# *Professional Development of Secondary Science Teachers of English Learners in Immigrant Communities*

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## Abstract

This is a research study of secondary science teacher professional development, in which 30 teachers learned about and implemented a series of teaching strategies aimed at increasing the participation and learning of English Learners in schools serving largely Latino immigrant communities within California's Central Valley. This study focuses on six of the 30 science teachers. Through a professional summer development workshop, teachers were exposed to science content that included the use of pedagogical strategies that intended to improve knowledge acquisition for students in immigrant communities. The pedagogical approach used for enhancing teacher skills was the 5E model. The methodology used to examine the pedagogical approach was qualitative teacher observations. Results indicate that all 6 teachers and their students increased engagement and explanation abilities, and students had opportunities to explore and elaborate their understanding of science content when teachers implemented the 5E model.

## Introduction

Across the United States, more than 12% of residents are immigrants. However, in California this percentage is more than 25% of the population (U.S. Census Bureau, 2009). As a result it is not surprising that, based on recent data, it is estimated that the number of students in K-12 schools who were classified as English Learners (ELs) was more than six million (Migration Policy Institute, 2010). Furthermore, school-aged ELs are highly concentrated in states with high rates of immigrant families (García, Jensen, & Scribner, 2009), and Spanish is the language most often spoken in these states, including: Arizona, California, Illinois, New Mexico and New York. In California, with more than 1.6 million school-aged ELs, 84% of these students speak Spanish as their primary language (Migration Policy Institute, 2010). Additionally, nearly all Spanish-speaking ELs in California are of Latino descent, with the majority of Mexican heritage (Educational Trust, 2006). It is important to note that students classified as ELs are not always foreign born (Hernández, Denton, & Macartney, 2008).

ELs, and in particularly Latino ELs in California, are performing below proficiency on standardized reading and mathematics tests (IES, 2009), and the gap in reading and mathematics achievement between Whites and Latino ELs has not improved substantially since 1971 (Kewal Ramani, Gilbertson, Fox, & Provasnik, 2007). In science education, the results are more troubling. A recent study by the Institute of Educational Sciences (2009) reported that 78% of all California students scored below basic and at basic in the state's standardized science test and 51% of Latino students scored at basic or below basic. There are several possible explanations for the poor performance of California students in science. One explanation is that, if EL students are challenged by reading and science relies on reading comprehension, then students will also struggle with science (Gibbons, 2006; Rodríguez, 2010). In other words, if EL students cannot access the text, they cannot fully participate in classroom discussions. An alternative explanation, one that we find to be more probable, is that science is challenging for ELs because science teachers in general are not making the kinds of adjustments needed to ensure that ELs have access to texts and are able to participate in the class learning experience (de Oliveira, 2010; Lee & Luykx, 2005; Lee, 2005).

Although, California has attempted to address multicultural education and immigrant communities through Cross-Cultural, Language, and Academic Development (CLAD), its real intent is to prepare teachers to work with ELs. The CLAD certificate prepares all current and future K-12 classroom teachers in three domains: second language acquisition theory, theory and methods of teaching ELs, and approaches to multicultural education, all of which are presented as standards that must be addressed in separate courses or integrated within existing teacher education courses (California Commission on Teacher Credentialing, 2011). The CLAD certification makes no distinction between the preparation of elementary and secondary teachers, or among secondary teachers in the various discipline areas. Accordingly, a secondary science teacher, for example, typically takes the same coursework for the CLAD as an elementary teacher. What this means is that in most cases, teachers are prepared with the theory and methods for teaching ELs in general, but not within particular academic disciplines or immigrant communities. Despite the CLAD certification, the broader issues and needs of immigrant students and ELs have not been addressed. In this same vein, most professional workshops focus on English teaching strategies to enhance content learning for EL students and immigrant communities. Research by EL specialists who are also science educators supports the contention that ELs can be successful in science when the teachers have relevant competencies for supporting student learning in ways that engage students, enable them to explore the meanings of scientific concepts through hands-on discovery, and scaffold protracted language in which students verbalize what they are learning (Lee, Lewis, Adamson, Maerten-Rivera, & Secada, 2007; Ramírez-Marín & Clark, in press).

