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"We Don't Teach Science": The Impacts of a New Model for Embedding Language in Science

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I. Objectives

English Language Learners (ELLs) are the fastest growing preK-12 student group in the United States, growing 64% from 1994 to 2010 (National Clearinghouse for English Language Acquisition, 2011). As of 2010, out of nearly 50 million students in the U.S., 10% were identified as ELLs. The percentage of ELLs who achieve proficiency on statewide assessments is 20 to 30 percentage points lower than among their non-ELL peers (Abedi & Dietel, 2004; Hemphill & Vanneman, 2011) which indicates a need to address language instructional methods. Simultaneously, there is an increased focus on improving K-12 science instruction as states across the nation adopt the Next Generation Science Standards (NGSS), partially in response to the lack of students entering Science, Technology, Engineering, and Math (STEM) careers (NGSS, 2012). Among those entering STEM careers, there is a disproportionate number of White males (Litzler, Samuelson, & Lorah, 2014).

ELLs are challenged with learning a new language and grade-level content taught in that language concurrently. Traditionally, the two tasks were separated; but researchers have discovered that combining the two can improve students' acquisition of English without losing subject area content (Echevarria, Short, & Powers, 2006; Lee, Quinn, & Valdes, 2013). This research is coupled with shifts in many states to new, ELL specific standards (i.e., in 2013 Oregon adopted new English Language Proficiency Standards (ELPS)). These standards shift the emphasis from the development of language based on accuracy and grammatical correctness to language focused on interaction, comprehension, and communication, scaffolded within content learning (Shafer-Wilner, 2013). Because these shifts have all occurred in the last five years, little research has been conducted on how best to meet the needs of students under the colliding influences of NGSS, ELPS, and integrated language.

Considering this confluence of events, one district sought to develop a new method of integrating science and language instruction (SAL). In SAL, all teachers, including English Language Development (ELD) teachers, teach science with embedded language instruction, three to four days a week, to all K-5 students. SAL seeks to build content and language simultaneously through science investigations that put language as the integral component to the learning. There is a dearth of empirical research that examines the impacts of innovative instructional models that integrate language with science content, therefore the purpose of this study was to explore the first-year effects of SAL, both as perceived by teachers and as evidenced by student test scores.

2. Perspectives

Studies indicate similarities in results using various language instructional methods (Echevarria, Short & Powers, 2006; McClure, 2009). The growing consensus is that one language acquisition model is not superior to another but success is dependent on the context in which the model is implemented (Celce-Murcia et al., 2014; Mize & Dantas-Whitney, 2007; Prabhu, 1990). What teachers and students "do" with language as opposed to the structural aspects of language (Carlsen, 2007; Kelly, 2007) is the emphasis for embedding language instruction into science content.

3. Methods & Data Sources

This case study of one Pacific Northwest district's implementation of an integrated content/language model sought triangulation through multiple sources and perspectives (Merriam, 2009). This triangulated approach involved utilizing three rounds of teacher surveys, teacher interviews, and quantitative analysis of both student science and language test scores. All teachers in the district were asked to complete a survey at the beginning (n = 51), middle (n = 86), and end (n = 55) of the first year of implementation of SAL. Because a variety of different perspectives were desired, interviews were conducted with 25 teachers in varying roles: 6 teachers on special assignment (TOSA) who were writing and teaching the SAL units, 1 district-wide ELL coach, 6 ELD teachers, and 12 K-5 classroom teachers. All teachers had previous experience working with ELLs: 55% of the students in the district are non-White, 40% of students are identified as ELLs, and over 35 different languages are spoken by students. Finally, three years of fifth grade Science assessment data and two years of ELP data were analyzed to gain a better understanding of student outcomes in science and language.

Qualitative data gathered from open-ended survey questions and teacher interviews was analyzed using a constant comparative approach (Glaser & Strauss, 1967) of dominant emergent themes. Constant comparison data chunks were coded according to overarching commonalities illustrated in the data. Analysis of the data was done using an iterative process of pattern coding (Miles & Huberman, 1994) to look for themes, patterns, and codes to form a 'thick description' of the instructional model (Geertz, 1973). Data were double-coded to ensure reliability. Qualitative survey and interview data were then integrated with quantitative survey and test score data to triangulate themes and patterns.

4. Conclusions

We're Teaching Science!

