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How to Integrate Content and Language Learning Effectively for English Language Learners

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ABSTRACT
This paper describes the challenges and successes of developing and scaling up a research-based instructional intervention known as the SIOP (Sheltered Instruction Observation Protocol) Model. The SIOP Model is an approach used widely in the United States for teaching subjects like mathematics and science to students learning through English, a new language. Teachers integrate techniques that make the concepts accessible with techniques that develop the students' skills in the academic language of the specific subjects. This article describes a program of research that developed the SIOP Model in one study and then tested its efficacy and refined its professional development design in subsequent studies in a number of different contexts over 15 years. Results revealed that students with teachers who were trained in the SIOP Model and implemented it with fidelity performed better on assessments of academic language than students with teachers who were not trained in the model.

Keywords: sheltered instruction, content-based language learning, English as a second language, academic language development, SIOP Model

INTRODUCTION

This article describes a program of research that developed an instructional model for students in U.S. elementary and secondary schools who have to learn English as a new language at the same time they have to study mathematics, science, and other subjects that are taught through English. The model was created in one study and then tested in subsequent studies in a number of different contexts over 15 years to demonstrate its effectiveness. The model which will be described here is known as the SIOP (Sheltered Instruction Observation Protocol) Model. In the United States it is widely used in all subject areas and at all grade levels.

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State of the literature

- There are research-based studies of instructional techniques, such as reciprocal teaching (a reading technique) and information gap activities (for oral interaction) but very few that have examined a combination of techniques that could be used consistently to plan lessons that integrate content and language in any subject area.
- Few empirical studies of sheltered instruction exist that look at the effects on language development of students in content area classrooms.

Contribution of this paper to the literature

- This paper discusses how subject area teachers can learn about the academic language of their subject area and how to teach it using a research-based approach.
- The research and development designs that led to the SIOP Model may be applied to other interventions that are being developed and refined over time in response to an pressing educational problem.

This article will highlight some of the SIOP Model's implementation with math and science teachers. The goal of SIOP instruction is for teachers to develop the learners' academic English skills while using specialized techniques to teach and have students engage with the subject area topics in a comprehensible manner (Echevarria, Vogt & Short, 2017). The article is offered as a design framework for other researchers who may have to develop an intervention for a pressing educational problem, identify the promising practices, determine how best to provide professional development to teachers on the intervention, and refine the process of implementation over time.

Historical Context

In the United States, the 1990s were a pivotal time for the education of English language learners for two reasons. The population of school-aged English language learners (ELLs) grew much more rapidly than the general school population and major educational reforms were implemented at the national level.

From 1995 to 2000, the percentage of ELLs grew 39% but the population of all students (including ELLs) decreased by 1%. In the 1990s, most English language learners were placed in English as a second language (ESL) programs for one to three years and the focus of their classes was learning to read, write, speak, and listen in English. Few states offered bilingual education. There was no national ESL curriculum nor state-level frameworks and so ESL instruction was uneven and varied from district to district and from state to state (Sheppard, 1995). Teaching these learners grade-level content subjects was often delayed until they developed some proficiency in English.

The educational reform movement in elementary and secondary schools led numerous professional teaching organizations to write standards for their subjects (e.g., mathematics, science, history, language arts) that delineated the depth and breadth of what students should

learn. As states transformed standards into curriculum frameworks, the instruction and expectations for student learning became more rigorous.

The focus on standards served as a catalyst to some educators of ELLs. In order to make the ESL classes more relevant to school, ESL teachers developed lessons around subject area themes (e.g., the solar system) (Crandall, 1993). This approach was known as content-based language instruction. In addition, some general education teachers began to use an approach called sheltered instruction. They integrated ESL techniques in their lessons, using visuals, gestures, and modeling to make content topics comprehensible. They did not however pay attention to English language development, except to teach subject-specific vocabulary. Both types of classrooms were quite diverse in their instructional practices and no research studies had yet identified which techniques were effective for student learning (Sheppard, 1995).

The Problem

As schools implemented more and more standards-based curricula in mathematics, science, and other subjects, educators noticed that ELLs who exited the ESL and bilingual programs were not successful in their general education classes where English was the medium of instruction. Given the increasing numbers of ELLs in schools, more general education teachers than ever were instructing these students but many had had no training to work with learners who did not speak English (Batalova, Fix, & Murray, 2007; National Center for Education Statistics, 2002). The teacher training programs in universities lagged behind the needs of the schools (Ballantyne, Sanderman, & Levy, 2008). In the mid 1990s, only California and Florida required specific coursework for all preservice teachers on topics like ESL methods and second language acquisition. Even 10 years later the number of states with such requirements had only risen to six of the 50 (National Comprehensive Center on Teacher Quality, 2009).

As the standards movement strengthened, schools were held accountable for student performance. Starting in 2002, the federal government required states to assess students in mathematics and reading based on the new standards. (Science was added later.) Even English language learners who were not proficient in the language of the tests were assessed. Schools were penalized and labeled "low performing" or "needs improvement" if their ELLs did not attain testing achievement targets set for native English speakers on tests that had not been designed or normed for English language learners (Abedi, 2002).

This situation created some need for change. ELLs lagged significantly behind their English-speaking peers on state standardized tests given in English (California Department of Education, 2004; Kindler, 2002). Performance on the sole national test in the U.S.—the National Assessment of Educational Progress (NAEP)—consistently showed wide achievement gaps between English language learners and non-English language learners in mathematics and reading at all grade levels tested (4th, 8th and 12th) (Braswell, Dion, Daane, & Jin, 2005; Grigg, Daane, Jin & Campbell, 2003). ELLs also had higher drop-out rates from high school than English-speaking students (Ruiz-de-Velasco & Fix, 2000). It became more and more evident that current educational practices were insufficient to meet the academic and language needs of the ELLs.

The problem then was the following: How could all teachers could help English language learners develop academic language skills and subject area knowledge concurrently so they would achieve in school? For over 15 years, we have conducted research to grapple with this persistent problem. Three major studies are described here along with a discussion of what we have learned, implications for math and science teachers, and future directions.