Unfortunately, many secondary teachers, even those with CLAD certification, remain unable to teach academic content in ways that facilitate learning for ELs. Bryan and Atwater (2002) suggest one of the reasons for this is that high numbers of preservice science teachers enter teaching with little or no cross-cultural or bilingual experiences, and they complete their programs with the same worldview they had upon entry. In other words, although they have taken CLAD coursework, their understanding of ELs' language and cultural backgrounds remains limited (Gándara, Maxwell-Jolly, & Driscoll, 2005). This phenomenon, coupled with minimal preparation for teaching science to ELs, we contend, contributes greatly to the continued failure of teachers to engage ELs in ways that make learning science relevant, meaningful, and challenging.

## Purpose of the Study

The study described in this article stemmed from a larger study conducted under Addiction Research and Investigation for Science Education (ARISE). The ARISE project was funded through the National Institute of Drug Abuse (NIDA) within the National Institutes of Health (NIH). An essential feature of the ARISE project was to provide professional development to science teachers teaching in public schools with large numbers of ELs. One of the goals of the ARISE project was to address the science achievement gap that exists between ELs and English-speaking students attending public schools in California's Central Valley. In the state of California, almost 15% of the entire EL student population resides in this area. Ninety-three percent of ELs in the Central Valley speak Spanish as their primary language (Goodban, Hedderson, Ortiz, & Branton, 2004). The other seven percent of students speak Asian or Southeast Asian languages. The curriculum used in the schools follow the state standards for English-speaking students, makes little or no adjustments for the diverse language and learning needs of ELs and provide minimal access to college preparation courses or educational resources geared to preparing ELs for post-secondary education (Reyes & Salinas, 2004).

The purpose of the ARISE science teacher intervention was to provide middle school and high school science teachers with a long term professional program aimed at preparing them to teach ELs through a constructive approach to science, one that also was especially attuned to the learning needs of these students. A by-product of the workshop was to integrate an established approach to EL science instruction for middle to high school teachers known as the 5E model. As a result of a professional development workshop and program that encompasses the 5E model, the question that motivates this study is whether or not secondary science teachers effectively utilize this model in science instruction with ELs.