The first clear theme was that prior to the adoption of SAL, no elementary teachers in the district had been teaching formalized science. One teacher described how "we weren't teaching science K-6 in any sort of sequential way," while another teacher took a historical perspective: "there hasn't been anything in the 12 years I've been here that was science for this grade, it wasn't consistent." Another teacher even described how they didn't have "the priority from the district that [teaching science] was a good use of time." Teachers were excited about the new opportunity to teach inquiry-based, hands-on science to smaller class sizes, which was made possible due to the "walk to SAL" model in which ELD teachers also taught classes. Even those teachers who were not in love with the district change described this positive exposure: "Kids are getting exposed to science whereas they weren't getting any science before. They like the science; the kids are excited about it." One ELD teacher described how students "minds were just exploding!" during a space unit that described how the moon orbits the earth, the earth orbits the sun, and the solar system orbits the galactic center. This theme was consistent across most of the interviews, and was triangulated by the survey data (Table 1), showing the average participant agreed that they liked to teach science throughout the year. In contrast, the survey participants did not feel as strongly about their students' science knowledge improving and did not generally recommend SAL to teach NGSS.

Benefits of implementing SAL were also reflected in the science standardized test scores, which are taken each year by the fifth-grade students statewide. A one-way analysis of variance was utilized to understand the changes over time, and revealed statistically significant differences across the three years, $F(2,1601) = 5.353$, $p = .005$. Tukey post-hoc tests revealed that students receiving SAL in 2016-2017 significantly outperformed students not receiving SAL in 2015-2016, $p = .004$, but not in 2014-2015. While these results are not definitive, they become clearer when percent meeting benchmark is analyzed, which ranged from 33% to 35% in the two years prior to implementing SAL, while scores increased significantly ($p = .01$) to 42% during the SAL implementation year. It appears that science knowledge, at least of fifth grade students, may have increased because of the new SAL program implementation.

But it's Not Meeting the Needs of our ELL Students

Despite the positive outcomes regarding science instruction, the overwhelming theme across all interviews and survey response was SAL does "not meet the needs of my low language proficiency kids, there's no question about it." All roles; classroom teacher, ELD teacher, TOSA, and district coach, felt similarly about this, that "SAL was not enough" for ELLs, and "the language needs to be better, hands down." Teachers were especially concerned about the youngest language learners (i.e., kindergartners) and the lowest levels of language learners (i.e., newcomers, beginners, and early intermediates). While some of the ELD teachers openly embraced, and enjoyed their role change, others were very upset with the change and felt their specific skill sets were not being utilized appropriately. For example, one ELD teacher said: "SAL leans more towards missing out on that explicitly taught language piece. It's more science. I feel like I've become a science teacher, not an ELD teacher." Some of the classroom teachers felt similarly in the opposite direction: "I'm not really interested in teaching language as much as I am science. I worry about the children getting everything that they should." This was reflected in the survey results finding only 59% of classroom teachers agreeing that they felt confident teaching ELLs, and most felt they needed more professional development on how to best to teach ELLs.

These results can also be seen in the surveys (Table 3), which show very high disagreement with items regarding the language impacts of the program. When disaggregated, several of these items showed significantly ($p < .05$) more negative responses by ELD teachers than classroom teachers. To back-up these teacher concerns, an independent samples *t*-test revealed statistically significantly higher language proficiency scores during the previous non-SAL year over the SAL year, $t(2{,}096) = 18.163$, $p < .001$.

Unintended Positive Consequences

Although the language outcomes, at least in the first year, were not as glowing as hoped for by the district, it appears there may be some other unintended positive outcomes of implementing SAL that may produce more positive long-term outcomes. First, it appears that:

"something that came to light was an enhanced recognition that [ELLs] are everyone's students and all teachers need to be aware of more ways to reach them." Second, one second grade classroom teacher described a "carryover in language" from language learned in SAL to other content areas: "we started off the year talking about comparing and contrasting landforms, then when we started comparing and contrasting in texts it felt really familiar and they had a lot of practice with the language, where in the past it might have been something that was really challenging." This happened for a kindergarten classroom teacher as well with a language strategy called a cooperative strip paragraph. He had never used that strategy before, and, "it was one of those ah-ha moments, I could do this with the book we're reading!" While SAL itself may not be producing noticeable effects right away, there may be a domino effect occurring.