Developing the Sheltered Instruction Observation Protocol (SIOP) Model: The CREDE Study (1996-2002)

In 1996, we began a design research study funded by the U.S. Department of Education through the National Center for Research on Education, Diversity & Excellence (CREDE). Our research questions were 1) What are the characteristics of a model of sheltered instruction that result in ELL achievement gains? and 2) What are the characteristics of an effective professional development program for implementing quality sheltered instruction to a high degree? We hoped to design and test a model of sheltered instruction that could be used with consistency across subject areas and across grade levels.

THEORETICAL BACKGROUND

To develop the model, we drew from theories of second language acquisition and the sociocultural view of teaching and learning. Acknowledging the distinction between conversational and academic English (Cummins 1981), we recognized that although students develop a moderate command of spoken English in social settings in 1 – 2 years, they need a longer time frame (i.e., 4 – 7 years) and more support to comprehend and use academic English successfully in school. They must master semantic and syntactic knowledge and functional language use in different academic subjects. For example, ELLs must be able to read and understand expository prose found in math textbooks; pose hypotheses before science experimentation; and justify solutions to word problems. They must also learn how to complete instructional tasks, such as writing a geometric proof or interpreting charts and graphs.

Research on second language acquisition provided direction to the types of supports that teachers can employ to help students learn the subject area topics and develop appropriate language skills. The theoretical underpinning is that language acquisition is enhanced through meaningful use and interaction. Comprehensible input (Krashen, 1985; Gass, 2013) is crucial when students are not proficient in the language of instruction. Teachers therefore use visuals, gestures, less complex speech, modeling, and other techniques to present key information. Comprehensible output (Swain, 1985; Gass, 2013) is also important so students can articulate their ideas, practice academic language, develop automaticity, and get feedback. Techniques, such as using sentence stems and structured conversations, can guide student output. Explicit instruction on language forms, academic vocabulary, and language learning strategies, along with building literacy from classroom talk, also contribute to language development and content comprehension (Ellis, 1999; Gibbons, 2003; Norris & Ortega, 2000).

Research on the sociocultural perspective gave insight into dynamics of the classroom. Student learning is promoted through social interaction and contextualized communication (Tharp &

Gallimore, 1988; Vygotsky, 1978), guided by "more capable others." Teachers can scaffold instruction so that students can construct meaning and understand complex concepts (Bruner, 1983) and they organize partner or group work so English learners have peer support to grapple with complex ideas. Teachers also assist learning by beginning instruction at a student's level of understanding and, with appropriate support, incrementally advance their knowledge and language skills. Teacher scaffolds might include preteaching key vocabulary before a reading assignment, adjusting speech by paraphrasing or elaborating on a student response, and asking questions that elicit detailed responses from the students rather than one-word answers.

Sociocultural research also revealed that students from immigrant families benefit from explicit socialization to the implicit cultural expectations of the classroom, such as turn-taking and participation rules (Cook-Gumperz, 2006; Moschkovich, 2007). Teachers can make explicit their assumptions for classroom behavior and interactional styles, such as encouraging students to ask questions and take roles in cooperative learning groups. They can also engage in culturally responsive teaching that recognizes and builds upon culturally different ways of learning, behaving, and using language (Nieto & Bode, 2008).

SIOP Model Development

To address the first research question, researchers at California State University, Long Beach and at the Center for Applied Linguistics in Washington, DC collaborated with a small group of middle school teachers (n =11) from core subject areas (math, science, social studies, and language arts) in three districts in the United States. We identified best practices for teaching content and language to ELLs from the professional literature and tested combinations of these techniques to build a model of sheltered instruction. At first, we organized these techniques into an observation protocol, but the collaborating teachers suggested that the SIOP Model be used for lesson planning and delivery as well. So we reframed it as an instructional approach that shows subject area teachers how to integrate academic language development into content instruction and how to use ESL techniques to make the concepts comprehensible. This was a departure from typical instruction and we anticipated that it would require considerable professional development because most math, science and social studies teachers had no background in linguistics, second language acquisition, or ESL methodology.

The most significant change concerned what became a hallmark of the SIOP Model—that all lessons include a language objective. Teachers would continue to plan lessons around a content objective (e.g., Students will represent translations, reflections, and rotations of an object in a coordinate plane.) but would now add a language objective too (e.g., Students will orally describe the position of the resulting image compared to the original position of the object.).

The increased focus on academic English was disconcerting for some. The collaborating teachers were willing to try planning with two objectives, but when we included eight more teachers from their schools in subsequent years, there was some resistance and anxiety to the notion of being responsible for language development in math or science class.

Over four years, we piloted and refined the model. To allay some teachers' concerns, we

worked with them to develop lesson plans and identify techniques and activities to include. We met in study groups to identify the critical features for instruction that would support both content and language learning. The teachers tried out various groupings of these features until in 2000, we finalized the SIOP Model with 30 features of instruction organized in eight components—Lesson Preparation, Building Background, Comprehensible Input, Strategies, Interaction, Practice & Application, Lesson Delivery, and Review & Assessment (Echevarria, Vogt & Short, 2000). Figure 1 provides brief descriptions of each component.

Once the SIOP Model was finalized, it was operationalized in the observation protocol, which has a 5-point scale for each of the 30 features. The tool allows observers to rate teachers' lessons for the degree of fidelity to the model and to provide explicit feedback to help teachers implement the model more consistently. A separate study established the validity and reliability of this protocol (Guarino, et al., 2001). (See the appendix for the protocol.)

Student Achievement

Beyond developing the model, we also needed to determine if SIOP implementation improved the language performance of English language learners, given the growing importance of testing and accountability in U.S. schools. We investigated the model's effects using a quasi-experimental design. Two groups of ELLs in sheltered classes participated: students whose teachers were trained in the SIOP Model (the intervention [aka SIOP] group) and a similar group of ELLs in the same district programs whose teachers had no exposure to the SIOP Model (the comparison group). Students in both groups were in Grades 6–8, represented a comparable range of English proficiency levels, and spoke a variety of native languages.

