SCIENCE VOCABULARY SUPPORT (SVS) PROGRAM DEVELOPMENT, REFINEMENT, AND PRELIMINARY EFFECTIVENESS EVALUATION

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Study setting

Newcomer Academy

- To enroll:
  - Year 1 in the U.S
  - Score ≤ 2 “Beginner” on the district’s English proficiency test (range 1-6; WIDA)
  - Middle/high school-aged (12-21)

- Sheltered instruction school for Grades 6-11 newcomers
  - 25 primary languages
  - ≈ 75% refugees
  - ≈ 25% limited or interrupted formal schooling

  - ***High School (Grade 9-11)***

Background: Student need

- Both teachers and students identify technical, specialized vocabulary as one of the biggest challenges for newcomers (Brown et al., 2006; Miller, 2009):

  [S1] “Language like scientific terms this is really giving me a problem and I don’t do well in science.”

  [S2] “I like Biology and I was the best in my class in my home country but now here it is difficult for me. The language is difficult.” (Brown et al., 2006; p. 157)

- Research indicates that vocabulary is a strong predictor of reading comprehension and standardized assessment performance (Cisco & Padrón, 2012)

Science Vocabulary & Research Gaps

- "The heavy use of scientific terminology to explain concepts [. . .] raises the readability level of science textbooks" (Harmon et al., 2005, p. 271)
  - *technical vocabulary*, concept-loaded words ('photosynthesis')
  - *nontechnical words*, not concept-loaded words ('component'; Hwang et al. 2014; Lawrence et al. 2012; Lesaux et al., 2014)
  - *signals* or *procedural vocabulary*, words linking concept-loaded ('be the result of'; Macken-Horarik 2002; Richardson Bruna et al., 2007)
- Research on specialized, technical vocabulary of science—pariculary when it comes to low-literacy bilingual ELs—remains limited (Tong et al., 2014; Miller, 2009)

Study objectives

1. To examine current vocabulary literature to identify effective, research-based vocabulary instruction principles, practices, and routines;
2. To develop the ***Science Vocabulary Support*** **(SVS)** program—focused on science + general academic vocabulary—suitable to the learning needs of newcomer high school ELs;
3. To refine the program based on teacher feedback and student performance; and
4. To conduct a preliminary investigation of the program effectiveness

SVS Development: Research-based practices and principles

- Vocabulary selection criteria
- Instructional principles, practices, routines
- Curricular materials

Vocabulary selection

- Textbook: *Physics in Action* (Eisenkraft, Smith, and Southard, 2009).
  - 76-page chapter
  - normally allocated 12-14 weeks of instruction
  - supplemented with a *Science Words* feature (new words bolded and defined both on a sidebar and in the glossary)

- Targeted vocabulary selection was conducted in close collaboration with the teacher and proceeded in two steps.

Step 1: Science vocabulary difficulty categorization schema adopted from Miller's (2009)

Vocabulary Category	Examples	Comprehension Problem Category
Non-scientific enabling words (directions)	**Opposite**, backward, rearward, forward, parallel, horizontal, vertical	New vocabulary
Scientific processes/descriptions of motion	At rest, **constant speed**, **accelerate** (acceleration), **decelerate** (deceleration), push, pull, cause to move (to accelerate/decelerate), **increase, decrease**	Scientific specificity + new vocabulary
Conceptual phrases	Apply (applied) force, active (acting) force, **exert a force, experience a force**, source of the force	Concept, scientific specificity
Measurements	Meter per second, time interval, unit of acceleration, **number, amount**, 1.0 N	Concept, complexity

Step 2: Wilson's (1998) science vocabulary selection criteria

1. Is the word necessary for students' initial understanding of a particular scientific concept?
2. Will the term add to a student's ability to link related concepts?

Example of selected words

Science specific words

- friction
- gravity
- inertia
- de/acceleration

Enabling words

- action
- amount
- in/decrease
- opposite

SVS programs' guiding principles

- Based on "powerful vocabulary instruction" theory and research (Nagy, 1988), the SVS program is guided by 3 principles:

1. **Integration**: to facilitate learning, instructed words and ideas need to be linked with other knowledge
2. **Repetition**: multiple exposures to the targeted words are needed to facilitate word learning and application
3. **Meaningful Use**: contextual use of the instructed words

SVS instructional practices

- Contextualization & decontextualization
- Focus on form
- Focus on meaning
- Predictable routines
- Teaching of learning strategies
- Negotiation

SVS Learning Cycle

- The SVS program targets **10 words per week**
  - **6 new words + 4 review words from previous weeks**

Target words:

- introduced through direct instruction on Monday
- incorporated in daily 5-15 minute Monday-through-Friday word study activities

Word study activities:

- rotate in a consistent fashion across each day of the week
- include games (e.g., picture match, definition match, charades, jeopardy)
- writing activities (e.g., spelling pyramid, sentence generation, quizzes)

