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Science for the English Language Learner: Strategies to Enhance Comprehension

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SUMMARY

Teachers can help their English language learners succeed in science through strategies that increase comprehension for all students.

This article addresses recommendations 1, 2, 4, 6, and 13 of the "Reading Next" and recommendations 1, 3, 4, 9, and 10 of the "Writing Next" reports of the Alliance for Excellent Education and the Carnegie Corporation of New York. (See pages 95-96 and 98)

"How do we help our English language learners better understand science?" is a question we hear often from teacher candidates enrolled in our adolescent graduate programs or alumni who come back to take professional development courses at our college. These teacher candidates take the required courses to equip them with the necessary knowledge, skills, and dispositions to become science teachers of adolescents. However, what these teacher candidates may lack, and they realize this when they enter the field, is the necessary training to work with ELLs to help them master science content. According to the National Center for Educational Linguistics [NCES] (1999b), most mainstream teachers believe that they are not adequately prepared to meet the needs of ELLs in academically demanding subjects, such as science and literacy. The gap in science still persists between mainstream students and ELLs. We offer teacher candidates in our programs our knowledge and experiences as current researchers/teacher educators and former English/ESL and science teachers, respectively. The purpose of this article is to recommend the same strategies we suggest to our teacher candidates, namely Discrepant Events and its substrategies that would help mainstream teachers make science learning supportable for their ELLs. These strategies benefit not only ELLs, but all students as well. They are research-based and tested by the two authors with secondary content area teaching experience.

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The Needs of ELLs in Science

According to the New York State Science Learning Standards, all students, including ELLs, need to "understand and apply scientific concepts, principles, and theories..." (NYS Learning Standards for Math, Science, Technology, 1996, p.1). [They] are expected to acquire skills such as discussing, analyzing, reading, and writing in ways similar to those of a practicing scientist" (Medina-Jerez, Clark, Medina, & Ramirez-Marin, 2007, Science for ELL, para. 2). Most students in science, however, have difficulty comprehending science content (Schoenbach et. al., 1999) and are challenged by the specialized terminology in science. Furthermore, students believe that science is a body of knowledge rather than a way to generate new knowledge or solve problems (National Institutes of Health). Therefore, they attempt to memorize new concepts rather than learn to think like scientists.

Obstacles Facing ELLs in Science

Science content, difficult to master for many mainstream students, can be even more challenging for many ELLs, who come from diverse backgrounds. Differences in culture, religion, alphabetic system and factors such as prior schooling experiences and first-language literacy levels may impede their success.

One of the biggest obstacles ELLs face is the lack of academic language. According to Cummins (1984), it takes ELLs only 1 to 2 years to acquire conversational language (Basic Interpersonal Communication Skills or BICS), but 5 to 7 years to acquire academic language (Cognitive Academic Language Proficiency or CALP) that would assist them in comprehending content-specific texts. It may take them even longer to learn the technical vocabulary of science, which is specialized and requires advanced levels of literacy. Science vocabulary includes words that have meanings familiar in different contexts (e.g., energy, family). Compound words may be challenging to learn (e.g., endocrine system). Science-specific abbreviations, acronyms, and symbols exist that must be learned (H_2O).

In light of these issues, there needs to be an overall strategy that transcends cultural and linguistic differences; one

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A discrepant event can best be described as an occurrence that appears to be illogical, but upon further examination is found to follow the laws of nature. It makes students wonder how it happened and to want answers to this question.

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that is motivating and that permits all students in a given setting to conceptualize the principles and theories of science by participating in the critical thinking and problem-solving processes.

Overall Strategy for Teaching Science to ELLs

Discrepant Events

A Discrepant Event (DE) is one that causes an unexpected contradiction in students' prior knowledge and experience of a scientific event in support of conceptual understanding (Wetzel, 2008). Students use problem-solving and critical-thinking skills in order to explain the phenomenon. Inquiry-based instruction that uses such strategies as discrepant events has the potential for developing scientifically literate students (Beerer & Bodzin, 2004).

The use of scientific DEs is an inquiry-based strategy that stimulates the natural, innate curiosity we all possess and thereby begins the process of exploring possibilities as a means of explaining that which appears to defy logic and the natural order of things. To understand how this strategy incorporates other sub-strategies and transcends cultural and linguistic differences, it is necessary to describe a classroom demonstration of such an activity.

Classroom Demonstration

The teacher places a wooden clothespin (missing one prong) on the tip of her index finger, tip to tip, and asks the class what would happen if she lets go (*see illustration on opposite page*). The overall response would probably be that the clothespin would fall to the floor, which is correct. If the teacher then places a leather belt onto the clothes pin, just under the remnant of the broken or missing prong and balances the clothespin and belt in the same manner, and asks the same question, the likely answer would be the same. However, the clothespin and leather belt remain balanced on the tip of the index finger. The obvious question is why?

