

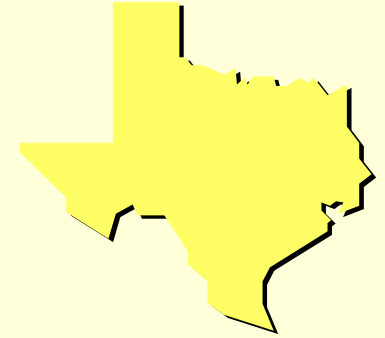
# Sul Ross State University

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## Mathematics Initiative for English Language Learners

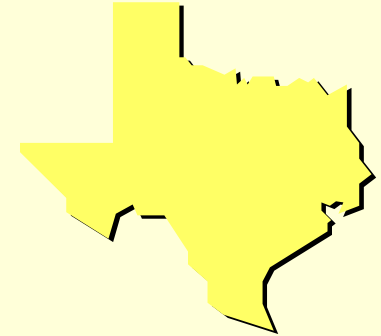
A search for Scientific-Based studies



## The Focus of our Literature Review:

### **SCIENTIFIC-BASED RESEARCH**

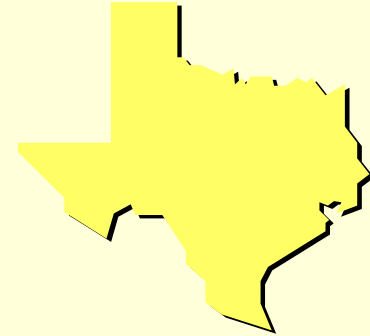
- Search of the existing literature data base
- Selected studies on effective methods for teaching mathematics to the English Language Learner (ELL)



## What are scientific studies?

❑ **QUANTITATIVE RESEARCH** - We included descriptive studies which established some relationship between variables and experimental studies which purported to establish causality.

❑ **QUALITATIVE RESEARCH** – Observational studies such as ethnographic and grounded theory studies performed by a competent independent researcher published (with verifiable data) were included.



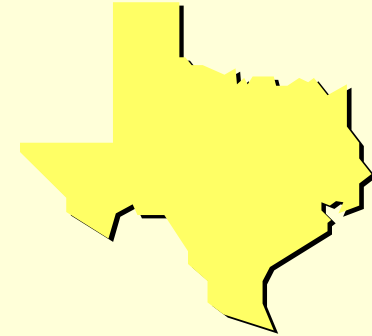
## **Size of Existing Data Base**

- Reviewed over 600 studies directly related to topic**
- Thousands of published articles (seemed like more)**
- Dozens of publish books**
- Hundreds of Web sites dedicated to subject**



## **Examples of “Scientific Based” Studies**

- ❑ Math Reform and English Language Learners**
  
- ❑ Bilingual Programs in Texas: A Multi-site Comparison**
  
- ❑ Testing Language and Math Scores of Bilingual Hispanic Students**
  
- ❑ Characteristics of a Dual-Language Program that is Meeting the Academic Needs of Linguistically Diverse Students**
  
- ❑ The Effects of English Immersion Mathematics Classes on the Math Achievement of Spanish Speaking LEP Students**



## More Examples

- The Effect of Dual Language Instruction on Academic Achievement as Measured by the SAT**
- The Effects of Text Format and Content on ESL Student's Ability to Solve Math Problems**
- Relative Language Dominance and Mathematical Problem-Solving Strategies in English and Spanish of High School Students**
- Responses to the Use of the Internet with a California Standards-Based Algebra Curriculum among Latino Students**



## **Examples of Published Articles**

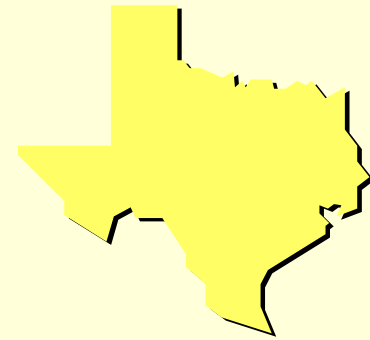
- Reforming Mathematics Instruction for ESL Literacy Students**
- The Astounding Effectiveness of Dual Language Education**
- A Meta-Analysis of the Effectiveness of Bilingual Education**
- The Effects of Sheltered Instruction on Achievement of...**
- Construyendo Puentes (Alvin ISD program results)**
- Teaching Math to English Language Learners**