	Word Study Routines	Science Activities
M	• Teacher introduces new words in mini-scenarios • Whole-class discussion of related words/parts • Students enter word, definition, picture/graphic • Students discuss terms in pairs (L1)	• S & L objectives • Short background videos • Chapter preview
Tu	• Picture Match (words +pictures) • HW: (a) spelling pyramid & (b) sentence generation	• Science Journaling (SJ): Procedures
W	• Card game (words + definitions) • Written homework assignment review	• Science investigation • SJ: Observations
Th	• Team games (Charades OR Jeopardy)	SJ: Report writing
Fr	Cloze exercise (quiz): Students match targeted words to sentences	Extension: Videos, extra chapter activities

SVS Curricular Components

Student set of weekly activities:

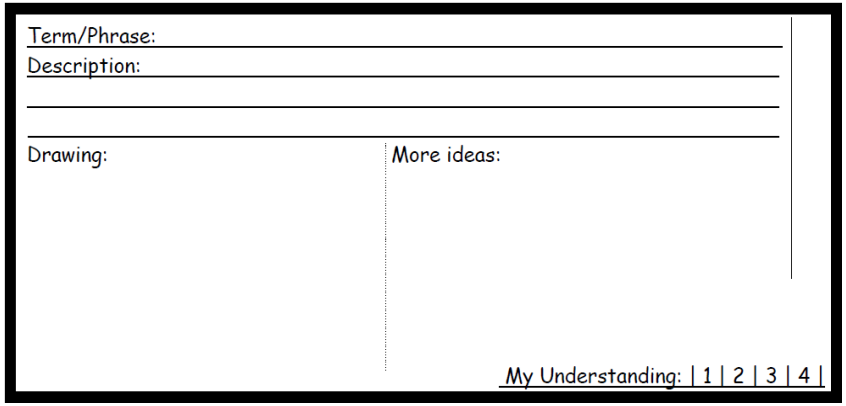
- word and picture cards for games and assignments

Weekly teacher Power Point:

- an individual slide per each new word for the Monday introduction
- directions for the Monday-through-Friday activities

Vocabulary Journal, a set of graphic organizers for each new word with space for (Marzano & Pickering, 2005):

- the term
- its definition
- graphic representation,
- additional information



Procedures & data sources

SVS implementation:

- Six weeks (October - January 2012-2013)

Program development and effectiveness evaluation was informed by three approaches:

a) situated ethnographic qualitative approach
b) weekly vocabulary quizzes
c) a pre-post design pilot study

Participants

Students - enrolled in four Grade 9-10 classrooms

- $N \approx 92$
- 51% female
- $M_{age} = 15.9$ (range: 14-19)
- English proficiency ranged from ‘entering’ to ‘beginning.’

Science teacher + ESL endorsement

- a Caucasian male with 15 years of teaching experience
- 5 years in the Newcomer Academy

Qualitative data collection

- grounded in the authentic practice of the teacher
- featured ongoing, extensive researcher-teacher collaboration
  - weekly curriculum materials development communications
  - classroom observations
  - post-instruction conversations and reflections
  - ongoing informal conversations

- semi-structured interviews
  - current practices and challenges (pre)
  - perceptions of the program impact (post)

Qualitative Results (pre-SVS)

- Teaching philosophy:
  - “a good way for the teacher is to step back and let the kids interact with the words a little bit”
- Teaching strategies:
  - students’ copying the day’s agenda (+ vocabulary)
  - using Cornell notes (two columns: words + meanings)
  - a student-generated glossary for their self-created books
  - word wall
  - teacher’s using images or acting out meanings of terms

4 “typical” of content-area teaching instances of new vocabulary use, namely: “in [. . .] teaching; the textbook; the class notes; and in talking to students” (Miller 2009, 588).

