



Language Effects in K-2 ESL Students Receiving Mathematics Intervention Support

Marialuisa Di Stefano, Kristy Litster,
and Beth MacDonald



Problem statement: background of studies on ELs and mathematics

- ELs are **underrepresented** in STEM-oriented fields.
- **Multisemiotic** nature of mathematics and its **register**.
- Interdependent relationship between **mathematics** and **language**.
- “Typical” experiences/English language proficiency may limit access to developing Algebraic concepts in mathematics.

Focus on mental reversibility: inversion and compensation tasks

Mental reversibility: individual's underlying mental actions that allow a person to understand the relationship of an action and its effect. Relying on mental reversibility:

- Individuals can describe operatively **inverse relationships** (whereby one operation undoes the effect of another, e.g. $4+x=7$ and $7-4=x$);
- Individuals can describe **compensation relationships** between numbers (whereby an operation returns to an equivalent state, e.g. $x+4-4=7-4$).

“Recognizing that **addition and subtraction can undo each other** has even been taken as evidence that a child is capable of reversing a mental action (reversibility), **a defining characteristic of operational (truly logical) thinking**” (as cited by Baroody & Lai, 2007, p. 132).

Inversion Task Example:

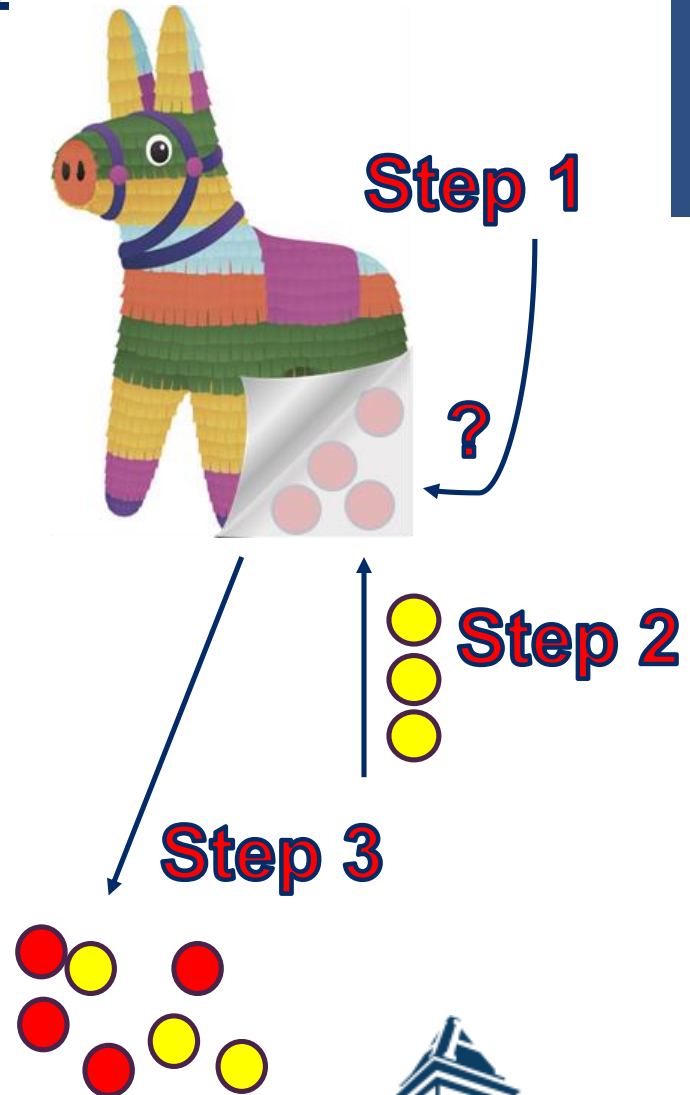
Piñata Task:

1 “I’m gonna put some candy in the piñata.

2 Later, I put 3 more pieces of candy in the piñata.

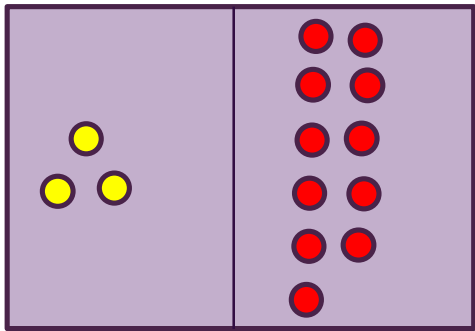
3 Then we hit the piñata. Whack! And 7 pieces of candy fell out.

