pre-taught words/phrases Use pre-taught vocabulary (e.g., word banks) to complete simple sentences Use L1 to support L2 (e.g., cognates) Use bilingual dictionaries and glossaries 	<ul style="list-style-type: none"> Identify topic sentences, main ideas, and details in paragraphs Identify multiple meanings of words in context (e.g., "cell," "table") Use context clues Make predictions based on illustrated text Identify frequently used affixes and root words to make/extract meaning (e.g., "un-," "re-," "-ed") Differentiate between fact and opinion Answer questions about explicit information in texts Use English dictionaries and glossaries 	<ul style="list-style-type: none"> Order paragraphs Identify summaries of passages Identify figurative language (e.g., "dark as night") Interpret adapted classics or modified text Match cause to effect Identify specific language of different genres and informational texts Use an array of strategies (e.g., skim and scan for information) 	<ul style="list-style-type: none"> Differentiate and apply multiple meanings of words/phrases Apply strategies to new situations Infer meaning from modified grade-level text Critique material and support argument Sort grade-level text by genre 	Level 6 - Reaching
	WRITING	<ul style="list-style-type: none"> Draw content-related pictures Produce high frequency words Label pictures and graphs Create vocabulary/concept cards Generate lists from pre-taught words/phrases and word banks (e.g., create menu from list of food groups) 	<ul style="list-style-type: none"> Complete pattern sentences Extend "sentence starters" with original ideas Connect simple sentences Complete graphic organizers/forms with personal information Respond to yes/no, choice, and some WH- questions 	<ul style="list-style-type: none"> Produce short paragraphs with main ideas and some details (e.g., column notes) Create compound sentences (e.g., with conjunctions) Explain steps in problem-solving Compare/contrast information, events, characters Give opinions, preferences, and reactions along with reasons 	<ul style="list-style-type: none"> Create multiple-paragraph essays Justify ideas Produce content-related reports Use details/examples to support ideas Use transition words to create cohesive passages Compose intro/body/conclusion Paraphrase or summarize text Take notes (e.g., for research) 	

Figure 1. "Can Do Descriptors" for English language learners. WIDA Can Do Descriptors © 2009 Board of Regents of the University of Wisconsin System, on behalf of the WIDA Consortium—www.wida.us (used with permission from WIDA).

The second significant resource that you may have in your school is a licensed ELL specialist. With their specialized training in scaffolding strategies and second language literacy, teachers with an ELL certification are experts in supporting academic language and differentiating instruction. Yet, too often, ELL teachers are viewed only as interpreters. Using this licensed teacher only as an aide is not utilizing his or her skills to their full potential. Some of the reading and vocabulary learning strategies that ELL specialists use regularly in language classes can be used by content-area teachers to great effect—and to the benefit of all the students in the STEM classroom. STEM teachers can maximize their personnel resources by collaborating and using strategies and scaffolding methods that the ELL teacher can model.

Language Support Teachers Provide to English Learners Benefits Other Students Too

The research-based best practices for teaching English learners offer two significant additional benefits: (a) They also help English-only students develop academic language, which is particularly important for struggling readers and students with learning differences (Center for Applied Linguistics, 2015); and (b) they help all students learn STEM content (National Science Teachers Association, 2015). Literacy in language acquisition for ELL students is not the end product but a process for further learning of the STEM content areas.

What STEM Teachers Need to Do: Using Literacy to Learn

STEM teachers can utilize the five following strategies to support language development among ELLs as well as support literacy among all students: (a) build background of new concepts, (b) support students' vocabulary-building skills, (c) model how STEM vocabulary should be used, (d) encourage student language production through increasing interaction opportunities, and (e) use different grouping strategies for distinct purposes.

Build Background of New Concepts

STEM teachers know that their content has to have direct connections to the real world. Teachers also know that these connections have to connect to the student's real world (e.g., a YouTube video) not the teacher's real world (e.g., a VHS tape). Extending this idea, teachers need connections to ELL students' cultural real world to make connections and facilitate learning of new concepts.

In addition to connecting to students' cultures, students need to have experiences in multiple representations: concrete with manipulatives, pictorial or graphical, numerical or algebraic, and real-world applications (Zollman, 2012). This is in accordance with STEM content area standards and, again, is helpful to English-only students as well as ELLs. Graphic organizers of a variety of types are particularly useful in helping ELLs understand and communicate understanding of complex topics (Haynes & Zacarian, 2010).

In our sample lesson, an egg is placed in a toy car and the car is released down an incline plane with a barrier at the bottom of plane. The egg will fly out of the toy car and land on the floor, breaking the egg. This lesson connects students' real-world activity of needing to wear a bicycle helmet to Newton's laws of motion. It also gives students context for understanding the lesson's key concepts, even if they do not yet understand all the language used in class. In contrast to

the traditional classroom in which lecture and reading are followed by comprehension questions and a culminating high-interest activity, we recommend that teachers of English learners “teach backward” by beginning a lesson with an experiment (or interactive experience, or video clip) then preteaching vocabulary and leading discussion before assigning a textbook reading or delivering a lecture. This process is analogous to reverse engineering in STEM education. The hands-on or visual experience—in this case, the egg demonstration—provides context for both the language and content the students will learn throughout the lesson.

