Culturally and Linguistically Responsive Math Instruction for English Learners in Multi-tiered Support Systems: PLUSS Enhancements

(Sanford, Pinkney, Brown, Elliott, Rotert, & Sennott, in press)

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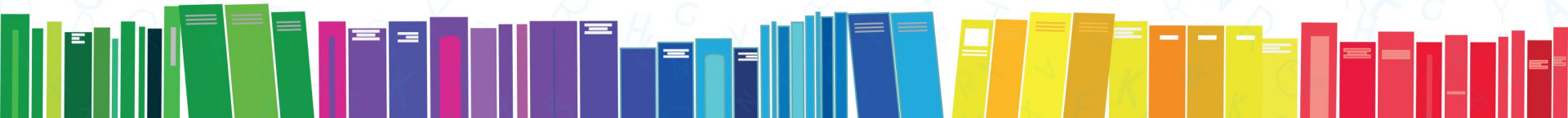

Thank you to the research team

Masters Project Team:

- Eleanor Scott,
- Mara Rappleyea,
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Session Outcomes

- Learn a research-based instructional overlay for instruction and interventions that targets English Learner students' linguistic needs and cultural contexts
- Review results of study using the framework during a math intervention
- Comments and questions from the audience

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Rationale

- Historically, culturally, linguistically and racially diverse students have been disproportionately represented in special education programs (Cartledge, Kea, Watson, & Oif, 2016; Klingner, Artiles, & Mendez-Barletta, 2006).
- One reason may be EL students are not fully benefitting from academic interventions because there is not enough language support in typical intervention programs.

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PLUSS Framework

- PLUSS conceptual framework synthesizes the research on effective instruction for English learner (EL) students (Sanford, Brown & Turner, 2012).
- Designed as an overlay for instruction and interventions
- Teachers may use framework to analyze their own teaching to ensure lessons include language and background supports

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PLUSS Framework for Evidence-based Instruction for ELLs

PLUSS Framework
Pre-teach critical vocabulary & prime background knowledge
Language modeling and opportunities for practice
Use visuals and graphic organizers
Systematic and explicit instruction
Strategic use of native language & teaching for transfer

Source: Sanford, A., Brown, J.E., & Turner, M. (2012). Enhancing instruction for English learners in Response to Intervention systems: The PLUSS Model. *Multiple Voices for Ethnically Diverse Exceptional Learners, 13,* 56-70

Component	Definition	Evidence
Pre-teach critical vocabulary and prime background knowledge	Identify and explicitly teach vocabulary and language structures that are unknown and critical to understanding a passage or unit of instruction; provide culturally relevant curriculum and make connections between new information and life experiences	Au & Kawakami, 1994; August, Artzi, Barr & Francis, 2018; Calderón, 2007; Carlos, et al. 2004; Echevarria, Vogt & Short, 2008; Gay, 2000; Hollie, 2012; Ladson-Billings, 1994; Linan-Thompson & Vaughn, 2007; Nieto & Bode, 2008; Paris, 2012; Sleeter, 2011

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Component	Definition	Evidence
Language modeling and opportunities for practicing	Teacher models appropriate use of academic language, then provides structured opportunities for students to practice using the language in meaningful contexts	Dutro & Moran, 2003; Echevarria, Vogt & Short, 2008; Gibbons, 2009; Linan-Thompson & Vaughn, 2007; Scarcella, 2003; Valdés, Poza, & Brooks, 2015

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Component	Definition	Evidence
Use visuals and graphic organizers	Strategically use pictures, graphic organizers, gestures, realia and other visual prompts to help make critical language, concepts, and strategies more comprehensible to learners	Brechtal, 2001; Echevarria & Graves, 1998; Haager & Klingner, 2005; Linan-Thompson & Vaughn, 2007; O'Malley & Chamot, 1990; Pang, 2013

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Component	Definition	Evidence
Systematic and explicit instruction	Explain, model, provided guided practice with feedback, and opportunities for independent practice in content, strategies, and concepts	Calderón, 2007; Doabler, Nelson, & Clarke, 2016; Flagella-Luby & Deshler, 2008; Gibbons, 2009, Haager & Klingner, 2005; Klingner & Vaughn, 2000; Watkins & Slocum, 2004;

