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INVITED

How English Learners Understand and Solve CAHSEE Algebra Problems

Being able to understand a mathematics problem is the first step towards solving it; however, very little is known about how English learners (ELs) in grades six through twelve individually engage with algebra tasks written in English.

Over one-third of the California High School Exit Exam-Mathematics (CAHSEE-M) is algebra. Between 2003 and 2008, CAHSEE-M pass rates for ELs ranged between 35% and 50%. Since all California students must pass the CAHSEE-M and an Algebra I course to graduate high school, these two requirements likely stop many of California's 600,000 secondary ELs from earning their diplomas and advancing to higher education.

We conducted an exploratory study examining how Spanish-speaking, secondary ELs engaged with CAHSEE-M algebra items in multiple choice and non-multiple choice formats.

Findings from this study can help task writers, curriculum developers, and secondary mathematics teachers and teacher-educators better understand how secondary ELs understand and solve written CAHSEE-M algebra items.

How The Study Was Conducted

Our study included 23 California ELs in grades nine through eleven, with English proficiency levels ranging from beginning to intermediate. We used word problems with specific types of lexical information. Two items, *Computer Consultant* and *Electric Bill*, required the reading and interpreting of continuous and discrete graphs to understand the linear relationship between two related numerical quantities. The other two items, *Apple Orchard* and *Books*, required the reading and multi-step manipulation of two to three related numeric and variable quantities to generate the sought after numeric or variable expressions.

There were two versions of each item: multiple choice and non-multiple choice. The research design called for each participant to work on two multiple choice items and two non-multiple choice items. Therefore, for each item,

some participants worked on the multiple choice version, while others engaged with the non-multiple choice version.

Following CAHSEE-M's administration guidelines, participants worked on the mathematics items in English individually, silently, and without a time limit. For each item, students recorded their work and answer.

In our follow-up interviews, participants were asked to do the following:

- explain why they chose their answer;
- read the item out loud and identify words and representations whose meanings were confusing or unknown;
- share employed reading comprehension and problem solving strategies; and,
- respond to follow-up questions about the item's key mathematical ideas.

Then, without confirming the veracity of their answer choice or their understanding of the item and the mathematics involved, the researcher provided the exact same item in Spanish. Participants immediately engaged with the Spanish version.

Seeing an Algebra Item Through EL Eyes

To better understand the overall results, we can examine EL engagement with the *Books* problem.

For example:

At the local bookstore, books that normally cost b dollars are on sale for 10 dollars off the normal price. How many dollars does it cost to buy 3 books on sale?

The students were asked to choose either:

- (a) $3b - 10$
- (b) $3b + 10$
- (c) $3(b - 10)$
- (d) $3(b + 10)$

The correct answer to the *Books* problem is (c): three times the sale price of the book (normal cost b) minus 10

dollars). Yet, ten of 14 EL respondents chose answer (d). For the non-multiple choice version, seven of nine ELs generated “30” as the answer. These responses derive from how participants interpreted the item.

Though nearly all of the ELs understood that three books were being purchased, “*books that normally cost b dollars are on sale for 10 dollars off the normal price*” was confusing, due to contextual prepositions, modifiers, and variables.

In terms of specific vocabulary, participants reported that *on sale*, *normally*, and *off the normal price* were the most troublesome. *On sale for* was often translated to mean “sold for”; *normally cost* was not interpreted as “price before the sale starts”; and *off the normal price* did not mean “sale price” to them.

Further, the book’s variable cost was conceptually difficult because in their experience, books typically have numerical costs, such as \$5 or \$20, not \$ b . Not knowing the actual cost of one book, and not being comfortable with b representing a range of possible book costs, made it difficult to identify and generate the variable expression price for the three books on sale.

Even after re-reading the problem several times, these language-mathematics interactions led many ELs to ignore the b and decide that one book costs \$10, so three books cost \$30. Their proportional thinking led them to choose answer (d)—the only answer representing 3 times 10 (using the distributive property)—or write “30.” Despite not fully understanding the item, ELs used sound logic to determine reasonable, but incorrect, answers.