How many pieces of candy did I put in at the beginning?”

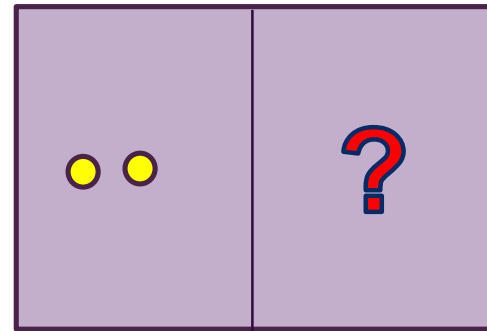


Compensation Task Example:

Your cupcake tray



My cupcake tray

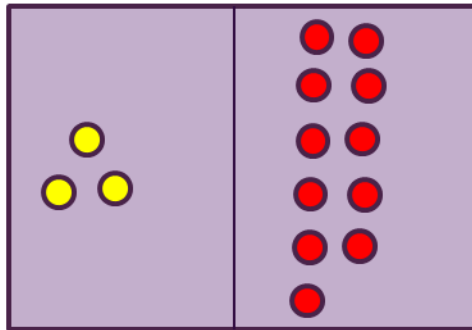


“How many cupcakes can we put in my empty slot, to make it so that we have the same number of cupcakes? “



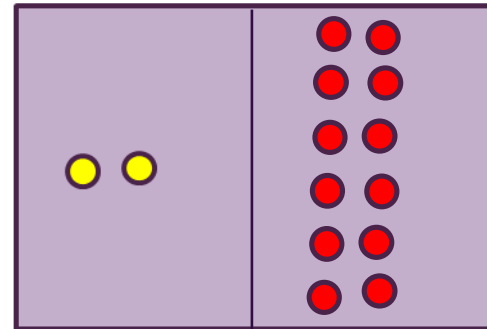
What is the Same???

Your cupcake tray

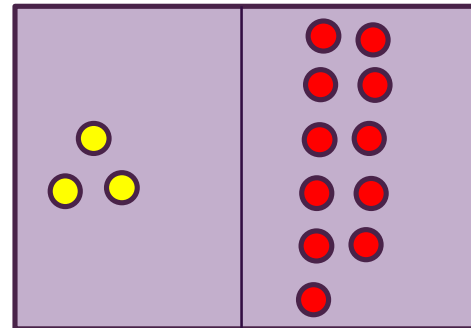
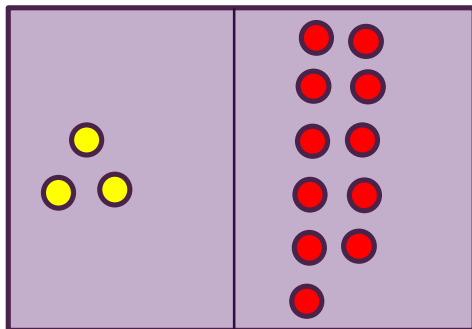