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Component	Definition	Evidence
Strategic use of native language & teaching for transfer	Identify concepts and content students already know in their native language and culture to explicitly explain, define, and help them understand new language and concepts in English	Carlisle, Beeman, Davis & Spharim, 1999; Durgunoglu, et al., 1993; Genesee, Geva, Dressler, & Kamil, 2006; Martinez, Harris, & McClain, 2014; Odlin, 1989; Schecter & Bayley, 2002

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The Study

- Implemented Go Math! (2011) with and without supports designed to address students' English language development needs.
- Research questions:
  - What were the effects of adding the PLUSS instructional enhancements to an evidence-based math curriculum taught in English for ELs who are identified as needing additional support in math on:
    - math vocabulary acquisition, and
    - math story problem solving containing target vocabulary?

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Participants and Setting

- Participants:
  - Four Latino 4th grade students
    - two students scored below 20%ile on easyCBM;
    - two referred by teacher; one identified with SLD
  - Enrolled in a Tier 2 math group

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Participants and Setting

- Setting:
  - A Title 1 kindergarten – fifth grade rural elementary school
    - 73.3% received free or reduced lunch
    - Total enrollment 247 (59.9% Hispanic, 37.2% White)
    - 5% of students received special education services
    - 50% of students received ESL/ELD services
  - A MTSS process for academics and behavior was in place
    - The system was more developed for literacy than for math

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Students' Current Levels of Performance in Winter of Fourth Grade – Pre-intervention

Student	Sex	Age	ELPA	Math	Reading Comprehension	Passage Fluency	Vocabulary
Alma	Female	10.3	505 – Early Intermediate	22 (22)	7 (7)	48 (2)	10 (6)
Berto	Male	10.3	496 – Beginning	20 (17)	14 (46)	85 (10)	7 (2)
Gino	Male	9.8	498 – Beginning	16 (8)	4 (3)	13 (0)	5 (1)
Julia	Female	10.6	502 – Early Intermediate	22 (22)	4 (3)	70 (6)	7 (2)

Note. ELPA = English Language Proficiency Assessment; Math Scores = Easy CBM Math Common Core State Standards raw scores; Reading Comprehension = Easy CBM Multiple Choice Reading Comprehension raw scores; Passage Fluency = Easy CBM Passage Fluency words correct per minute; Vocabulary = Easy CBM Vocabulary raw scores; Percentile rank in parentheses.

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Dependent Variables & Measures

- Dual dependent variables:
  - students' acquisition of content specific math vocabulary
  - generalization of this knowledge to complete math application problems
- Dependent measures:
  - Vocabulary assessment: ten words were administered during the baseline phase, and
  - Application: five math story problems were administered.
- Following baseline, words and concepts were gradually introduced to scaffold students' instruction in manageable amounts

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Vocabulary Acquisition

- Baseline assessment: definitions of ten target words were given and participants chose the correct term from a word bank of 10 target and 10 distractor words (Espin, Shin, & Busch, 2005; Kim & Linan-Thompson, 2013)
- Range of possible scores for the vocabulary assessment = 0-10 points:
  - Step One: 0 - 2 possible points
  - Step Two: 0 – 4 possible points
  - Step Three: 0 – 7 possible points
  - Step Four: 0 – 10 possible points

PLUSS Math Assessment Step 4- #6

Directions: Use the words in the Word Bank to answer each of the questions given below. Some words will be not used. If you do not know an answer, you may leave it blank.