The writing assessment from the Illinois Measurement of Annual Growth in English (IMAGE) test was used as an outcome measure of academic literacy. A standardized test of reading and writing, the IMAGE was used by Illinois districts at that time to measure the annual growth of these skills for ELLs in Grades 3 and above. The test was valid and reliable and had correlational and predictive value for achievement scores on the standardized state achievement tests in reading and mathematics (Illinois State Board of Education, Assessment Division, 2004). It provided scores for five subtests on aspects of writing—language production, focus, support/elaboration, organization, and mechanics—as well as a total score for each student.

We administered the IMAGE as a pretest in the fall and a posttest in the spring. Scores were analyzed for the students who were present for both administrations (n = 241 for students in SIOP classes, n = 77 for students in comparison classes). Because there were differences between the two groups in their pretest scores, analyses of co-variances (ANCOVA) were conducted. Comparisons between SIOP and comparison groups on their total scores found the students whose teachers were trained in the SIOP Model made significantly better gains than the comparison group in writing ($F(1,312) = 10.79$; $p<.05$). Follow-up analyses on student performance on the various subtests of the writing assessment found that the SIOP group performed at a significantly higher level in language production ($F(1,314) = 5.00$; $p<.05$), organization ($F(1,315) = 5.65$; $p<.05$), and mechanics ($F(1,315) = 4.10$; $p<.05$) than the comparison group. The SIOP group also made gains over the comparison group in the focus

and support/elaboration subtests, but not to a statistically significant level (Echevarria, Short & Powers, 2006).

Lesson Preparation: Each SIOP lesson has separate language and content objectives that are linked to the curriculum & standards and taught systematically. Teachers plan their lessons carefully, with appropriate content concepts, the use of supplementary materials, adaptation of content as needed, and meaningful activities that integrate concepts with language practice.

Building Background: Teachers make explicit links between new concepts and past learning and between concepts and students' personal experiences. These connections help students organize new information as part of their cognitive processing. Teachers must directly teach and emphasize the key academic vocabulary and provide opportunities for ELLs to use this vocabulary in meaningful ways.

Comprehensible Input: Teachers modulate their rate of speech, word choice, and sentence structure complexity according to the proficiency level of ELLs. They explain academic tasks clearly, both orally and in writing, and provide models and examples. Lessons incorporate a variety of techniques to make instruction accessible, including the use of visuals, hands-on activities, demonstrations, gestures, and body language.

Strategies: Lessons provide students with instruction in and practice with a variety of learning strategies. Teachers scaffold the delivery of new information as they guide students to a higher level of understanding and independent practice. They also promote higher-order thinking through a variety of question types and tasks.

Interaction: Lessons are designed with frequent opportunities for interaction and extended discussion among students and with the teacher so students practice important skills like elaborating, negotiating meaning, persuading, disagreeing, and evaluating. Teachers group students to support the content and language objectives, provide sufficient wait time for student responses, and clarify concepts in the student's first language, if possible and as needed.

Practice & Application: Lessons include hands-on materials, manipulatives, and/or physical movement to practice new content. Teachers plan activities for students to apply their content and language knowledge through all language skills (reading, writing, listening, and speaking).

Lesson Delivery: Teachers implement lessons that clearly support content and language objectives with appropriate pacing, while students are engaged 90% to 100% of the instructional period. All students must have opportunities to practice language skills within the context of the academic tasks.

Review & Assessment: Teachers provide a comprehensive review of key vocabulary and concepts, regularly give specific, academic feedback to students, and conduct assessment of student comprehension and learning throughout the lesson. Teachers should offer multiple ways for students to demonstrate their understanding of the content.

Adapted from Echevarria, Vogt & Short (2017).

Figure 1. Description of the SIOP Model Components

We also calculated the Cohen's *d* effect size of the intervention which was .833. This effect size is considered large by most indices (Cohen, 1998), suggesting that the SIOP intervention led to significant gains over time in students' overall writing performance.

Professional Development for the SIOP Model

From 2000-2002, we began to address the second research question but did not answer it fully. We had learned that help with lesson planning and a teacher study group were helpful. We developed some professional learning materials, namely two videos of exemplary SIOP instruction and a teacher training manual. The materials were designed for teachers at all grade levels in all core subject areas and ESL, because the need was spread across these diverse areas. We also started to provide workshops in other school districts and to collect feedback on what teachers understood about the SIOP and what they had questions about. However, the full scope of an effective professional development program wasn't realized until our next large-scale research project which involved teachers who had not been part of the design study.

Scaling Up SIOP Research: The New Jersey SIOP Study (2004-2006)

In 2004 we expanded the research to a new study with more teachers and students, funded by the Carnegie Corporation of New York. It was also quasi-experimental in design and took place in two matched districts (one SIOP, one comparison) in northern New Jersey, each with two middle schools and one high school. The research questions for this study were 1) Do teachers reach high levels of implementation of the SIOP Model during a sustained professional development program after 1 year or 2 years? and 2) Does implementation of the SIOP Model in subject area classrooms result in increased student achievement after 1 year or 2 years? We had a representative sample of teachers in both districts who taught in Grades 6-12. Teachers in the SIOP district taught mathematics, science, history, language arts, ESL, special education, and technology. Approximately 35 teachers participated for two years (Cohort 1) and an additional 23 during the second year (Cohort 2). The comparison district did not have cohorts so the same 19 teachers participated both years. The comparison teachers taught mathematics, science, history, and ESL.

The SIOP Professional Development Program

Before we could measure the teachers' level of implementation, we had to provide professional development in the SIOP district. These middle and high school teachers were not building the model with us, as was the case with the CREDE study, so we needed to craft a complete professional learning program that would support the teachers. We began with the basic question: What did teachers need to know about the academic language of their subject? We concluded they needed to know how to identify the types of language in their standards, textbooks, and curriculum frameworks so they could generate language objectives. They then needed to know how to teach these aspects of language and which techniques they could incorporate in lessons to let student practice and apply the language while studying the content topics.