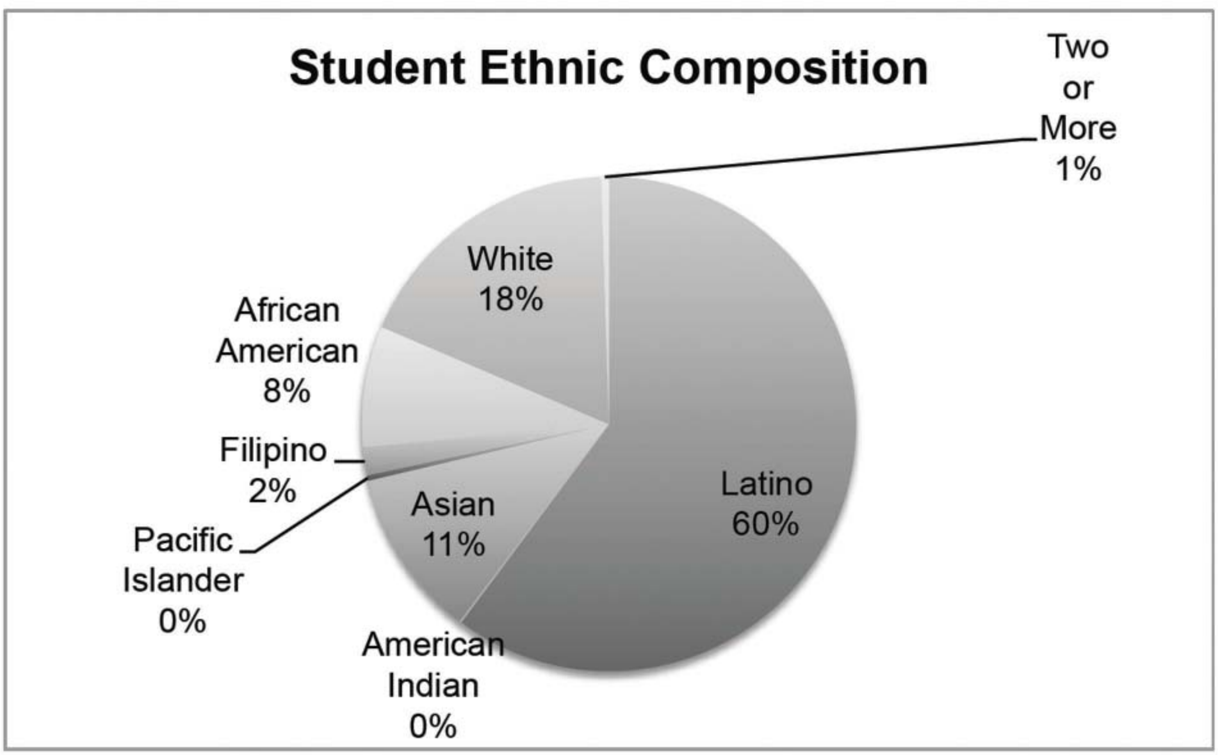
## Methods

### Participants

The ARISE program recruited 30 CLAD-certified science teachers from 7th through 12th grade for the yearly professional workshop during the academic school year of 2009-2010 from public schools across California's Central Valley. A sub-set of 6 teachers were selected for classroom observations after they participated in the professional workshop and one teacher served as a pilot observation to ensure that the observers knew how to classify instances of the 5E strategies. The San Joaquin County Office of Education site coordinator distributed brochures with information about the project and a registration link to superintendents and academic directors in the Central Valley. They then distributed the information to science teachers in their districts. Teachers who voluntarily signed up were contacted by the ARISE site coordinator with details about the project. Teachers who agreed with the requirements then submitted an application and a refundable check to UC Davis. Participants received their refundable check and a stipend at the end of the workshop and at end of the program.

The mean age for the six participants was 41.8 years old. Approximately 29% of the participants were males and approximately 71% were females. Figure 1 illustrates the ethnic composition of the students for the six teachers in the study. Table 1 indicates the percentage of socioeconomically disadvantaged students and EL students in ARISE teacher classrooms.

**Figure 1. Student Ethnic Composition**




| **Table 1. Socioeconomically Disadvantaged Students and English Learners** | |
|---|---|
| Group | Percent |
| Socioeconomically Disadvantaged | 62.67% |
| English Learners | 19% |
| Average Number of Students Per School | 1,800 |

## Procedure

The teachers underwent a nine-month program, launched by a five-day intensive Neuroscience and Cultural Nuanced Learning Summer Institute of 6 hours per day. Teachers learned about the 5E model and science instructors for the institute modeled the 5E model in a course that focused on neuroscience and addiction. The 5E model of instruction is organized around the following components: 1) Engagement, 2) Exploration, 3) Explanation, 4) Elaboration and 5) Evaluation for making science accessible to English learners (Carr, Sexton, & Lagunoff, 2007). The 5E model is based on a constructivist approach to science teaching and learning, and it incorporates many of the elements found to be relevant for teaching secondary ELs (Faltis, Arias, & Ramírez-Marín, 2010). This model suggests that EL students will improve their science learning if teachers use the 5E teaching strategies. Engagement seeks to access learners' prior knowledge and organize students' thinking toward learning new concepts by interacting with students to build their prior knowledge using comprehensible language and scaffolds to extend their interaction (Hansen, 2006). Exploration seeks to examine students' existing understandings (including misconceptions), and abilities to help them generate Student Ethnic Composition exploratory questions about what they are studying (Keenan, 2004). Explanation focuses students' attention on particular aspects of their engagement and exploration inquiries, with an eye toward developing conceptual understanding of processes, concepts, and ways of explaining the inquiry process (Gibbons, 2006; Stoddart, Pinal, Latzke, & Canaday, 2002). Teachers also learn ways of explaining concepts and processes, using visual support and verbal scaffolding to support student explanation. Elaboration is when teachers challenge and work to expand students' conceptual understanding and language abilities (See Edelsky, Smith, & Faltis, 2008, for examples of how teachers support and stretch langu age during science inquiry interactions.) Evaluation helps students assess their own understandings and learning abilities and provides opportunities for teachers to evaluate student learning throughout the learning process.