?
=

My cupcake tray



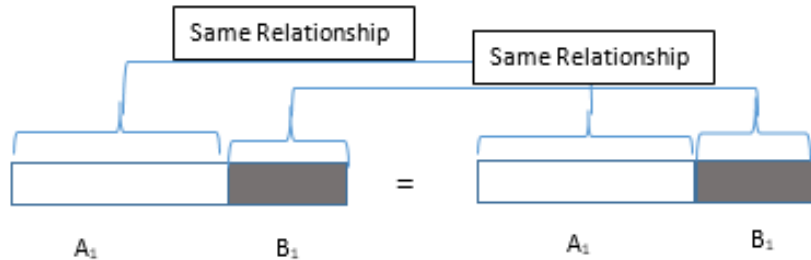
?
=



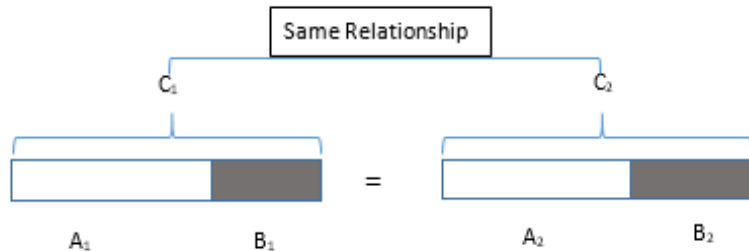
Compensation Strategy Development

Slide
7 of 16

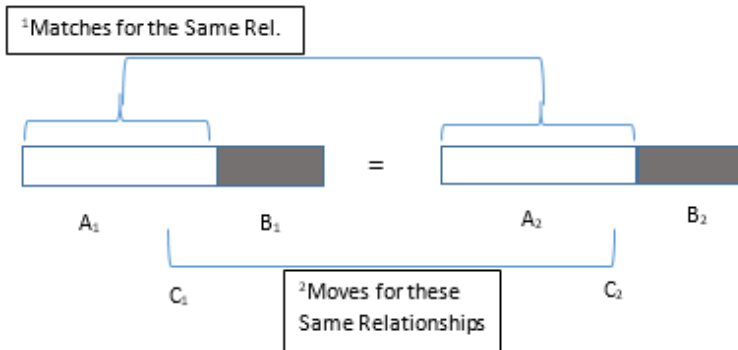
Match Strategy:



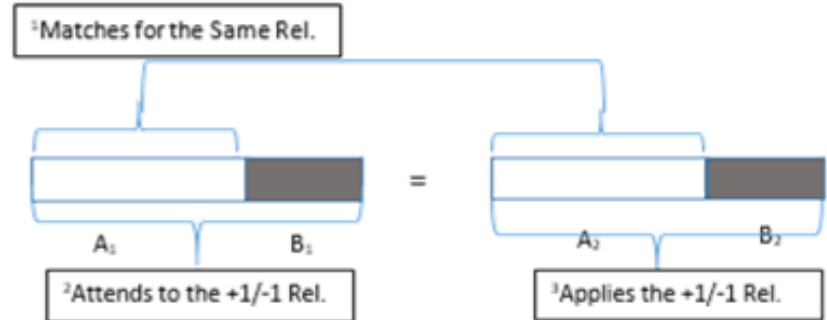
Counting Totals Strategy:



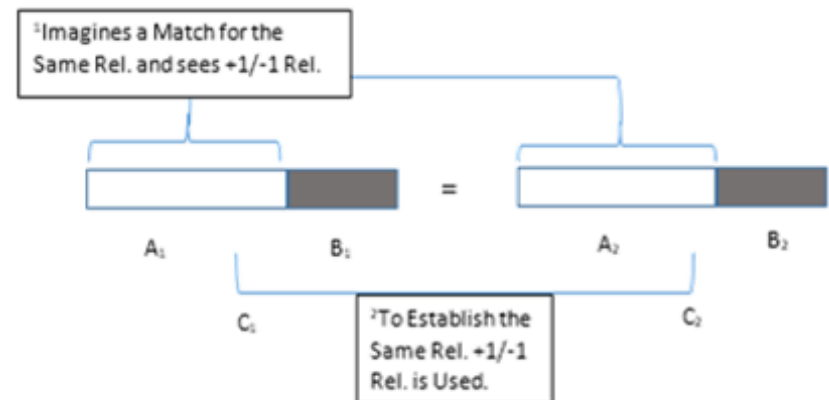
Match and Move Strategy:



Count-Match Strategy:



Imagined Match and Move Strategy:



Study setting and methodology: background of the study

- Larger inquiry-based intervention to promote children's construction of mental reversibility. Participants: 11 students, K-2, in the West Mountain Region of the U.S.
- Proceeding from the larger study, we focused on 7 of the 11 students, as they identified as being **ELs**:
 - How **culturally embedded mathematics perception** and English language proficiency levels interplay with children ability to solve inversion and compensation mathematics tasks.
 - How **educators can facilitate** the development of algebraic reasoning and address individual differences of ELs.
- Methods: case study; participant observation, field notes, students' interviews, and TEMA-3 scores; conceptual and retrospective analysis.