We therefore designed a series of workshop around the SIOP components that highlighted

language learning. The first ones introduced the teachers to categories of academic language that should be considered when writing language objectives, such as vocabulary, language skills and functions, and language structures. Academic vocabulary was the "low hanging fruit." Teachers were comfortable teaching key content words, but we had to broaden their instruction. First, they needed to realize that ELLs required more than the subject-specific terms like *logarithm* and *exponent*. They needed to learn general academic terms too that would let them talk, read, and write about a concept or topic: a) process verbs like *determine*, *solve*, and *represent*; b) cross-curricular nouns such as *result*, *effect*, and *condition*; c) conjunctions and logical connectors such as *given that*, *however*, and *in sum*; and d) polysemous terms that might cause confusion like *power* and *division*. Second, the teachers had to instruct in ways that facilitated ELLs' meaning-making—not a quick orally stated definition or a glossary entry, but a technique that involved students in learning the words, such as using a concept definition map or drawing pictures of the terms. Third, the teachers needed to plan activities in the lessons where students would practice using the words, such as reading them in mathematics text, using them in a writing task, or talking about them when problem solving.

In similar ways, we explored the other categories with the teachers, asking them to identify the language skills students use in class (e.g., Are students reading to find a scientific claim or to follow directions? Are they taking notes or writing a summary of what they learned?) and the language functions they want students to produce (e.g., Will students be asked to justify their solution to a problem? Will they hypothesize?). To identify language structures, we had teachers work with authentic texts that students would read and samples of student written work. We drew attention to examples of passive voice, nominalizations, conditional sentences, pronoun referents, and the like, and discussed how these aspects of language might be difficult for English language learners.

Once teachers began to understand what kind of language students were expected to use in class, we showed them ways to teach these language targets explicitly. Figure 2, for example, illustrates sample language objectives for algebra and how they could be addressed in several lessons. This type of instruction was more challenging for teachers at the secondary level than for those in elementary schools who commonly taught language skills. We had to reassure the secondary teachers that they weren't expected to become teachers of grammar but that they should call attention to language structures that appeared frequently in their materials (e.g., use of the imperative in lab directions).

We wanted teachers to build student academic talk through interaction. So when teachers asked students to "discuss the solution to a problem" in a small group or "turn and talk" to a partner, we encouraged them to also give guidance regarding the type of language they wanted students to use. For instance, if students were asked to discuss comparisons in an elementary math classroom, they could be explicitly taught to use frames like:

"___ is smaller than ... "
"___ and ___ are equivalent because ...."

If they were in a secondary math class and had to interpret and analyze graphs, they might practice with frames like:

"Based on the graph, we conclude that ..."
"The intersection of the lines shows that ..."

In all of these classes, a word bank with key terms could also be provided to highlight targeted vocabulary that the ELLs were expected to use. These language frames, sentence starters, and word banks were scaffolds for students to become fluent in academic language in classroom contexts (see Donnelly & Roe, 2010; Zwiers & Crawford, 2009, Short & Echevarria, 2016 for more discussion).

Type of Language Objective	**Algebra Example**
Academic Vocabulary: key terms needed to discuss, read, or write about the lesson's topic (subject-specific, general academic, or word parts) ↓	Students will define and give examples of positive and negative slope.
What it means instructionally	Teacher uses a concept definition map with class to define slope, call attention to related words (e.g., increase, decrease, vertical, horizontal), and elicit real-life examples of slope.
Language Skills and Functions: skills students will use in the lesson (e.g., read for main idea) or the specific purpose for using language (e.g., to compare, to persuade) ↓	Students will orally justify the slope of a line between two points.
What it means instructionally	Teacher demonstrates how to find slope using a geoboard and offers language frames to justify the determination, such as "The slope is positive/negative __ because ...".
Language Structures: grammar or language structures in the written or spoken discourse of the lesson ↓	Students will use if-then statements to describe what happens to a line when the slope changes.
What it means instructionally	Teacher teaches (or reviews) how to form two types of if-then sentences: 1) when the if clause comes first and 2) when it comes in the second half of the sentence. Teacher points out use of present tense in the *if* clause and future tense in the *then* clause.

Adapted from Echevarria, Vogt & Short (2017).

Figure 2. Categories and Examples of Language Objectives

In other workshops, we demonstrated techniques that the teachers could add to their lessons to help students practice and apply the new language and concepts they were learning. Instead of telling students to read a chapter in the textbook on solving problems with improper fractions and do exercises, we suggested a teacher write a problem's solution on paper as a series of steps, make numerous copies, cut up the steps into strips, scramble them, and have student pairs put them in order. Students would discuss their ideas, look for logical connections between one step and the next. Or, as another activity, student groups could create their own fraction problem, write it on an index card, and send it to another group to solve. That group would discuss, solve, and send it back to the original group to assess.

We also proposed that teachers assign tasks that would require higher-order thinking and communication among students. For example, suppose student groups each had to make a poster about a different human organ system (e.g., respiratory system, circulatory system). The assignment might be "List the top five facts a person should know about this system and draw a diagram". The students would have to discuss facts about the system, negotiate some consensus on the top five, create the poster, and illustrate the system. They might have to read and extract information from a textbook or Internet resources.

To further academic language practice, the teacher might use the "Walkers and Talkers" technique. Each group's poster is placed on a wall and one student remains at the poster as the talker to explain it to others who come by. The rest walk around and listen to the explanations of the other systems. These walkers record the information they learn in a notebook. (The teacher might model an effective oral presentation of a sample poster, in advance.) When time is up, the groups reconvene at their posters and the walkers explain what they learned from the other posters to the talker who takes notes in his or her notebook. Through this project, students practice all of the language skills.

The final SIOP workshops focused more on lesson planning, after the teachers had become familiar with a variety of language development techniques. We used a series of progressive activities. First, teachers were given a SIOP math or science lesson plan which had a content objective and a language objective. They were asked to indicate where in the lesson the teacher explicitly instructs on the language objective and how students practice it. This activity raises teacher awareness of language development within instruction. Next, teachers were given a fairly traditional math or science lesson and asked to write a language objective for the lesson and add some language practice opportunities. Finally, teachers were tasked with writing their own SIOP lesson plan and received feedback from the teacher trainer.