Word Bank

acute angle	hundredth	obtuse angle	right angle
compare	line	parallel lines	straight angle
decimal	line of symmetry	perpendicular lines	tens
equivalent	line segment	quadrilateral	tenth
hundreds	line symmetry	ray	whole

1. An imaginary line that divides a shape into two congruent parts is a _____

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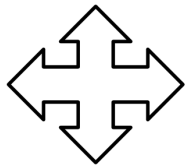
Story Problem Application

- Baseline: participants assessed on ability to apply math vocabulary knowledge by completing story problems (addition, subtraction, decimals, fractions and geometry) containing the previously taught math vocabulary
  Orosco, 2014a ; Orosco, 2014b ; Orosco, Swanson, O'Connor, & Lussier, 2011)
- Story problems read to participants who were given as much time as they needed to complete the problem.
- Range of possible scores for the story problem application = 0-5 points:
  - Step One: 0 - 2 possible points
  - Step Two: 0 – 3 possible points
  - Step Three: 0 – 4 possible points
  - Step Four: 0 – 5 possible points.

3. Henry drew the figure below. Draw a line of symmetry through Henry's figure.



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Inter-observer Agreement

- Assessments scored by three graduate students in special education
- Raters practiced scoring until 100% agreement was met on three consecutive assessments
- Inter-observer agreement was calculated for 16 out of 34 of the sessions
  - When there was a disagreement between two raters, a third rater scored the answer, and the majority response was the final response
- Inter-observer agreement ranged from:
  - Vocabulary Assessment: 90%-100% (mean = 99%)
  - Story Problem Application: 75%-100% (mean = 99%)

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Conditions: Baseline Phase

- The purpose of the baseline phase was to:
  - validate instructional need
  - establish students' current level of performance on identifying math vocabulary definitions and their application on story problems instructed in general education

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Conditions: PLUSS Intervention

- Independent variable:
  - targeted math instruction with the PLUSS framework (Sanford, Brown, & Turner, 2012) overlaid to address the unique linguistic and learning needs of English learners
- Content objectives were from the Go Math! Curriculum lesson
- Language objectives were based on the linguistic needs of the participants

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PLUSS Components:

Pre-teaching Critical Vocabulary

- The Go Math! units were reviewed and ten vocabulary words were selected and assessed.
- Vocabulary explicitly taught and practiced (modified from Archer & Hughes, 2011; Honig, Diamond, & Gutlohn, 2013):
  - **introducing** and **pronouncing** the word,
  - **student friendly definition** in both English and Spanish; Spanish cognate if available
  - **examples and non-examples** with illustrations and multiple ways to engage with the word (via word maps; e.g., Archer & Hughes, 2011; Honig et al., 2013 ; Schwartz & Raphael, 1985)
  - opportunities for students to **use the word in context** with sentence frame support (i.e., sentence frames written on sentence strips to support students in using the word correctly).

Priming Background Knowledge

- Each lesson reviewed prior material

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PLUSS Components

Language Modeling and Opportunities to Practice

- Participants were taught the academic language structures and vocabulary needed to express their mathematical thinking
- Sentence frames were used to provide a visual cue and opportunity to practice
- Example sentence frames for defining words:
  - "The word _____ means _____."
- An example sentence frame for describing thinking:
  - "When we write the fraction _____ (e.g., 6/10) as a decimal, we write the ____ (6) to the right of the decimal point."

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PLUSS Components

Use Visuals and Graphic Organizers

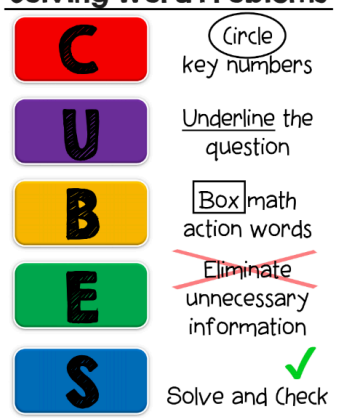
- Go Math! curriculum included visuals and graphic organizers
- interventionist ensured these were used and provided extra examples when necessary (i.e., videos, paper shapes, real objects)

Systematic and Explicit Instruction

- Utilized explicit problem solving steps (CUBES)
- Curriculum provided some explicit and systematic instruction, additional guided practice was provided (Stein, Kinder, Silbert, & Carnine, 2006) by:
  - Using more explicit teacher language
  - Increased opportunities to practice the content with manipulatives