Support Students’ Vocabulary-Building Skills

English learners must learn three tiers of vocabulary. The first tier is common vocabulary used in social or daily life interactions. The second tier is the vocabulary needed for school that students might not encounter in their everyday lives or social interactions; examples might include words like *seldom* or *classify*. The third tier of vocabulary consists of academic content words which have STEM-precise definitions used in specific situations (Haynes & Zacarian, 2010). Among third tier vocabulary words, STEM language definitions vary from the English social vocabulary. For example, the term *plane* has different meanings depending upon the context of the setting. In common vocabulary, plane means an airplane to most students (ELL and native speakers.) In mathematics, plane means the coordinate plane of the x - and y -axis in mathematics. But, in our activity, plane means an incline plane that stores potential gravitational force. When STEM teachers are presenting all their students with Tier 3 vocabulary, they can look through their assignments and see which Tier 2 vocabulary words their ELLs will need to know to complete the assignment successfully. Preteaching the STEM content vocabulary words, as well as supporting ELLs by pointing out these Tier 2 vocabulary words, can help speed acquisition of the hundreds of words that they need to learn to be able to achieve grade-level proficiency in STEM content (File & Adams, 2010).

The notion of considering three different tiers of vocabulary may seem excessive to teachers who are not language specialists, but consider the following steps in our example. First we have the students predict what will happen to the egg in lay terms. Later we introduce and model scientific vocabulary. Still later, we expect students to apply an understanding of Newton’s laws of motion. ELL students’ understanding of language is a developmental process for conceptual understanding, much as we guide all STEM students’ understanding of content in a developmental process for conceptual understanding.

Teachers support vocabulary development in a variety of ways—such as encouraging students to keep vocabulary journals or creating mnemonic aids—but the key to learning vast numbers of words is to use the words often in a variety of interactions. Research on language learning in STEM content areas supports the necessity of students using target vocabulary multiple times in reading, writing, speaking, and listening in order for students to retain large numbers of new words (Mancilla-Martinez, 2010; Folse, 2006; Lee & Muncie, 2006). Some research-based methods of recording and practicing vocabulary include student-created index cards with translations, definitions, pictures, or mnemonic devices (Katz, 2014); websites and apps such as Quizlet; interactive word walls; and personal dictionaries that may include translations and graphic or pictorial representations (Echevarría, Vogt, & Short, 2012). Such tools can be useful, but research has shown that the timeworn practices of writing dictionary definitions or studying isolated word lists out of context and are not efficient in helping students retain vocabulary (Echevarría et al.,

2012); rather, we learn new words through using those words in meaningful ways.

Returning to our sample lesson, a word wall of technological terms can direct the scaffolding of building conceptual knowledge. The teacher can use the word wall to guide the precise definitions of incline plane, inertia, momentum, acceleration, mass, and force as the students repeat the experiment and reflect upon the lesson in verbal and written form.

Model How STEM Vocabulary Should Be Used

Using literacy to learn means not just having discrete language skills but also being able to apply and use those skills in order to learn content. Learning new vocabulary is essential for all students—particularly English language learners who need to learn even more vocabulary to catch up with their grade-level peers—but knowing the definitions of dozens of words is of limited utility if students don't know how to use the words to explain their learning. Learning a language involves becoming proficient at several levels of language usage: the word level (vocabulary), the sentence level (grammar), and the discourse level (organization and cohesion of ideas; WIDA, 2013). As an example, consider the student who has learned a number of words in a foreign language but does not know how to express a complex idea with those words. Even students who speak only English often do not know how to comprehend or construct complex sentences in academic English (sentence-level proficiency), much less comprehend a large amount of dense text (discourse-level proficiency).

Table 2
STEM Language Functions and Sentence Structure Frames

STEM language functions	Sentence structure frames	Sample sentences using Tier 1 vocabulary	Sample sentences using Tiers 2 and 3 vocabulary and target concepts
Sequence	First, _____, then, _____, and finally, _____.	We saw that first the car rolled down the board, then the car hit the brick, and then the egg flew out of the car.	We observed potential gravitational energy of the object at the top of the incline plane. Then the object accelerated due to gravitational force and Newton's first law of motion. Finally, the eggshell broke because of Newton's third law of motion.
Hypothesize	If _____, then _____ will _____. If _____, then _____ would have _____.	If we let the egg roll down the board, it will break when it hits the brick.	From Newton's first law of motion, we hypothesize that the momentum of the object will cause the object to stay in motion when the vehicle hits the barrier.