Teacher Implementation

To address the first research question in this NJ SIOP study, we delivered the SIOP professional development program to the teacher cohorts in the treatment district. In Year 1, this consisted of seven workshops spread over the course of one year. By teaching components of the SIOP Model over time, we gave teachers a chance to practice in their classes and build on their knowledge. To help teachers incorporate the model into their teaching, we organized the workshops in a participatory manner for the teachers with hands-on activities, cooperative mini-projects, analysis of videotaped instruction, and integration of research and theory. We

also recruited and trained three local coaches at the school sites (part-time teachers) to observe in classes and give feedback, and we offered technical assistance via electronic media.

In addition to the workshops, the coaches and sometimes the researchers observed and gave feedback to teachers to assist with implementation. Because the coaches were on-site, some teachers also sought their advice in lesson planning. We created a project website and posted sample lesson plans and step-by-step explanations of instructional techniques. Teachers could use the closed group electronic list to share information, challenges, and successes.

The PD workshops in the second year for the Cohort 2 teachers were very similar to Year 1. We also offered three additional workshops on lesson and unit planning to Cohort 1 teachers to help them implement SIOP better. We added more teaching materials to the project website and hosted online chats on topics like math language techniques. With district support, we increased the number of coaches from three to five and they were given more time during the day to devote to coaching. This was an important change because the number of teachers involved rose to almost 60 in this second year.

Comparison teachers did not receive SIOP Model professional development, but all teachers had a one-hour, district-sponsored workshop on student diversity and accommodating ELLs in the classroom. The ESL teachers had workshops on topics such as designing thematic units and using the new content-based ESL textbooks.

We conducted classroom observations, took field notes, and rated lessons of each SIOP and comparison teacher on the SIOP protocol twice per year, in the fall and spring. In this way, teacher fidelity to the intervention was measured. Comparison teachers were also observed because it was anticipated that they might incorporate some characteristics of sheltered instruction in their lessons. We recorded scores on individual items and the overall percentage score in a teacher database. We used the scores to determine which teachers were high, medium, or low implementers based on the following guidelines: high implementers scored 75% or higher; medium implementers scored between 50% and 75%; and low implementers scored 50% or below on the protocol's scale.

Teacher implementation data revealed that in the SIOP district, after one year of professional development, 56% of Cohort 1 (in Year 1) and 74% of Cohort 2 (in Year 2) were high implementers of the SIOP Model. After two years, 71% of Cohort 1 reached a high level. As a subset of the teachers, the Cohort 1 math teachers (n=10) reached the second highest level of implementation in Year 2, after the language arts teachers, averaging a score on the SIOP protocol of 83.3%. The Cohort 1 science teachers (n=5) implemented the SIOP Model less well, reaching an average score of 69.2%.

At the comparison site, only 5% of the teachers reached a high level in Year 1; 17% in Year 2. The features of the SIOP Model were thus much better implemented in the SIOP district (Short, Fidelman, & Louguit, 2012).

Student Achievement

To address the second research question, we examined student performance on tests required by the state to assess student knowledge of the standards. The outcome measure of academic

literacy was the IDEA Language Proficiency Tests (IPT), the standardized assessment of English language proficiency in New Jersey at that time. The IPT provided a total score for each student and subtest scores for oral language, reading, and writing. We also examined student performance on several state subject achievement tests. The subjects of the data collection were students in the ESL programs in Grades 6-12 in both districts. SIOP students (n = 387) spoke more than 15 different native languages and were from 35 countries of origin. Comparison students (n =193) spoke eight different native languages with 25 countries of origin.

English language proficiency. We collected the IPT scores for ELLs in both districts. We first gathered baseline IPT data on all ELLs from the Spring 2004 administration. In 2005 and 2006, we collected the IPT scores of ELLs with at least one SIOP teacher or at least one comparison teacher. It is important to note that in these district ESL programs, new students enter and others exit annually. As a result we had a cross-section of students that was not matched across the years and so we examined the average mean scores of the groups. Because the districts had a high level of student mobility, only a small number participated in all three IPT administrations, so no longitudinal analyses were undertaken.

We compared IPT mean proficiency level scores for SIOP and comparison groups each year. Then, using 2006 data, we employed analysis of variance (ANOVA) measures to determine if the teachers' SIOP training influenced the students' English language achievement.

For oral language proficiency, the average mean scores were at about the same level in both districts in the baseline year, but SIOP students performed better than comparison students in 2005 and continued to outperform them in 2006 at which time the average mean score in the SIOP district was statistically significantly higher than in the comparison district ($F(1, 434) = 8.49$, $p < .004$). Reading had a similar trend except that SIOP students performed better than comparison students only in 2006 and the differences in average mean scores did not reach statistical significance ($F(1, 434) = 2.49$, $p = .12$). In writing, comparison ELLs had slightly higher performance in baseline year; however, in 2005 SIOP students had higher mean scores. By 2006, this difference was statistically significantly ($F(1, 433) = 9.74$, $p < .002$).

Total English proficiency level scores showed the same trends as the oral language and writing data results but were moderated by the reading results. Nonetheless, we found that although comparison students had better total proficiency scores than SIOP students in the baseline year, SIOP students surpassed them in 2005 and showed a statistically significant difference in mean scores by 2006 ($F(1, 433) = 5.36$, $p < .02$).

The ANOVA results provided some evidence of SIOP as a predictor of achievement in oral language, writing, and total English proficiency. We calculated Cohen's d effect size (Cohen, 1988) and found that the SIOP scores were more than one fourth of a standard deviation higher than those of the comparison group for oral language (0.29), almost one third of a standard deviation higher for writing (0.31), and close to one fourth for total English (0.23). These were considered small to moderate effects (Short, Fidelman & Louguit, 2012).

Subject area performance. We wanted to examine the SIOP's effects on student achievement in the subject areas too but the data collection and analyses of the state tests were

problematic for several reasons: a) the number of student subjects was very small for most tests (n<30 in one or both groups) so the results were not generalizable, b) tests were only administered in Grades 6, 7, 8, and 11, at the end of the school year, c) the students took these tests only once, while in that particular grade, and d) New Jersey changed tests in 2006. Nonetheless, with these limitations in mind, the results showed a significant difference ($p < .05$) in mean scores in favor of SIOP students on five state subject area tests: reading and language arts for Grade 6 in 2005, language arts for Grades 6 and 7 in 2006, and mathematics for Grade 11 in 2006. There was a significant difference ($p < .05$) in mean scores in favor of students in the comparison district on one state content test: social studies for Grade 7 in 2005. There were no significant differences between groups on the other 19 content tests (Short, Echevarria & Richards-Tutor, 2011).