## Examples of Web Sites

- ELL Subcommittee Annual Progress Report (NY)**
- Bilingual Accommodations for LEP Students**
- Principals Annual ELL Report (CA)**
- CREDE Educational Practices Report**
- CA Education Report Card: Stanford 9 (multi-year)**
- Math Instruction in bilingual Classrooms**
- ELL Report (MN)**

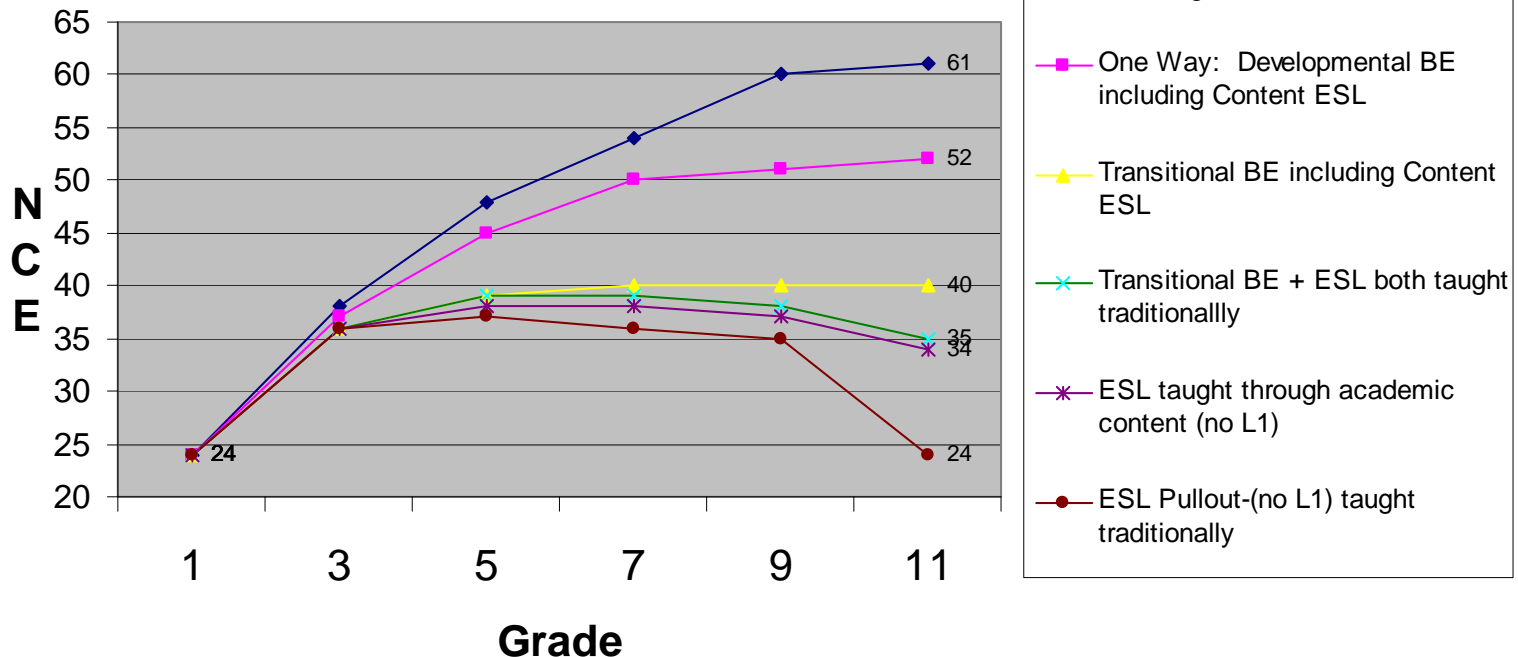




## Example of Data from Studies

### English Learners=Long-Term K-12 Achievement in Normal Curve Equivalents (NCEs)

(Results aggregated from a series of longitudinal studies of well-implemented, mature programs in five school districts from 1998-2000.)