When the 10 ELs who chose answer (d) were given the same item in Spanish, their confidence rose immediately. After reading the problem out loud faster, and with a stronger voice, they understood the context and what was being asked. However, understanding which of the four different algebraic expressions represented the cost of the three books on sale was so challenging that only two of the ten students chose and appropriately justified the correct answer.

The low EL success rate on the *Books* problem, even when presented in Spanish, was disappointing despite the item’s combined language and mathematics demands. However, improved item comprehension did enhance their problem solving self-efficacy, a factor shown in academic motivation research to improve academic achievement.

Conclusion

In summary, we propose that more effective teaching strategies to facilitate students’ learning of algebraic concepts

and academic language can be developed if educators better understand how ELs interpret and solve algebra problems. Stakeholder groups can then help California’s ELs raise their CAHSEE-M passing rates, lower their high school dropout rates, and graduate from high school in greater numbers by addressing their mathematics and language needs.

—**Carl Lager, Cassandra Ruffo,
and Madalyn K. Gordon**

This report summarizes a larger research study supported by a University of California Santa Barbara 2008-09 Faculty Career Development Award.

For more information on this study go to (www.HuertodeManzanas.com) and click on the “CAHSEE Study” tab.

Research Grants Awarded

Due to rapidly changing financial circumstances, the UC LMRI Faculty Steering Committee restructured the criteria for the February 2009 Grant Call and ultimately awarded “mini-grants” to five Dissertation Research Grant applicants. Those awarded will receive \$8,000 each. All grantees from this competition must spend their awards in the current fiscal year, ending June 30, 2009.

The awards went to :

- **Jeanie Nam, UC Riverside**

Grant #09-09CY-05DG-R

An Examination of the Predictive Validity of Early Literacy Measures for Korean English Language Learners

- **Jennifer Sun, UC Riverside**

Grant #09-09CY-06DG-R

Examining the Concurrent Validity of Fluency-Based Literacy Measures and Standardized Reading Assessments with Chinese English Language Learners

- **Thao Duong, UC Berkeley**

Grant #09-09CY-02DG-B

Pathways to Oral and Written English Language Competence for Young Vietnamese and Spanish Language Learners

- **Shivani Burrows-Goodwill, UC San Diego**
Grant #09-09CY-01DG-SD

Activity setting for out-of-school literacy: Examining the bilingual funds of literacy among the Spanish-speaking families and communities of young English learners

- **Brianne Davila, UC Santa Barbara**
Grant# 09-09CY-03DG-SB

Negotiating “Special” Identities: Structure and Agency in Special Education

Also awarded was \$10,000 to **Michael Orosco, UC Riverside**, for a reduced Individual Research Grant (#09-09CY-02IG-R, Dynamic Strategic Math).

is currently restructuring funding for all of its Multi-Campus Research Units (MRUs), UC LMRI will cease operations at UCSB as of June 30, 2009.

As of press time, it was currently unclear whether funding for UC LMRI will continue at another UC campus. Arrangements have been made to continue hosting the UC LMRI website beyond June 30, so the wealth of resources available there will still be accessible to the public.

Our sincere thanks to everyone over the years who contributed to UC LMRI’s success while at UCSB. We are grateful to have been able to provide twenty-five years of leadership in identifying emerging and under-researched issues in the education of English language learners.

UC LMRI To Cease Operations at Santa Barbara Headquarters

UC LMRI has been headquartered at UC Santa Barbara (UCSB) since its inception in 1984; however, because the University of California’s Office of the President (UCOP)

THANKS!

Gallery of UC LMRI Staff, Students, and Conference Personnel

Over the course of twenty-two annual conferences, UC LMRI has had the good fortune to have had many dedicated staff members, including undergraduate and graduate students, who worked many long hours to see that the conferences were truly a success for all who participated. Putting on a conference takes a lot of effort and enthusiasm, and UC LMRI’s various conference team members through the years always managed to get rave reviews.