We also tried to compare the results of students who had been in the study for two years on the tests that they took in the second year (2005-06). We wanted to see if participation in SIOP instruction over two years influenced student performance. The number of students in both the SIOP and comparison groups exceeded 30 for only two tests however—the mathematics and language arts tests given in Grade 11. For these assessments, we found a significant difference in favor of SIOP for mathematics ($p < .05$), but no significant difference for language arts.

Focusing on One Subject Area: The CREATE SIOP Science Study (2005 – 2007)

As a result of the New Jersey SIOP study, we felt that we needed to refine the professional development program and try to increase teacher fidelity to enhance student outcomes. We decided to concentrate our efforts on one subject area, science. With funding from the U.S. Department of Education through the National Center for Research on the Educational Achievement and Teaching of English Language Learners (CREATE), we created an experimental-control study for middle school science and we included native English speakers and former ELLs in the analyses in addition to English language learners. Science was selected because of its importance in schooling and because it was a recent addition to federal testing mandates. The research question was the following: What are the effects of the SIOP Model on the acquisition of science language among English language learners in middle school science classrooms?

In 2005–06, with teacher consultants, we developed four Grade 7 SIOP life science units (Cell Structure and Function, Photosynthesis and Respiration, Cell Division, and Genetics) based on the district curriculum and state standards to support the fidelity of implementation. With these units, teachers would have lessons already embedded with SIOP features to teach while they were learning the model. We also designed and field-tested curriculum-based assessments for each unit to measure life science concepts, scientific vocabulary, reading comprehension skills, and writing skills. These assessments included multiple choice and essay items.

In 2006–07, we randomly assigned ten middle schools in southern California to SIOP or control conditions. Two control schools dropped out however as the research began, leaving a total of

12 teachers in the study. Because of California's teaching certification requirements, the science teachers in both conditions had had some university preparation for teaching ELLs.

SIOP Professional Development

Life Science was taught at Grade 7 for only one semester in this district. This was a limitation that condensed the time for professional development, data collection, and potential impact. Teachers in the five SIOP schools received only 3 days of training in the SIOP Model. As part of the professional development, participants explored the eight components of the SIOP Model by watching videos illustrating effective classroom implementation of each component's features, rating the video lessons using the SIOP protocol, and practicing SIOP techniques to deepen their understanding. Participants were given binders of the SIOP Life Science units with supplementary materials (e.g., graphic organizers for students to take notes from text readings, activity sheets to be used for lab experiments and vocabulary development). They reviewed the SIOP lesson plans in these units and were able to ask questions and suggest changes.

From September through December, SIOP teachers taught the four science units. Biweekly coaching support for all SIOP teachers was provided by the project staff. The teacher and coach reviewed the lesson plan beforehand, the coach observed and recorded notes using the SIOP protocol, and then the coach met with the teacher to provide detailed feedback. We viewed this coaching process as critically important given the reduced number of workshops we could provide.

In the three control schools, no SIOP training or coaching was provided. Teachers taught the same curricular topics but with their own unit lessons. Both groups of teachers had the same textbooks available for use.

Student Achievement

Students in both conditions were given the CREATE science language assessments as a pretest at the beginning of each unit and as a posttest at the end to measure growth in acquisition of science language. The essays were scored using the IMAGE writing rubric. In the data analysis, we compared the assessment results of students in the SIOP classes (n = 649) to those of control students (n = 372). The sample included students who were native English speakers, former ELLs who had been redesignated, and English language learners.

We used hierarchical linear modeling (HLM) to determine if SIOP instruction had an impact on students' science language and concept development. The individual students were nested within teaching sections, sections within teacher, and teachers within schools. In this way we could analyze individual student results on the assessments in conjunction with teacher and school variables. Because student and teacher level fixed effect variables may influence student outcomes, we examined the students' pretest scores and their language classification (e.g., native speaker, ELL) as student variables, and the level of SIOP implementation (high, medium, low) and the condition (SIOP or control) as teacher variables. We aggregated the scores of the four posttest assessments but analyzed the composite scores for the essay and multiple choice components separately as outcome variables.

Results from the conditional ANCOVA model of HLM indicated that students in the treatment condition for all language proficiency classifications—outperformed, on average, those in the control, although not to a statistically significant degree. There was an approximate 0.9 point advantage (ϒ = 0.9, s.e. = 2.1, t =.429, p =.67) for students in SIOP schools on the multiple choice component of the posttest and a larger 5.5 point advantage (ϒ = 5.5, s.e. = 6.8, t =.809, p =.418) on the essay component.

We also calculated the Hedges' g effect sizes (Hedges, 2007). The effect of SIOP instruction on the multiple choice component of the posttest was associated with Hedges' g = .103, whereas the effect on the essay component of the posttest was g =.197. These results indicated small positive effects (Echevarria, Richards-Tutor, Canges, & Francis, 2011).

Teacher Implementation

The results were disappointing but not too surprising, given our classroom observations and the limited time we had for professional development. SIOP and control teachers were observed five times and their lessons were rated using the SIOP protocol. The scores were averaged into an overall score and the teachers were categorized as high, medium, and low implementers (as in the NJ SIOP study). We found that teachers in both groups scored across these ranges. Some SIOP teachers were low implementers and some control teachers were high (possibly because of their university preparation).

We decided next to examine whether the level of teacher implementation played a role in student achievement. We compared teacher results with their students' average scores across the four assessments. The analyses indicated a positive relationship between teacher implementation level and average student gains. In other words, students whose teachers implemented the SIOP Model to a high degree performed significantly better on the assessments than students whose teachers were low implementers (R^2=.22, p<.05), emphasizing the importance of fidelity to the model. This result held true for English language learners, former English language learners, and native English speakers (Echevarria, Richards-Tutor, Chinn, & Ratleff, 2011).