Strategic Use of Native Language and Teaching for Transfer

- Instruction was delivered in English but with bilingual interventionist could translate when appropriate
  - Definitions of concepts in Spanish
  - Identified cognates



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Research Design and Analysis

- An A, B1, B2, B3, B4 changing criterion design was used (Kratochwill , Hitchcock, Horner, Levin, Odom, Rinsdskopf, and Shadish, 2012)
- The criteria were set in advance at 100% performance for three consecutive trials for 3/4 participants (Gast & Ledford, 2014)
- The four phase changes were:
  - A: Zero words taught but 10 assessed; all five story problems
  - B1: Two words taught and assessed; two story problems
  - B2: four words taught and assessed; three story problems
  - B3: seven words taught and assessed; four story problems
  - B4: 10 words taught and assessed; five story problems

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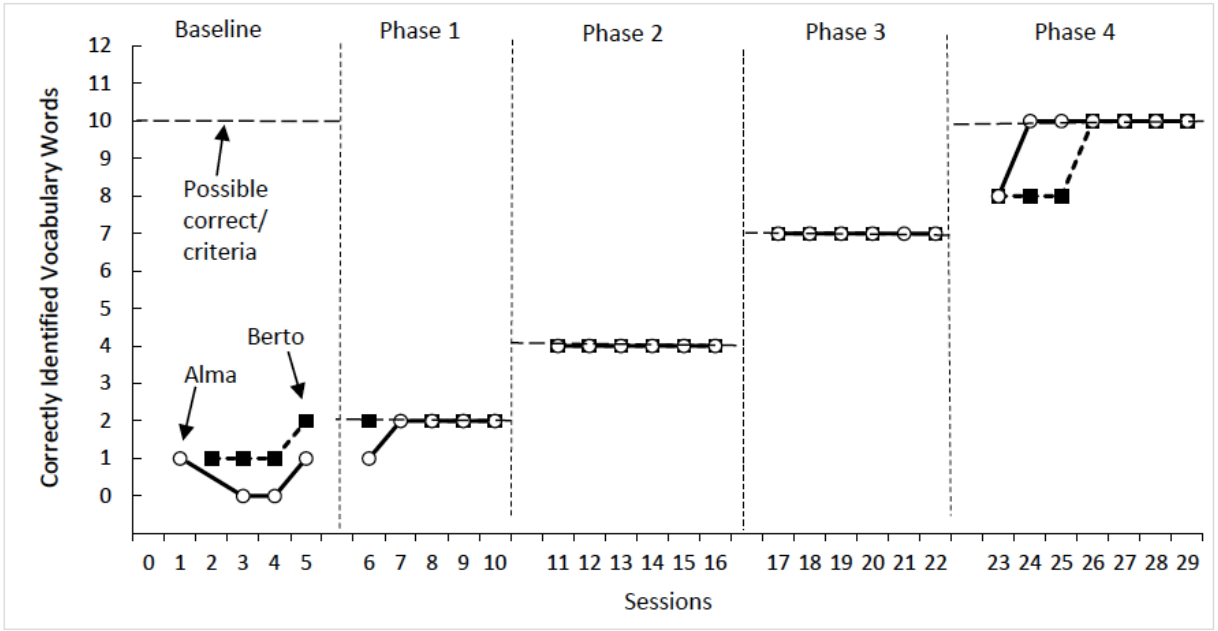
Effects of PLUSS on Math Vocabulary: Alma & Berto