The teacher asks students to describe verbally, in detail, what they witnessed and to explain why they think this phenomenon occurred, building on students' background knowledge and science vocabulary. The next step would be to test the validity of those inferences by conducting experiments. The class is divided into smaller groups of four or five for the purpose of discussing what they believe is taking place. Each group records its inferences in the form of a graphic organizer and shares them with the teacher and entire class as a means of attempting to explain the event. The teacher introduces scientific terminology, principles and theories through the use of visuals and manipulatives. Skills involving making observations, performing critical thinking, making predictions (hypotheses), and communicating ideas through the use of appropriate terminology are practiced by the students themselves.

Generally, the overall reactions of students — secondary students as well as our own graduate teacher candidates — who witness these activities are awe, surprise, and bewilderment. Our practicing teachers who have used DE in their classrooms attest to their effectiveness with all students, including diverse populations, because they tap their curiosity and interest and lead to meaningful inquiry.

Substrategies Used in DE

The type of apparent illogical occurrence in DE lends itself to the use of a variety of instructional substrategies that promote science learning in ELLs, such as (a) activation and building of prior knowledge and vocabulary, (b) visuals, (c) manipulatives, and (d) small-group work. A brief description of each substrategy, including examples of our teacher candidates' perspectives on using the strategy, is presented below.

Activation and Building of Background Knowledge and Vocabulary

Many ELLs lack background knowledge to make sense of new concepts and vocabulary in science. It is important to activate students' prior knowledge and build on it to help them connect to new knowledge. For example, the teacher in the scenario just described can activate students' prior knowledge of concepts and words that they may be familiar with in other contexts, such as torque, in relation to vehicles, and then apply them to the context at hand (rotating force). The teacher could also activate background knowledge of words that contain prefixes, suffixes, and root words or Spanish cognates, such as gravity, with which Spanish-speakers may be familiar. When ELLs have background knowledge and vocabulary, they will be able to use other strategies.

Our student, Melissa, calls for the need to encourage the development of students' background knowledge or schemata:

> Increasing schemata allows students to scaffold the newly introduced material. Teachers can do this in a number of ways, such as starting discussions about the text material prior to reading, viewing media clips to initiate a topic, or using computers and the Internet to set the stage for new theories.

Visuals

Visuals, in general, clarify content for ELLs and make it easier for them to remember science content. The visuals

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METHODOLOGY

Illustrating a Discrepant Event

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used in the DE scenario include, among others, pictures, drawings, videos, PowerPoint, and graphic organizers. Graphic organizers are visual representations of concepts. They allow ELLs to represent large amounts of information in a linguistically simple way (Reiss, 2008) and to organize the information in a conceptually easy way.

Our student, Carey, states:

Using visual aids, pictures, and diagrams will allow those visual learners to get a firm grasp on the key concepts involved by creating a mental image of things and seeing what [they] look like in action.

Manipulatives

Manipulatives can help ELLs express their understanding of math concepts while building their language skills (Lee, Silverman, & Montoya, 2002). They allow students to learn experientially. When students learn by doing, such as conducting experiments, they retain the information better. Manipulatives also appeal to kinesthetic learners who need more hands-on approaches. As an assessment, they provide the means for students to demonstrate their knowledge without necessarily being required to use language.

Small-Group Work

Small-group work and cooperative learning support the Vygotskian notion that learners construct knowledge through interaction with their peers. Vygotsky (1978) suggested that learning takes place when the child's knowledge and adult structures approach each other in a zone of proximal development. Teachers need to stretch students' knowledge across the zone of proximal development toward a higher level of learning. The cooperative learning environment incorporates the learning contexts needed for learning implied by Vygotsky. In the cooperative learning setting, peers can learn when they engage in discussions and verbal interaction, when they are listened to and when they receive a response as a way of creating knowledge rather than merely finding who has what knowledge.

Collaboration on tasks is especially important when it applies to ELLs. Working with native speakers on hands-on tasks promotes ELLs' language development (Rigg & Hudelson, 1986). Small group experimentation is beneficial for ELLs because it allows them to practice concept development and oral communication in social interaction with native-speakers.

Carey agrees with the benefit of students working together to accomplish tasks:

Students get to try exercises or activities by themselves or with a partner for help and get the needed repetition to master the terms or concepts involved.

Use of Multimodalities in DE

"Classroom teaching for diverse students is most effective when it incorporates all senses, all intelligences, and all learning styles" (Lincoln & Beller, 2004, p. 30). DE and the substrategies discussed above accomplish this objective. Technology, in the form of PowerPoints, slide shows, etc., could also be used to stimulate their academic growth. With limited English proficiency, ELLs need alternative ways to process information and also demonstrate their knowledge. Multimodal teaching ensures that diverse students' needs are met.

Conclusion

The strategy of Discrepant Events piques students' curiosity and motivates them to participate in exploring science content. The strategy can benefit all students, but is particularly effective for ELLs, who may lack language and content knowledge, because it provides them with hands-on, concrete, real-life experiences. The substrategies of activation and building of background knowledge and vocabulary, visuals, manipulatives, and small-group work can support ELLs when they participate in Discrepant Events.

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