DISCUSSION

While the research we have conducted to date has had positive results, the outcomes were not as strong as desired. In the SIOP design study, the students of SIOP-trained teachers significantly outperformed the comparison students on the writing assessment. In the NJ study, the significant differences in the average mean scores in favor of the SIOP student group on oral language, writing, and total English proficiency indicated that the SIOP professional development had a positive impact on the development of English among the ELLs in classes with SIOP-trained teachers. There was a small impact on achievement in some subject areas but results were not generalizable, given the limitations of the testing process. In the CREATE study, which had a shortened time frame for professional development and implementation, the science language achievement results were less robust.

One important finding from the work is that sustained, high quality professional development is critical if teachers are to implement interventions with fidelity. Providing workshops and lesson plans alone, as in the CREATE study, may not lead to high levels of implementation, particularly for a comprehensive approach like the SIOP Model. Site-based coaching appears to be an essential element of overall professional development, offering teachers the job-embedded support required to sustain changes in their practice.

In the NJ study we found that only 56% of the treatment teachers in Cohort 1 became high implementers of SIOP after one year whereas 74% of the Cohort 2 teachers reached the high implementation level in that time frame. We argue that the context of the SIOP Model initiative played a role in this difference. SIOP was a new initiative in 2005 when Cohort 1 teachers participated in the professional development. The coaching support was more limited then, the notion of focusing on language development in content courses was new, and a culture of working in a cross-disciplinary way was lacking. In contrast, Cohort 2 teachers entered an existing SIOP culture in 2006 and joined a team of teachers and coaches who had already experienced success. The SIOP Model was also viewed favorably at that point by the administration which devoted more staff time to coaching, affording teachers more support.

Another finding was that fidelity to the model led to higher student achievement. In the CREATE study this was true for all types of learners—ELLs, former ELLs, and native English speakers. SIOP instruction did not just benefit students learning English as a new language, it benefited all students in the classes. But fidelity does not occur naturally. Teachers need time to get good at the SIOP Model and we have to contextualize the PD activities in their particular subject areas and classrooms to facilitate their mastery of the teaching practices.

IMPLICATIONS FOR MATH AND SCIENCE TEACHERS

Because U.S. educational reforms put pressure on English language learners (and their teachers and schools) to reach the average performance levels of native English speakers on high-stakes tests in reading, math, and science before they were proficient in English, our early focus had been on serving as many teachers as possible through professional learning opportunities. However, in recent years we have had opportunities to offer subject-specific PD on the SIOP Model (Echevarria, Vogt, & Short, 2010; Short, Vogt, & Echevarria, 2011) and we think this is a sensible evolution of our research program.

Our work with math and science teachers showed us that they did not typically think about developing academic language among students when they planned their lessons. They were capable of communicating concepts, explaining procedures, exploring theories, modeling problems, analyzing patterns, and making real-world connections through a variety of methods. Yet although they used academic discourse themselves, they were not prepared to teach it explicitly to their English language learners. They readily applied SIOP techniques that helped make the content concepts comprehensible (e.g., pre-teaching key terms, using videos to illustrate a concept, using manipulatives and other hands-on materials) but were not comfortable at first with the pedagogical practices we

recommended to elicit mathematical or scientific language from students who were still learning English. They understood that ELLs should interact with the content concepts by talking, reading, and writing about them, but they needed support to make such communication happen. Therefore, we needed to enhance the instructional repertoire of the mathematics and science teachers so they could more easily integrate language and content instruction.

In order to transform math and science teaching practices, job-embedded professional development is needed. This involves a range of workshop activities geared to the specific curricula: demonstrations of math and science language techniques, discourse analysis of the language in math and science textbooks, examination of student work from a language perspective, video clips of meaningful lessons that simultaneously teach content and develop English language skills, practice opportunities to write language objectives for lessons, collaboration with language teachers to prepare language frames, and more. Workshops alone will not lead to high levels of implementation, so in-class coaching and lesson planning assistance are needed as well to promote teacher uptake of the new practices and to sustain the professional learning over time.

DIRECTIONS FOR FUTURE RESEARCH

Although we have conducted research on the SIOP Model for 15 years, there is more to learn. The following suggestions could be applied to a single content area, like mathematics or science, or could be used with mixed content areas.

In the SIOP research studies conducted to date, the student achievement data has been collected concurrently with the teacher professional development. Consequently, medium and high levels of implementation are not reached by all teachers before student assessments begin. Future research might consider investigating the effects on student achievement after SIOP professional development is completed and teachers implement the model with fidelity. Such a study would offer a more valid picture of SIOP's impact on student performance.

Another gap in the research is a longitudinal analysis of SIOP implementation. It would be worthwhile to examine the effects on student performance in language development and subject matter knowledge after they have had continuous exposure to SIOP instruction. For example, an experimental study could look at the effects of SIOP instruction on the same cohort of students over three to five years' time and compare their achievement to that of a control group. Teachers would need to be trained in advance (e.g., one year prior). The study would also need to carefully plan for appropriate pre- and posttest measures to capture growth over time.

A third area is for researchers to examine the specific genres and academic language of subject areas like mathematics and science. This can be accomplished with discourse analysis of written and spoken discourse and case studies of teachers and students (see, for example, Moschkovich, 2010 and Unsworth, 2000). We know that it is not enough to make content teachers familiar with the techniques of integrated language and content instruction, we also have to strengthen their understanding of how academic language is

used in their subject area and how they can build student competence with it. We have begun some work in this area but more is needed.

Finally, most of our professional development work has been with practicing teachers. Our field would benefit from some design research at the undergraduate level in teacher education. The course load for teacher candidates is already full, but it is not preparing them for today's students. How can pedagogy courses incorporate more attention to strategies and techniques that are effective in teaching content and academic language to English language learners? What practicum opportunities can not only expose teachers-to-be to culturally and linguistically diverse classrooms but allow them to observe high quality teaching? What action research might they undertake to learn about the students' real-life experiences with second language acquisition?

CONCLUSION

The pressing need to improve instructional practices and academic language development for English language learners in the 1990s in the United States led to the development of the SIOP Model. Drawing from the professional literature and teacher input, we built an instructional approach and tested it over time. In an iterative process, we refined the professional development program based on classroom observations, teacher feedback, and student performance on assessments. The pressure has continued into the 21st century and the overarching goal of the SIOP Model, namely to make language an integral part of lesson design and delivery, is still relevant. It is one approach that has merit and a research base which shows that high levels of implementation lead to student achievement.