Culturally Responsive Teachers:

Connect mathematical concepts by connecting contexts with students' experiences and cultures

Teacher-Researcher: Remember how rocket ships count off? How they count backwards like that?

Allen: [shakes his head to indicate he does not understand]

Teacher-Researcher: Like three-two-one blast off!

Allen: [nodding].

Teacher-Researcher: Yah? Can you do that when you start at ten for me?

Allen: [seems disengaged, he plays with his chair and seems not to understand what he has been asked to do].

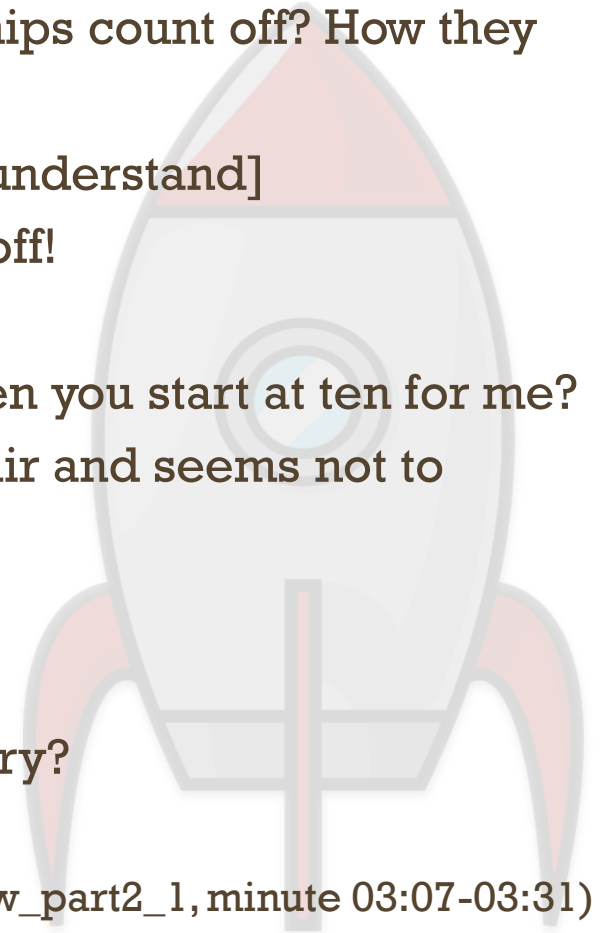
Teacher-Researcher: Like ten, nine, ...

Allen: I can't do.

Teacher-Researcher: you can do that; can you try?

Allen: Nope!

(Student's interview, PRE_03ScreeningInterview_part2_1, minute 03:07-03:31)



Story problems: the “cupcake tray” with Georgia

■ Part One:

- a. Cultural reference: cupcakes trays contain 12 cupcakes.

■ Part Two:

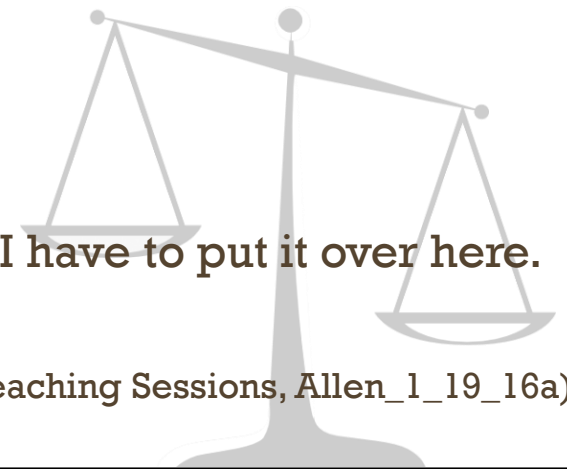
- a. Conscious use of language when asking questions: similar vs. the same.
- b. Use of simpler instructions: “Do we have the same number of cupcakes?” “How many should you have **altogether** (vs. all together).”

■ Part Three:

- a. “How can I make mine the same as yours?”