5. Significance

Integrated language is one answer to our current dilemmas of not meeting the needs of ELLs (Hemphill & Vanneman, 2011) and the promotion of science instruction that emphasizes learning through local contexts and rich language (NGSS, 2013). The polarity of the results of this study indicate the complexity of this issue. These mixed results may be due to the fact that language intensive practices rely heavily on academic discourse to develop both student content and language knowledge, and teachers are generally unfamiliar with procedures that develop rich classroom discourse (Thompson, Widschitl, & Braaten, 2013).

This may all come down to a need for professional development (PD). This theme came up again and again in the interviews and surveys, and appears alluded to in the language and science test scores as well. Teachers: "need training on inquiry-based instruction because it's different than what we've done before, and then how to incorporate language instruction throughout the whole day." This suggests the need to support teacher learning through PD that expands teacher academic experiences to discursive strategies that support ELLs (González-Howard, McNeill, & Ruttan, 2015). Additionally, there is a need to examine how teachers work through issues of coherence of previous beliefs and new learning, which can impact the effectiveness of PD and instruction (Allen & Penuel, 2015).

It's clear there is more work to do in this area, and shifts are required by all involved. This take-away is perhaps summed up best by one teacher participant: "It's a shift in the belief system, as a teacher, that any time I'm teaching any kind of content I'm also teaching language, and that's a lot to own. Because it used to be the ELD teacher would just sprinkle English on them and send them back." Based on the history of the results of the "sprinkle approach," however, it appears a "flood" is necessary.

Table 1

	Time	*n*	*M* (*SD*)	Disagree	Neutral	Agree
I like to teach science.	Pre	51	4.02 (0.88)	8%	14%	78%
I like to teach science.	Post	55	4.07 (0.90)	2%	31%	67%
My students' science knowledge has improved because of SAL.	Mid	86	3.83 (0.98)	9%	23%	67%
My students' science knowledge has improved because of SAL.	Post	55	3.91 (0.99)	5%	20%	75%
I would recommend SAL to teach NGSS.	Mid	86	3.04 (1.33)	31%	26%	43%
I would recommend SAL to teach NGSS.	Post	55	3.06 (1.33)	35%	20%	45%

Note. NGSS = Next Generation Science Standards.

Table 2

Year	*n*	5th Grade Science Standardized Test Score		
		M	*SD*	Percent Passing
2014-2015	523	222.26	8.50	33%
2015-2016	519	221.05	10.18	35%
2016-2017	562	222.93*	9.75	42%*

Note. $*p < .05$.

Table 3

Survey Item	Time	*n*	*M* (*SD*)	Disagree	Neutral	Agree
My students' language skills have improved because of SAL.	Pre	51	2.53 (0.83)	45%	45%	10%
ELD Teachers		8	2.63 (0.52)	38%	63%	0%
Classroom Teachers		43	2.51 (0.88)	47%	42%	12%
My students' language skills have improved because of SAL.	Mid	86	2.50 (1.07)	49%	31%	20%
ELD Teachers		14	1.93* (1.00)	72%*	21%	7%
Classroom Teachers		72	2.61 (1.06)	45%	33%	22%
My students' language skills have improved because of SAL.	Post	55	2.29 (0.98)	60%	27%	13%
ELD Teachers		11	1.82* (0.87)	73%	27%	0%
Classroom Teachers		44	2.41 (0.97)	57%	27%	16%
I would recommend SAL to teach ELPS.	Mid	86	2.17 (1.14)	60%	26%	14%
ELD Teachers		14	1.57* (0.85)	79%*	21%	0%
Classroom Teachers		72	2.29 (1.16)	57%	26%	17%
I would recommend SAL to teach ELPS.	Post	55	2.13 (1.07)	65%	20%	15%
ELD Teachers		11	2.00 (1.10)	64%	27%	9%
Classroom Teachers		44	2.16 (1.10)	66%	18%	16%

Note. ELPS = English Language Proficiency Standards. $*p < .05$.

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Abstract

A paradigm shift of beneficial language acquisition pedagogy for preK-12 English Language Learners (ELLs) is taking place in the United States. There has been an increase in studies that support creating an academic environment that socially develops language through context and experience as opposed to isolated instruction of specific language elements. This study examines the first year of one district's attempt to integrate language learning within the context of science instruction. Data was obtained through surveys and interviews with teachers as well as assessments of English Language Proficiency and Science Standards. Examining the implementation process and stakeholder perspectives sheds light on the difficulties and opportunities of this model of language development for ELLs.