The SIOP Model can be applied to any schooling situation where students are learning content through a new language. It can used with any state standards, in any grade and in any subject (see for example, Watkins & Lindahl, 2010 and Whittier & Robinson 2007.). However as with most interventions, lasting effects require structures at the school level, such as onsite coaching, to sustain the teacher development necessary for delivering effective sheltered instruction (Batt, 2010; Friend, Most & McCrary, 2009; McIntyre et al., 2010).

Currently, the movement of peoples across borders and into lands of cultural and linguistic diversity is widespread. Many countries are educating immigrants and refugees who do not speak the language used in school. The SIOP Model offers a framework for instruction that accommodates their varied levels of proficiency in the new language yet allows them access to the subject matter at the same time. In the United States, the SIOP has been used in dual language classrooms where some non-native speakers, of Spanish for instance, are studying the grade-level curriculum through Spanish (Howard, Sugarman & Coburn, 2006). In the Netherlands, SIOP instruction has been used in Dutch math and science classrooms with immigrant learners (Hajer & Meestringa, 2009). In Korea, the SIOP has been used to train English as a foreign language teachers (Song, 2016).

With SIOP instruction, teachers use techniques to make academic topics accessible to students and practice the academic language as it is used in specific subject areas. Key features for the academic success of English language learners include language objectives

in every lesson, the development of background knowledge, the acquisition of academic vocabulary, cooperative group activities, and the emphasis on subject-specific genres for reading, writing, listening, and speaking tasks. When teachers reach high levels of implementation, with coaching support and time, English language learners develop academic language and content knowledge.

APPENDIX

The Sheltered Instruction Observation Protocol (SIOP)
(Echevarria, Vogt, & Short, 2017)

Observer: _____
Date:_____
Grade:___ _____
Class:_____

Teacher:_____
School:__ _____
ESL level:_____
Lesson: Multi-day Single-day (circle one)

Cite under "Comments" specific examples of the behaviors observed

Total Score: _____ % Score _____

Lesson Preparation	**4**	**3**	**2**	**1**	**0**	**NA**
1. Clearly defined content objectives for students	☐	☐	☐	☐	☐	
2. Clearly defined language objectives for students	☐	☐	☐	☐	☐	
3. Content concepts appropriate for age and educational background level of students	☐	☐	☐	☐	☐	
4. Supplementary materials used to a high degree, making the lesson clear and meaningful (graphs, models, visuals)	☐	☐	☐	☐	☐	
5. Adaptation of content (e.g., text, assignment) to all levels of student proficiency	☐	☐	☐	☐	☐	☐
6. Meaningful activities that integrate lesson concepts (e.g., surveys, letter writing, simulations, constructing models) with language practice opportunities for reading, writing, listening, and/or speaking *Comments:*	☐	☐	☐	☐	☐	

Building Background	**4**	**3**	**2**	**1**	**0**	**NA**
7. Concepts explicitly linked to students' background experiences	☐	☐	☐	☐	☐	☐
8. Links explicitly made between past learning and new concepts	☐	☐	☐	☐	☐	
9. Key vocabulary emphasized (e.g., introduced, written, repeated and highlighted for students to see) *Comments:*	☐	☐	☐	☐	☐	

Comprehensible Input	**4**	**3**	**2**	**1**	**0**
10. Speech appropriate for students' proficiency level (e.g., slower rate, enunciation and simple sentence structure for beginners)	☐	☐	☐	☐	☐
11. Explanation of academic tasks clear	☐	☐	☐	☐	☐
12. A variety of techniques used to make content concepts clear (e.g., modeling, visuals, hands-on activities, demonstrations, gestures, body language) *Comments:*	☐	☐	☐	☐	☐

Strategies	**4**	**3**	**2**	**1**	**0**	
13. Ample opportunities provided for student to use learning strategies	☐	☐	☐	☐	☐	
14. Consistent use of scaffolding techniques throughout lesson, assisting and supporting student understanding such as think-alouds	☐	☐	☐	☐	☐	
15. A variety of question types used throughout the lesson including those that promote higher-order thinking skills	☐	☐	☐	☐	☐	
Comments:						
Interaction	**4**	**3**	**2**	**1**	**0**	**NA**
16. Frequent opportunities for interactions and discussion between teacher/student and among students, which encourage elaborated responses about lesson concepts		☐	☐	☐	☐	
17. Grouping configurations support language and content objectives of the lesson	☐	☐	☐	☐	☐	
18. Sufficient wait time for student response consistently provided	☐	☐	☐	☐	☐	
19. Ample opportunities for students to clarify key concepts in L1 as needed	☐	☐	☐	☐	☐	☐
Comments:						
Practice & Application	**4**	**3**	**2**	**1**	**0**	**NA**
20. Hands-on materials and/or manipulatives provided for students to practice using new content knowledge	☐	☐	☐	☐	☐	☐
21. Activities provided for students to apply content and language knowledge in the classroom	☐	☐	☐	☐	☐	☐
22. Activities integrate all language skills (i.e., reading, writing, listening, and speaking)	☐	☐	☐	☐	☐	
Comments:						
Lesson Delivery	**4**	**3**	**2**	**1**	**0**	
23. Content objectives clearly supported by lesson delivery	☐	☐	☐	☐	☐	
24. Language objectives clearly supported by lesson delivery	☐	☐	☐	☐	☐	
25. Students engaged approximately 90-100% of the period	☐	☐	☐	☐	☐	
26. Pacing of the lesson appropriate to the students' ability level	☐	☐	☐	☐	☐	
Comments:						
Review & Assessment	4	3	2	1	0	
27. Comprehensive review of key vocabulary	☐	☐	☐	☐	☐	
28. Comprehensive review of key content concepts	☐	☐	☐	☐	☐	
29. Regular feedback provided to students on their output (e.g., language, content, work)	☐	☐	☐	☐	☐	
30. Assessment of student comprehension and learning of all lesson objectives (e.g., spot checking, group response) throughout the lesson	☐	☐	☐	☐	☐	

Comments:

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