Math Vocabulary Words Correctly Identified for Alma and Berto



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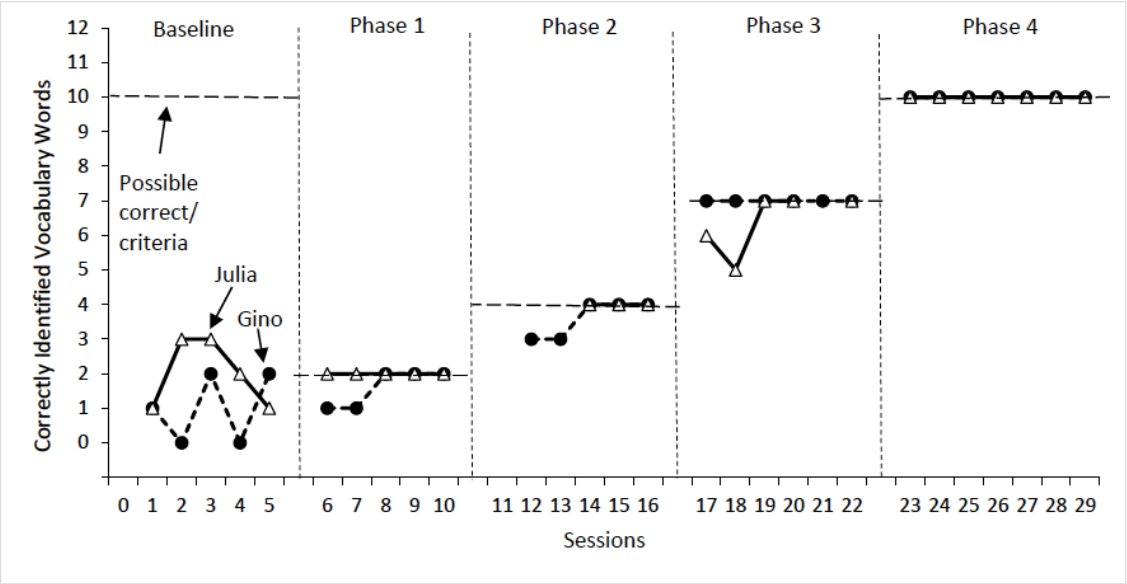
Effects of PLUSS on Math Vocabulary: Gino & Julia

Math Vocabulary Words Correctly Identified for Gino and Julia



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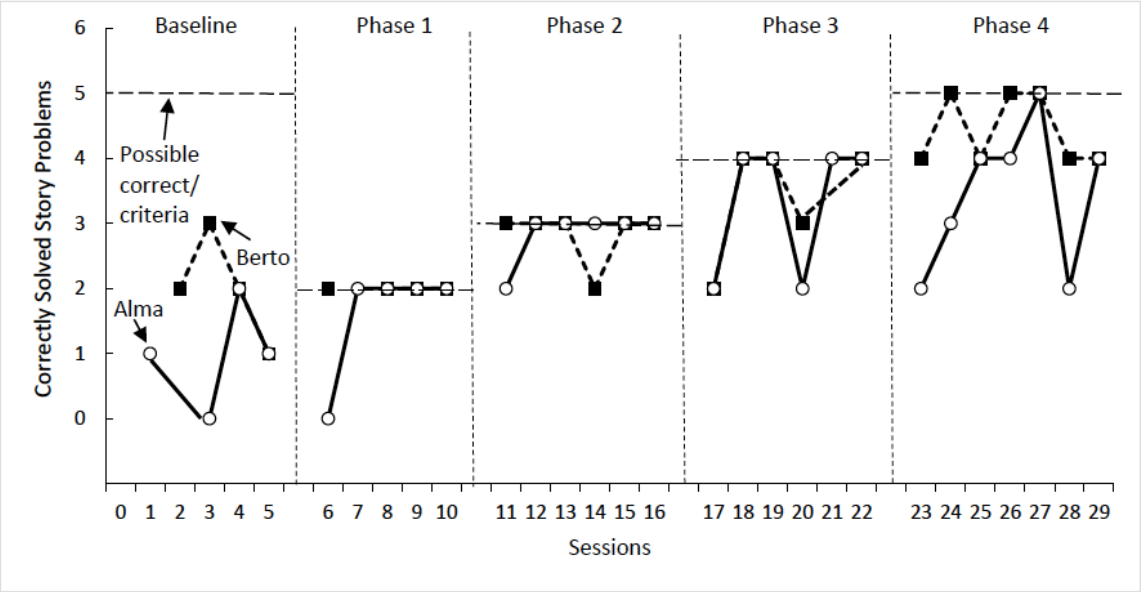
Effects of PLUSS on Story Problems: Alma & Berto