The UC LMRI Faculty Steering Committee

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Gallery of UC LMRI's Directors

(*Not pictured: Henry Trueba)



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Joseph Castro



Aida Hurtado



Laura Sterponi



Carmen Portillo



Jamal Abedi



UC LMRI's 22nd Annual Conference • May 1 - 2, 2009 Mission Inn • Riverside, CA

UC LMRI's 2009 annual conference, co-sponsored by UC Riverside's School of Education, was a great success, like so many of LMRI's conferences in the past. We have received many requests for copies of presenters' papers and we hope to make them available to academicians, practitioners, and policy makers in a book under the editorial guidance of UC LMRI Faculty Steering Committee member **Robin Scarcella**, Professor at UC Irvine (*rcscarce@uci.edu*).

To help celebrate the 25th anniversary of UC LMRI, we have posted a selection of pictures from past conferences. Enjoy!

Preparing 'Highly Qualified' Teachers of English Learners

Friday, May 1, 2009

Keynote Speaker



Aida Walqui

*The "Highly Qualified Teacher"
and the Reality of Teaching English Learners*



Richard Duran

Saturday, May 2, 2009

Featured Presentation by distinguished panel of past UC LMRI Directors:

Richard Duran, Reynaldo Macias, and Russell Rumberger

*25 Years of Research
on English Language Learners*



LMRI FORMER DIRECTORS



Dean Steven Rumberger



ROBERTA FERRER

ROSELO CHAVEZ

ROSELO CHAVEZ

co-sponsored by:



A Selection of UC LMRI Conference Presenters and Attendees: 1985-2009

1992 Conference: San Diego



1993 Conference: Santa Barbara



1996 Conference: Sacramento



1999: Sacramento



2000 CONFERENCE RIVERSIDE



1996 Conference: Sacramento



2000 Conference Riverside



1996: Sacramento



2002 Conference: Berkeley



LMRI Conference 1998



2001 Conference: Los Angeles



1996



1998 Conference: Santa Cruz



2005 Conference: San Francisco



2003 Conference: San Diego



UC LMRI Postdocs:
Julie Maxwell-Jolly and Jill Leafstedt



2002 Conference: Berkeley



2007: Arizona



1999: Sacramento



2007: Arizona



Message from the Director

It is with a little sadness but also excitement about the future, as I say farewell to my position at UC LMRI. *As we go to press with this newsletter we are unable to positively confirm the passing on of the Institute to UC Davis under the leadership of UC LMRI Faculty Steering Committee member Jamal Abedi.*

During the time that I've worked here, first for a year as Assistant Director and then as Interim Director for the past year, I have developed warm friendships with a talented group of scholars who conduct excellent work on the educational well-being of English learners.

Thank you to **Russ Rumberger** who gave me the opportunity to serve you; to the Faculty Steering Committee for their support and encouragement; to **Beverly Bavaro**, UC LMRI's Editor and Web Manager, for her guidance and problem-solving; and to **Elena Cruz**, for her commitment to organizing our 2009 annual conference. I'll take with me good memories of a rewarding experience in which I have grown personally and professionally. Best and sincerest wishes for the continued success of UC LMRI.

Please keep in touch through my UCSB Department of Education email address:

lromo@education.ucsb.edu.

Newsletter Production Team

Laura Romo..... Executive Editor
Beverly Bavaro..... Editor

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In alphabetical order:

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Reports in This Issue

Abstracts from UC LMRI Research Grant awards and from Final Grant Reports featured in the newsletter are edited for space considerations.

A searchable database of all UC LMRI-funded grants can be found on the UC LMRI website.

Back Issues: Newsletters from 1992 to the present are archived on the UC LMRI web site. A limited number of hard copies are available by request.

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