Moving beyond discrete vocabulary words to sentence-level language support may seem like the realm of an English teacher, but STEM teachers can help increase sentence-level academic English proficiency during the course of a STEM lesson as well. For example, using simple

cloze-style sentence frames allows teachers to model the types of sentence structures needed for STEM literacy in a systematic way (Dobb, 2005; Hoffman, 2013). By displaying simple examples like those in Table 2 and prompting students to follow the template when speaking or writing, STEM teachers can explicitly teach STEM language without taking time away from content instruction. With the expectation that students will write in all STEM areas, modeling various sentence structures empowers students with tools to write across the curriculum. Considering that many students who speak only English also need practice using standard academic English sentence structure, this language assistance strategy supports both academic English growth and STEM literacy for all students. Using sentence frames in class discussions gives students multiple practice opportunities with listening, speaking, reading, and writing key STEM sentence structures. Merely posting a template on a board or digital whiteboard has only marginal effect, but repeated exposure will support all students' STEM literacy skills if the teacher scaffolds the lesson to deeper and deeper conceptual understanding.

Encourage Student Language Production Through Increasing Interaction Opportunities

In order to use a language proficiently, learners need to engage receptive skills (reading and listening) as well as productive skills (speaking and writing). Students' receptive oral vocabulary, words that they comprehend in listening, often grows more quickly than their productive written vocabulary, words they can use effectively in writing (Peregoy & Boyle, 2013), so students need to practice using their newly acquired vocabulary in a variety of ways. Increasing interaction involves STEM teachers planning classroom activities with an eye toward increasing interaction opportunities as well as thinking about what language students will need to use to complete the task—a *language objective* (Echevarría et al., 2010).

Again, we go back to our sample lesson. First, students predict what they believe will occur the first time they see the egg at the top of the incline plane. The students then verbally share their predictions with another student. In later experiments with the egg activity, the teacher guides, challenges, and edits the students' scientific terminology in their oral then written communications.

Use Different Grouping Strategies for Distinct Purposes

When teachers ask us how to group students in class when different languages are involved, we respond by saying, "It depends on the purpose for the cooperative group." Teachers often arrange student groupings so that ELL students are grouped with English-only speakers to encourage group communication in English. This grouping strategy encourages ELLs to practice their language skills.

However, STEM content teachers should not be afraid of students using their native languages at times in class. Research supports the value in ELL students using their native language to clarify and solidify concepts (Echevarría et al., 2010). Many teachers across disciplines have been misinformed that students should not use their native language at all in school, or that students and families should be discouraged from using their native language at home in order to facilitate quicker English learning. However, federal mandates specify that schools may use a student's native language to help teach both English and academic content (Zacarian, 2012). As far as students and parents speaking their native language, decades of research on language learning supports the importance of retaining first language use in the home. For example, The National Literacy Panel on

Language Minority Children and Youth found that literacy skills, concept attainment, and content knowledge learned in one language will transfer to a new language more quickly if a student can utilize his or her background in the home language (August & Shanahan, 2006; Cummins, 2000). Students in STEM classrooms often find great benefit in using their home languages periodically in order to check their understanding and solidify their learning with peers and teachers who speak their first language. Similarly, STEM teachers should take advantage of any print or multimedia resources available in students' home languages to use as supplementary teaching materials. In our sample lesson, we want ELL students first to use their native language to build the background for the concepts that will be presented later in the sequence of Newton's laws of motion.

Connecting What We Know and What We Do

Finally, good instruction for learning is good for every student. We already have three ways to view ELL students' learning. First, similar to the STEM research on female students and gender bias, teachers sometimes assume that a specific group of students (ELLs) are not as capable as other students and, not wanting to make the students uncomfortable, ask only lower level questions to those students (Shahrill & Mundia, 2014). We want all students to obtain the Common Core State Standards for Mathematical Practice (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010) of Problem Solving, Reasoning, Communicating, Modeling, Using Tools Strategically, Attending to Precision, and Making Use of Structure. These standards will not be attained if the teacher expects only lower level responses from the ELL student. The teacher has a responsibility to all students to challenge them to succeed.

Second, each school district gives an English proficiency test on reading, writing, speaking and listening to ELL students. Students then have an Individual Learning Plan (ILP) or a Pastoral Support Programme (PSP) plan that delineates accommodations for instruction and modifications for assessments. These seem daunting to a STEM teacher. But think back 10 years ago and receiving Individualized Education Programs (IEPs) for students with learning disorders. Educators learned to include IEPs into their lesson planning; in the same manner, educators will become accustomed to providing scaffolding and language support for ELL students' needs.

Third, since ELL students are emerging bilinguals (or may already be multilingual before learning English), ELL students in class are already utilizing more of their brain function than other students. So, we challenge STEM teachers to view having ELL students in one's class as having gifted students in the class. Native English-speaking students benefit socially and especially academically from having interaction with ELL students in their class.

Closing Thoughts

An ELL student may speak with an accent, but this does not mean that the student thinks with an accent. We know that students achieve more from teachers who scaffold instruction and activate schema, beginning class with motivating demonstrations, videos, manipulatives, real-world applications, or laboratory experiments. We also know that beginning class with visual or concrete clues gives context to learning, helping not only ELLs but also all STEM students—using literacy to learn is good for all.

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