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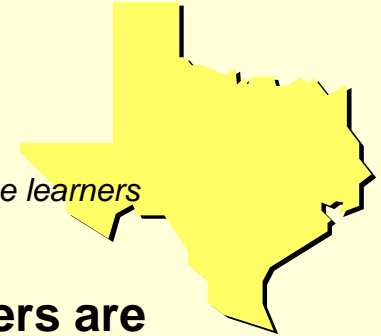
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## Report on Selected Literature Relevant to MELL

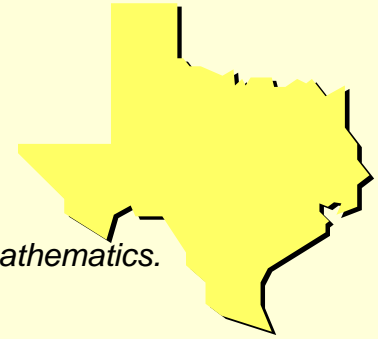
Jessica Portillo



Abedi, J., & Dietel, R. (2004) *Challenges in no child left behind act for English language learners*  
CRESST Policy Brief No. 7

**Assert that the challenges for English language learners are especially difficult and include both educational and technical issues:**

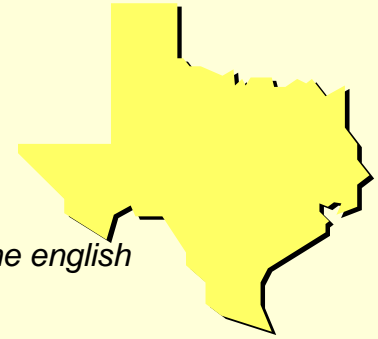
- **Historically low ELL performance and slow improvement**
  - lower than many other subgroups.
- **Measurement accuracy**
  - test measures of two skills—subject and language.
- **Instability of the ELL student subgroup**
  - reclassified and the ELL subgroup scores tend to drop
  - continuous in-flow of ELL students
- **Factors outside of a school's control**
  - parent education level
  - family's socioeconomic status



**Schwartz, W. (1991).** *Teaching limited english proficient students to understand and use mathematics.* ERIC DIGEST No. 70 (ED334310)

## Described Two math instruction programs that hold promise for LEP students.

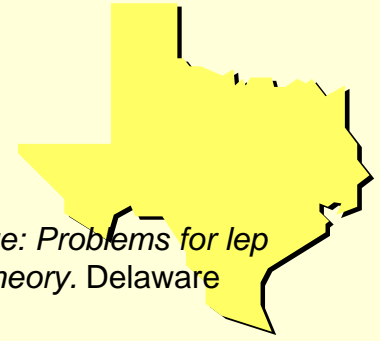
- **Active Mathematics Teaching (ATM):** direct instruction, highly structured information, for beginning students. Emphasis on language of mathematics.
- **Cognitively Guided Instruction (CGI):** focuses on thought process, students express themselves in the language they can use most comfortably. In doing so, the student's English language fluency is expected to increase.



Crandall J., Dale, T., Rhodes, N., & Spanos, G. (1985). *The language of mathematics: The english barrier.*

**Defined the critical factor in ELL student success in mathematics—the language of mathematics.**

- **the role of language is ubiquitous**
  - **medium by which teachers convey knowledge**
  - **texts and problems are read and solved**
  - **math achievement is measured.**
- reading to comprehend mathematics texts and word problems
  - listening to understand and follow an instructor's presentation



**Kessler S., Quinn, M., & Hayes, C. (1985).** *Processing mathematics in a second language: Problems for lep children.* In a. Labarca and L. Bailey (Eds.), *Issues in L2: Theory as practice, practice as theory.* Delaware Symposium on Language Studies 1985, 151 – 163.

## **Established relationship among mathematics, language, and second-language acquisition.**

- **the nature of mathematical performance**
- **mathematics as a facilitator of second-language development**
- **problems that mathematics pose for ESL students**
- **the language of mathematics**

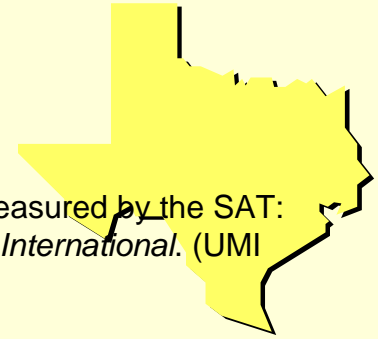


**Kessler S., Quinn, M., & Hayes, C. (1985).** *Processing mathematics in a second language: Problems for lep children.* In a. Labarca and L. Bailey (Eds.), *Issues in L2: Theory as practice, practice as theory.* Delaware Symposium on Language Studies 1985, 151 – 163.