As indicated earlier, science faculty modeled the 5E strategies daily to teach neuroscience and addiction content to the teachers. Examples used by science presenters included the following techniques: think- pair-share, word banks, scaffolding exercises, and electronic quizzes using clickers for immediate evaluation of science content knowledge. These activities were done to demonstrate to teachers how the 5E model can be implemented in their own classroom to help ELs grasp the science content (Carr, Sexton, & Lagunoff, 2007).

At the start of the school year, the 30 science teachers who had attended the Summer Institute enrolled in a series of six follow-up workshops to reinforce their neuroscience and addiction content knowledge, EL strategies, implementation of the 5E model, research design, develop an Integrated Instructional Unit (IIU) and construct a research poster to be presented at a research symposium. The IIU is based on the content presented at the ARISE workshop. More specifically, the IIU includes lecture or presentation, individual student reading material, multimedia, and directions for a laboratory experience that incorporates opportunities for inquiry.

Addiction Research and Investigation for Science Education teacher participants also received additional coaching from the San Joaquin County Office of Education site coordinator who visited teachers and provided support in the development of projects and implementation of the 5E model. On average each teacher's classroom was visited three times by the site coordinator and observed once by three researchers. In addition, teachers were paired with a university science faculty who acted as a mentor and provided support for the research project throughout the tenure of the program. Mentors provided teachers with guidance in the design and implementation of their research project. Furthermore, and most importantly, the faculty mentors served as a gateway into science for and as a source of inspiration to the EL students. At the end of the school year, students presented their research projects orally with visual and textual support.