Story Problems Correctly Identified for Alma and Berto



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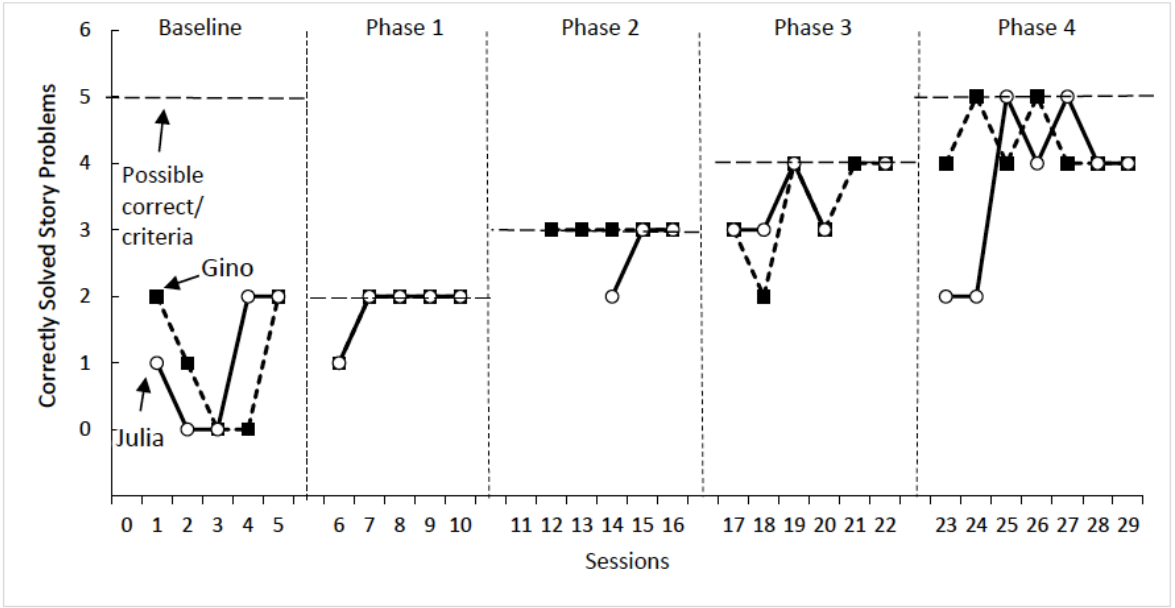

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Social Validity

- Surveys were administered to:
  - Interventionists/researchers
    - utility, practicality and efficacy of PLUSS framework
  - Participants
    - practicality and efficacy of intervention
    - whether they would like to continue using it
- Open-ended questions were included in both surveys

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Social Validity: Interventionists

- The interventionist/researchers agreed or strongly agreed:
  - I think the PLUSS math intervention helped improve the outcomes for my English language learners,
  - The PLUSS math interventions were practical and effective,
  - I preferred teaching the curriculum with the PLUSS intervention,
  - I would continue using the PLUSS intervention after the project ended,
  - I would recommend the PLUSS math intervention to my colleagues.

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Social Validity: Interventionists

- 2/4 indicated lesson planning was time consuming
- All commented that the most positive aspects were high level of student engagement, concrete models for conceptual learning, and repeated vocabulary practice

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Social Validity: Participants

- All participants agreed
  - the enhanced instruction helped them learn math vocabulary and to solve math problems better,
  - they would like to continue this instruction
- Comments included:
  - *"I like the sentence frames because it was fun to talk with other people."*
  - *"Practicing the words every day" was helpful.*

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Implications

- For ELs, instructing language and vocabulary supported math content acquisition
  - Must teach the language/vocabulary to address double cognitive load of learning concepts and language
- Time is needed for teachers to plan interventions that address language and culture of students

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Implications

- The results here, albeit from a small sample, suggest PLUSS is a promising practice to address the need for concurrently providing language support and skill development in the instruction of ELs.
- This model may also help in answering the “difference or disability” question, although more research is critically needed.

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