**Processing mathematics successfully rests on the ability to utilize very precise language of mathematics in doing mathematical reasoning.**

- **context reduced language of mathematics**
- **extensive use of logical connectors**
- **specialized vocabulary and syntactical structures**
- **appropriate discourse rules**

**All present a complex set of problems for LEP children engaged in mathematics discourse (p.152).**

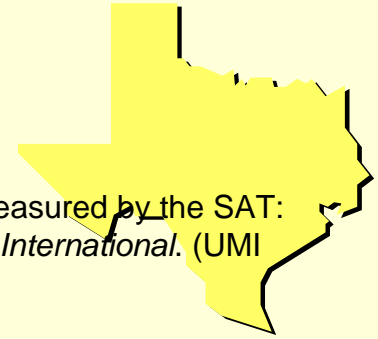


**Conde, C. (1998).** The effect of dual language instruction on academic achievement as measured by the SAT: An evaluation of the “International Studies Program” of Miami. *Dissertation Abstracts International*. (UMI No. 9903323).

**Study examined effect of dual language program on standardized testing in a second language. Investigated how students’ academic achievement in content areas is impacted by second language only instruction. The researcher used two groups of third grade students who:**

- (1) received content instruction in two languages – English and Spanish
- (2) received content instruction in English only.

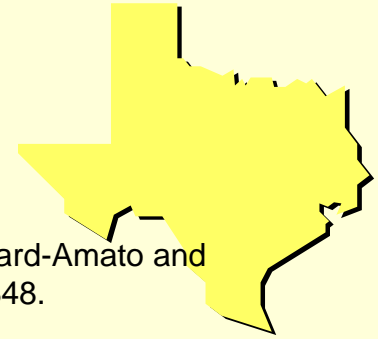




**Conde, C. (1998).** The effect of dual language instruction on academic achievement as measured by the SAT: An evaluation of the “International Studies Program” of Miami. *Dissertation Abstracts International*. (UMI No. 9903323).

**Results of the Conde study over a four-year period revealed a significant difference in performance between the students who received instruction in two language and those who received instruction in English only.**

- participants in Dual Language programs scored as well or better than English only students on the math application section of the SAT.
- participants in Dual Language programs scored as well or better than English only students on the math computation section of the SAT.
- participants in Dual Language programs scored as well or better than English only students on the reading portion of the SAT.



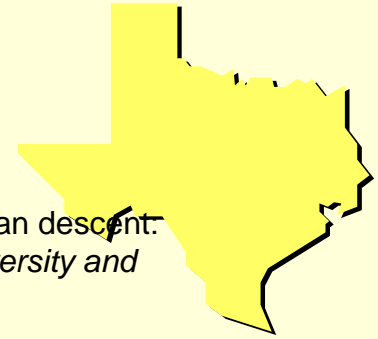
Dale, T., & Cuevas, G. (1992). Integrating mathematics and language learning. In P. Richard-Amato and M. Snow (Eds.), *the Multicultural Classroom*. White Plains, NY: Longman Publishing 330-348.

**Provides content area teachers with a working knowledge of the challenge of teaching second language learners mathematics and the strategies and techniques to make that teaching effective.**

• **mathematics is a language and has a “register”**

A subset of language composed of meanings appropriate to the communication of mathematical ideas together with the terms or vocabulary used in expressing these ideas and the structures or sentences in which these terms appear. A “Register” includes:

- **unique vocabulary**
- **syntax (sentence structure)**
- **semantic properties (truth conditions)**
- **discourse (text) features.**



Henderson, R., & Landesman, E. (1992). Mathematics and middle school students of Mexican descent: The effects of thematically integrated instruction. *National Center for Research on Cultural diversity and Second Language Acquisition*. Retrieved from [www.nclear.gwu.edu/pubs/nrcrds11/rr5.htm](http://www.nclear.gwu.edu/pubs/nrcrds11/rr5.htm)

## **Reported the effects of thematically integrated mathematics instruction on achievement, attitudes, and motivation in mathematics among middle school students of Mexican descent.**

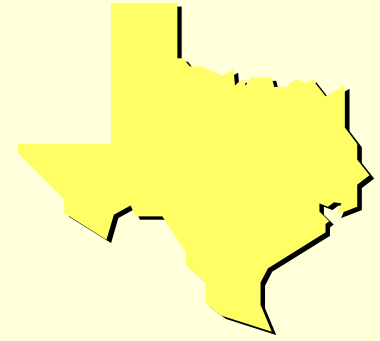
### •Thematic instruction

- provides an effective way to contextualize instruction
- incorporates a concrete learning-by-doing orientation
- has the potential to facilitate cooperative and interactive learning

### •cooperative learning provides

- opportunities for hands-on activities
- mental activities and active problem solving

**These features have been identified as characteristics of classrooms that have proved effective for Hispanic students with limited English proficiency.**



## Other Literature Related to MELL:

**Mather and Chiodo (1994)** noted that it is important to evaluate the methods teachers are using to teach students in general and to evaluate the methods used in the process of teaching mathematics in particular. To decide which methods to use, the authors question whether or not an understanding of English is needed to understand and acquire mathematics skills.