“Balance scale” activity with Allen under culturally relevant pedagogy lens

- Part One:
 - a. Cultural reference: unfamiliar with balance scale
- Part Two:
 - a. “What do I need here to make it balanced?”
 - b. “Which one is more?”
 - c. “Which one has more?”
- Part Three:
 - a. “We matched these two. They would be equal, wouldn’t they?”
 - b. “Take one away”
- Part Four:
 - a. “So you want to take one off”
 - b. “It goes one away with that”
 - c. “If I take one away, I can’t take it off altogether. I have to put it over here. It is my only way of doing it”

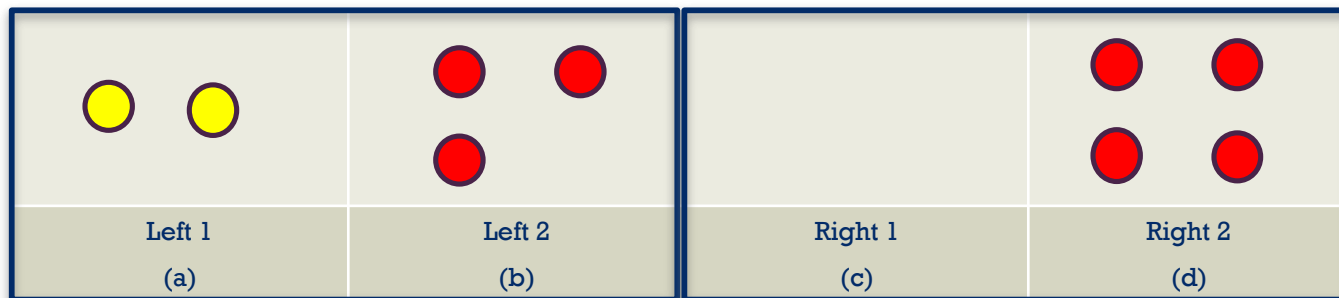


(Teaching Sessions, Allen_1_19_16a)

Language register: Phrasal Verbs

Phrasal verbs: one verb + one preposition.

- Phrasal verbs are one of the most complex elements of the English language for ELs



Teacher-Researcher: No. So, what can we do to make these two equal?

Allen: Take one off. Take one away... [Indicating d]

Teacher-Researcher: Ok, well let me tell you this, watch. If I take one away, I can't take it off *altogether* I have to put it over here. [Indicating c] Now, are these two matched?

Allen: [shakes head to indicate “no”]

Mathematics register: Vocabulary

Language features that influenced mathematics development are: **Vocabulary** (35%), **Syntax** (33%); **Culture** (31%)

- Take home message: teachers should be **linguistically responsive** by considering the language of instruction (e.g., use of phrasal verbs, vocabulary, sentence structure, questions used in mathematical tasks).

(Allen&Becka_3_22_16a, minutes 08:09-08:27)

Language and Cultural Changes

BEFORE

- Vocabulary: turn it around, balanced/equal.

Build
Up

AFTER

- Vocabulary: rotate, the same number.
- Syntax: use of cognates from Spanish (e.g., remove, cancel).

- Syntax: use of phrasal verbs (e.g., take off, take away)

Adapt

- Linguistically responsive approach to mathematics: use “you language.”

- Cultural reference: rocket ship.

Replace

- Culturally Responsive: piñata, cupcake trays.

What teachers should do to help ELs

Linguistically Responsive

Language

- Use “you language”.
- Limit the use of phrasal verbs and choose other more **descriptive vocabulary** (e.g., remove, delete, cancel, add, subtract, rotate).
- Ask students to explain their thinking with their own words.
- Limit or explain when words can be used as **synonyms** (e.g., equal/matched/balanced don't have the same meaning)

Culturally Responsive

Context

- Structure story problems on **culturally relevant materials** (e.g., piñata).
- Incorporate **students personal experiences** (e.g., cupcakes).
- Support uncommon children experiences with **visual aids** (e.g. balance scale, rocket ship).
- Know your students socio-cultural background. **Knowledge is not static**, and for this reason must be viewed critically.

Thank you!!!

Marialuisa Di Stefano, Ph.D.
marialuisa.distefano@aggie
mail.usu.edu

Kristy Litster, M.S.
chemile@hotmail.com

Beth L. MacDonald, Ph.D.
beth.macdonald@usu.edu

*“Teaching kids
to count is fine,
but teaching
them what
counts is best.”*

-Bob Talbert