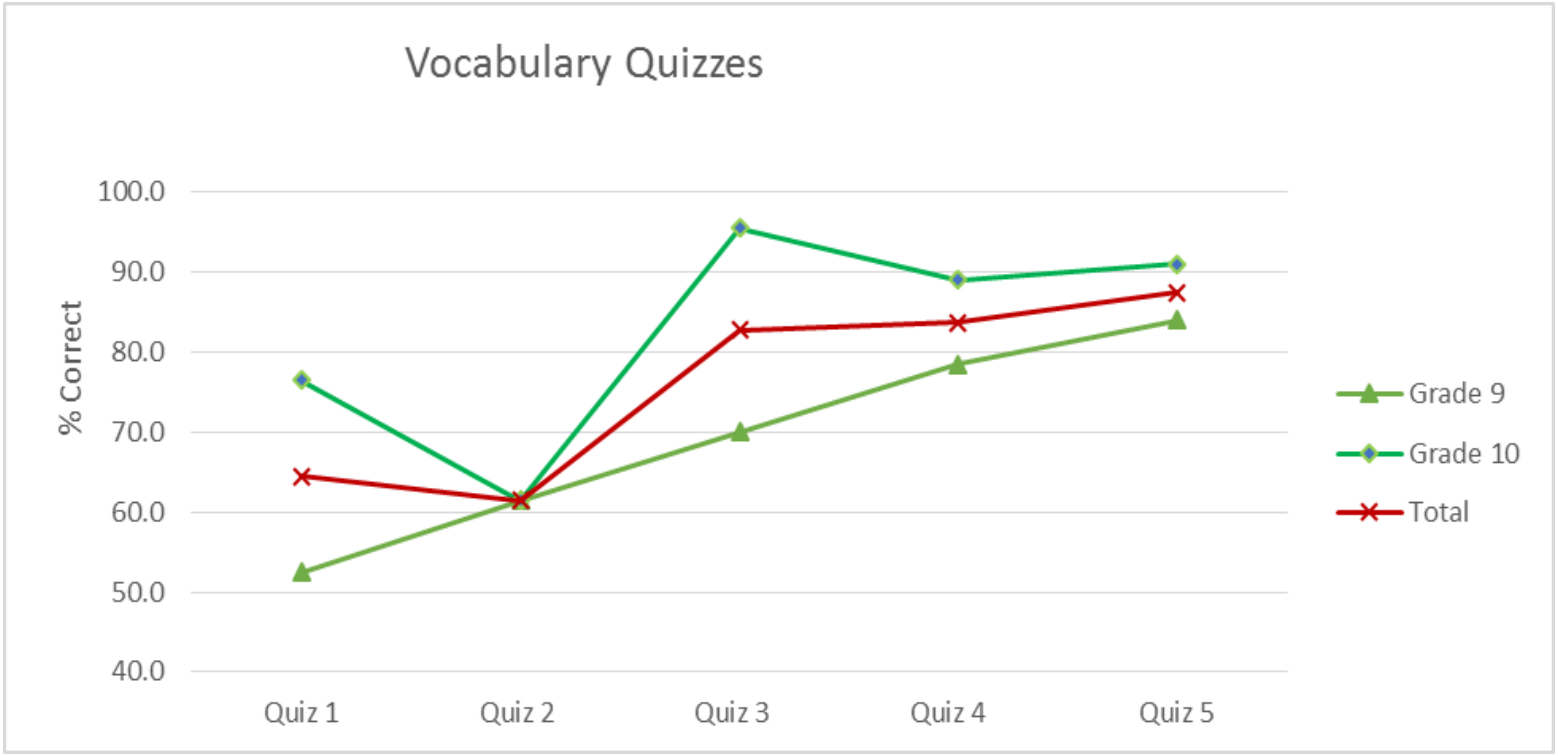
Weekly Vocabulary Quizzes

- A word-sentence-match format (8 words: 6-8 new + 2-0 review)

  Example item: *We say that a car is _____ when it is going faster and faster* (solution: ***accelerating***).

- Task format = ‘cloze’ or a ‘word fill-in’ task
  - concurrent validity (correlations SAT verbal: .36 -.65; Cohen, 2012)
  - internal reliability (alpha reliability range: .77–.86; Lesaux et al., 2010)

Weekly Vocabulary Quizzes: Results



An average increase of 23%

- Total: 65% to 88%
- Grade 9: 53% to 84%
- Grade 10: 77% to 91%

Pre-Post Pilot: *Science Vocabulary Measure*

- Two tasks (Beck & McKeown, 2007; Townsend & Collins, 2009):
  - **picture**, selecting a corresponding targeted word from a set of four (4 items; *a format that, in essence, allows to test 16 words; Nation, 1983*)
  - **verbal**, matching vocabulary with definitions (6 items)
- Scored as 0 = *incorrect* or 1 = *correct*
- Raw scores were converted into % correct
- Reliability: .67 (pre) and .68 (post)

Science Vocabulary Measure: Descriptive statistics, *t*-test results, and effect sizes

	Pretest		Posttest			
	M	*SD*	*M*	*SD*	*t(60)*	*d* [95%CI]
Total	57.54	25.34	72.30	24.86	4.55	0.59 [0.23; 0.95]
Verbal	57.93	31.27	71.58	31.53	3.07	0.43 [0.08; 0.79]
Picture	56.97	28.19	73.36	26.17	3.93	0.60 [0.24; 0.97]

Note. $N = 61$. All *t*-tests are significant at $p < .005$.

Qualitative Results (post-SVS)

- SVS benefits:
  - **structured, intentional revisiting of targeted words**: “frontloading, revisiting the same words again in the context of science-centric instruction; and revisiting again” using different modalities such as pictures, acting out
  - **teaching language tailored to specific science instruction**: “allows my students to access prior knowledge and express what they are learning.”

Summary statement: “**I feel confident my students can better express what they learned**.”

Study significance

- Merit of specifically targeting science-specific, technical vocabulary for instructional interventions
- Demonstrate the effectiveness of research-based vocabulary development strategies with a new population of high school newcomer ELs

Study in press

Ardasheva, Y., & Tretter, T. R. (in press). Developing science-specific, technical vocabulary of high-school newcomer English learners. *International Journal of Bilingual Education and Bilingualism.*

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