**Moschkovich (2002)** explores three perspectives on bilingual mathematics learners. She asserts that research needs to address the relation between language and mathematics learning from a perspective that combines current perspectives of mathematics learning with current perspectives of language, bilingualism, and classroom discourse.

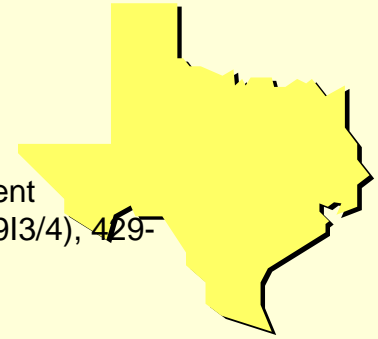
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**Report on Selected Studies  
Relevant to MELL**

Dr. Jo Lynn Suell



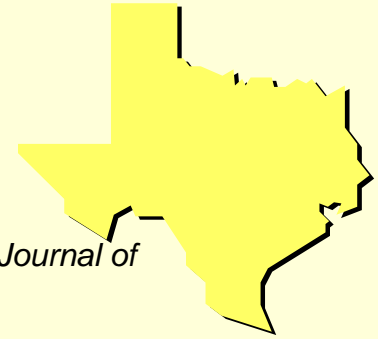
**Hewlett-Gomez, M., & Solis, A. (1995).** Dual language instructional design for educating recent immigrant secondary students on the texas-mexico border. *The Bilingual research Journal*, 19(3/4), 429-452

**Reported on the *Literacy Program for Recent Immigrant Students*, an English/Spanish program of instruction for recently immigrated secondary students located in a south Texas school district. This program was utilized in two middle school campuses serving grades 6, 7, and 8.**

### **Five features of the program are:**

- sensitivity to students with the most limited English skills and mainstream experiences,
- instruction in two languages
- comprehensive instruction in listening, speaking, reading, and writing
- Instruction in language and content
- incorporation of student's cultural experiences into the curriculum

**The program also stressed parental involvement.**

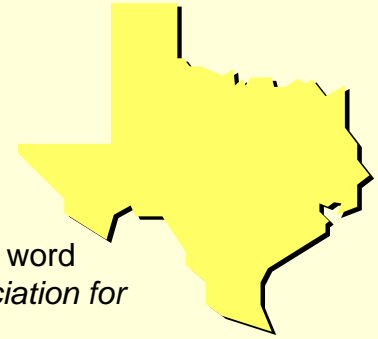


Reyes, P., & Fletcher, C. (2003). Successful migrant students: The case of mathematics. *Journal of Curriculum and Supervision*, 18(4), 306-333.

- **Cited the lack of literature on effective methods for teaching mathematics to migrant students**
- **Conducted a qualitative study of six highly successful school districts (four in Texas, one in Illinois, and one in Montana) who had met with success in educating migrant students.**

### **Identified major themes**

- (1) a workplace culture focused on instructional improvement
- (2) respect for all students
- (3) student centered instruction
- (4) a spiraling curriculum that emphasized constant review



**Leon, R. (1994).** The effects of the presence of extraneous information in the mathematical word problems on the performance of hispanic learning disabled students. *New York State Association for bilingual Education*, 9, 15-26.

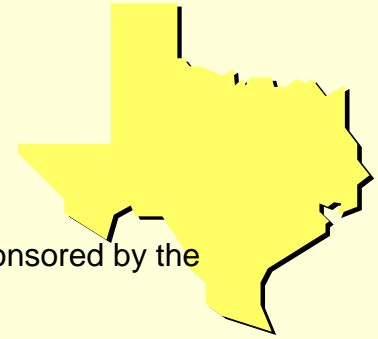
**To set up the study, two sets of mathematical word problems were developed incorporating addition and subtraction with extraneous wording and without extraneous wording.**

### **Results of the study showed**

- students had difficulties in discriminating between essential from non-essential information
- majority of the students knew how to execute the arithmetic computations but they did not know how to apply them to mathematical word problem-solving solutions.