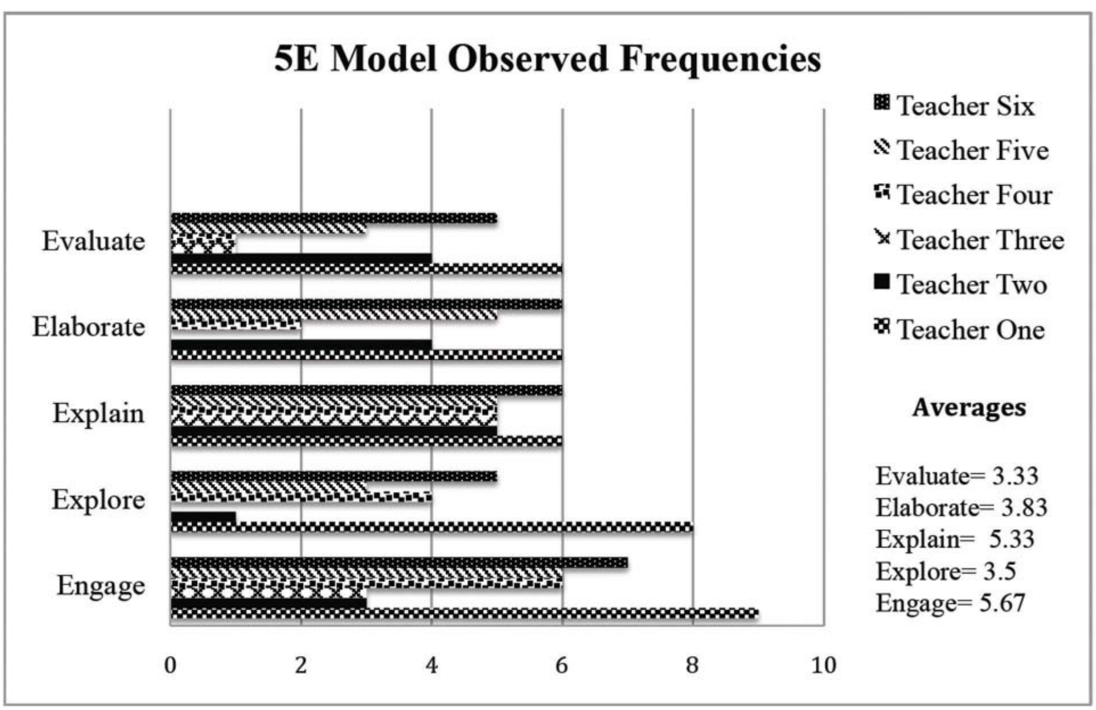
## Data Collection and Analysis

To collect data for this study, classroom observations were conducted by three trained researchers who observed together each of the six selected teachers to document the degree to which teachers employed the 5E model in their classrooms. The observation tool (template) was based on a checklist of indicators that described activities that illustrated the use of the 5E model by the teachers (Carr, Sexton, & Lagunoff, 2007). For example, teachers were assessed on engagement by the extent that they could bridge their students' past knowledge with the current science learning objectives. Classroom visitations were scheduled during February to March 2010, in order to observe 1.5 hours of classroom science content presented by the six selected ARISE teachers. The observational techniques also included an environmental scan of the classroom prior to instruction in order to gauge classroom layout and the content students were able to access to support their learning. For example, science visuals such as posters and scientific models were included in the environmental template used for assessment. Data examination consisted of content analysis and analytic induction, which is an analysis of the units of measurement (Merriam, 1998). In this case, the units of measurement we focused on were frequency and variety of messages presented to students using the 5E model. The researchers checked for consistency of the coding of their 5E observations, and analyses showed nearly 90 percent agreement for each classroom observation.

## Results

Observations of student-teacher interactions indicated that ELs appeared to be more responsive to science content material when teachers relied on the 5E strategies. In addition, it was observed that the 5E strategies were employed when teachers engaged students with topics that had meaning for them. That is, if teachers built on past knowledge and bridged this knowledge to current science content, students were more engaged with learning activities. Figure 2 illustrates the observed frequencies of each of the 5E strategies in the six classrooms. As indicated in Figure 2, the engagement and explanation strategies were the two most used by teachers. Explore, elaborate and evaluate were moderately used in the classrooms. It was observed that teachers who were able to employ the engagement strategy early on during the class period were also able to employ more of the 5E strategies. On the other hand, teachers who used the engagement strategy less often were less likely to implement the rest of the strategies.

Figure 2. Observed frequencies of each of the 5E strategies in the six classrooms.



An example of how one of the teachers used the 5E strategies comes from Mrs. Belmont's (pseudonym) Chemistry class.

> *Engage:* Mrs. Belmont asks students what would happen if a match were lit near a gas container. She tells them that chemistry is a "lifestyle thing" that can be applied to many instances, such as the process that goes on when their mom is cooking. Mrs. Belmont reminds students to write down notes, as she continues to use examples from the students' own life experiences, such as fog on the roads during wintertime. *Explain:* Mrs. Belmont explains the concept of depression point by using the mechanical engine example that all students can easily see. Once she uses the example, students begin referring to this example. Next, she explains the similarity between the mechanical engine example and the way that solutes relate to the melting point of water. *Evaluate:* After explaining a concept, Mrs. Belmont asks students a question about what she had just presented to evaluate their understanding of the concept reviewed. She also asks students to discuss the ideas to each other to see if students understand the concept. *Elaborate:* Mrs. Belmont asks students to explain in their own words to each other what they understood, and how it made sense to them. This strategy not only served as a way to have students interact about science ideas, but also helped them extend their understanding. *Explore:* When students do not know how to answer a question or are unsure of the concept, Mrs. Belmont asks them to review their notes and come up with questions they have about the concept. This strategy encourages students to explore the concept more deeply, by posing questions that are of interest to them, and to provide interpretations of their learning.

The findings from the classroom observations also indicated that when teachers were not able to engage students in the lesson, there were fewer instances of the other strategies. For example, one of the teachers in the project, Mrs. Thompson (pseudonym), spent about 25 minutes to get students' attention on the goals and procedures for collecting and analyzing pond water. Mrs. Thompson was finally able to engage students in collecting samples, to have them explore the types of living organisms that were present in sample, and explain what kinds of organisms might live in ponds. However, when Mrs. Thompson and students returned to the classroom for the lab analysis, she again had difficulty focusing the students' attention on the task at hand, and students were not fully engaged with the next steps. While this example shows Mrs. Thompson was capable of using several of the 5E strategies, it was a challenge for her to keep her class on task in the classroom. Our observations of other teachers showed that each of the teachers varied in how they incorporated the 5E model during instruction. Finally, as indicated in the literature that supports the use of analytic induction techniques in classroom observations, hypotheses may change after several observations. We originally expected equal distribution of all 5E techniques by ARISE teachers. However, as the data above suggest we found that this distribution was unequal across teachers and across categories.

## Discussion

The most important finding from this intervention was that the six science teachers who participated in the study were able to incorporate the features of the 5E model into their instruction with EL students. We also learned that while the use of the 5E strategies varied across teachers, all teachers incorporated elements of the 5E strategies some of the time during their instruction, which created opportunities for students to explore science concepts on their own, to explain what the concepts meant to them and to the teacher, and to elaborate on their own learning by working with each other. Teachers were most able to engage students to interact about and interpret new information, and to encourage students to explain what they were learning, which juxtaposed against the magnitude of challenges these teachers faced with teaching science concepts to their EL students in ways that made sense to students, was a huge step in the right direction. As we mentioned in the introduction, while most secondary teachers have pedagogical content knowledge in their subject matter disciplines, few possess the knowledge and practices needed to ensure that EL students participate fully in and benefit from classroom learning about subject matter content.

Our findings indicated that the 5E model for science instruction provided experienced science teachers who were unfamiliar with teaching ELs one critical piece of the complex puzzle of teaching EL students academic content. One piece of the puzzle is admittedly not enough, as teachers also need to continually work on providing opportunities for students to interact about important concepts, interpret the information being taught, and present what they have learned (See Chapter 6 of Valdés, Capitelli, & Alvarez, 2011).

Further research is needed for a deeper understanding of the factors that impact successful and unsuccessful integration of the types of pedagogical models science teachers use. As the professional development literature indicates, it is not easy for teachers, especially at the secondary level, to take knowledge presented in a workshop and put it into practice in the classroom (Wilson & Berne, 1999; Stoddart, Pinal, Latzke, & Canaday, 2002), especially when the new knowledge asks them to change the way they understanding teaching (Clarke, 2007; Lucas, 2011).

Based on the type and duration of this intervention, it was not possible to examine the capacity of these teachers to sustain the 5E model in their classroom. Moreover, we could not differentiate by time of arrival the differential impact of this model. This certainly warrants further attention to better understand the efficacy and resiliency of this model as a long term teaching strategy for these types of teachers and variations among immigrant students. These variations stem from each students prior formal schooling quality and experiences in their home country prior to their enrollment in schools in the United States (Faltis & Coulter, 2007). Moreover, given that this is a qualitative and exploratory analysis of these data thus far, there are limitations of generalizability to the group. These limitations are a result of the following: sample bias and size, duration of teacher observations, no access to student outcome data, and no inclusion of pre-program teacher observation data. Nevertheless, the study does shed light on how science teachers adopt evidence-based EL science teaching pedagogy, and the extent to which professional development programs may facilitate the use of these programs in their classrooms. In addition, it is critical to highlight that professional development programs alone may be necessary, but not sufficient in fully developing EL science teachers' appreciation of their immigrant students' funds of knowledge as well as the local context in which they teach. Future research should include these considerations in order to develop a fuller and deeper understanding of teaching and learning within this immigrant communities.

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