**The building of mathematics concepts and vocabulary is crucial; therefore, both should be somehow related to the experiences the child brings into the classroom.**



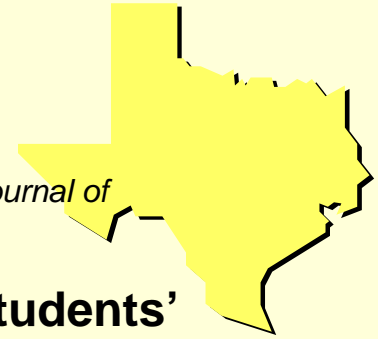


**Greene, J. (1998).** *A meta-analysis of the effectiveness of bilingual education.* A Report sponsored by the Tomas Rivera Policy Institute.

**A meta-analysis on the effectiveness of bilingual education found that children with limited English proficiency who are taught using at least some of their native language perform significantly better on standardized tests than similar children who are taught only in English.**

- limited number of studies
- did not identify ideal amount of native language that should be used
- did not identify age groups in which these techniques are most appropriate.

**The author notes cautiously, “It is possible that the individual needs of students are so varied that there may be no simple set of ideal policies.”**



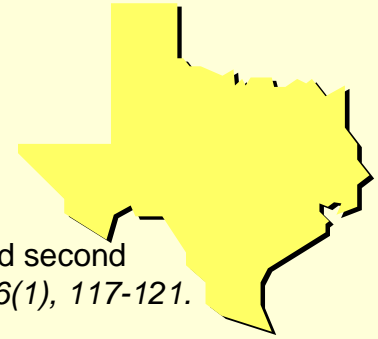
**Bernardo, A. (2002).** Language and mathematical problem solving among bilinguals. *The Journal of Psychology*. 136(3) 282-297

**A study to determine whether Filipino-English bilingual students' understanding and solving of word problems in arithmetic differed when the problems were in the students' first and second languages.**

### **The results of the study revealed**

- students with Filipino as a first language got more problems in Filipino correct than in English
- students with English as a first language got more problems in English correct than in Filipino
- arithmetic problem solving of bilingual students was poorer with word problems in both the first and second languages compared with the same problems presented in a purely numerical form.

**Bilingual students seem to be more effective when the problem to be solved is presented in the first language rather than the second language.**

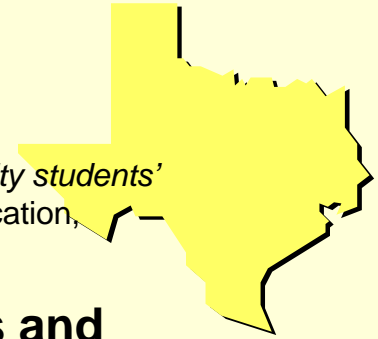


**Bernardo and Calleja (2005).** The effects of stating a problem in bilingual students' first and second languages on solving mathematical word problems. *The Journal of Genetic Psychology*, 166(1), 117-121.

**Explored the effects of stating the word problems either in the first or second language of bilingual problem solvers on how they would solve word problems that required the application of real world constraints.** (follow-up to previous study)

## **The results showed**

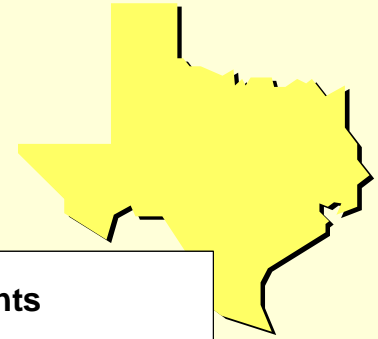
- Students were more successful in applying the appropriate arithmetic procedures with problems written in Filipino than in English even though mathematics was taught in English.
- Including English language texts, readings, and word problems!



**Thomas, W. & Collier, V. (2002).** *A national study of school effectiveness for language minority students' long-term academic achievement (CREDE Research Brief # 10)* Center for Research on Education, Diversity and Excellence.

**Fourteen years of research on language minority students and their academic achievement. The study collected data from five school districts across the US and attempted to understand how effective were various programs serving language minority students. Four distinct theoretical program designs were included:**

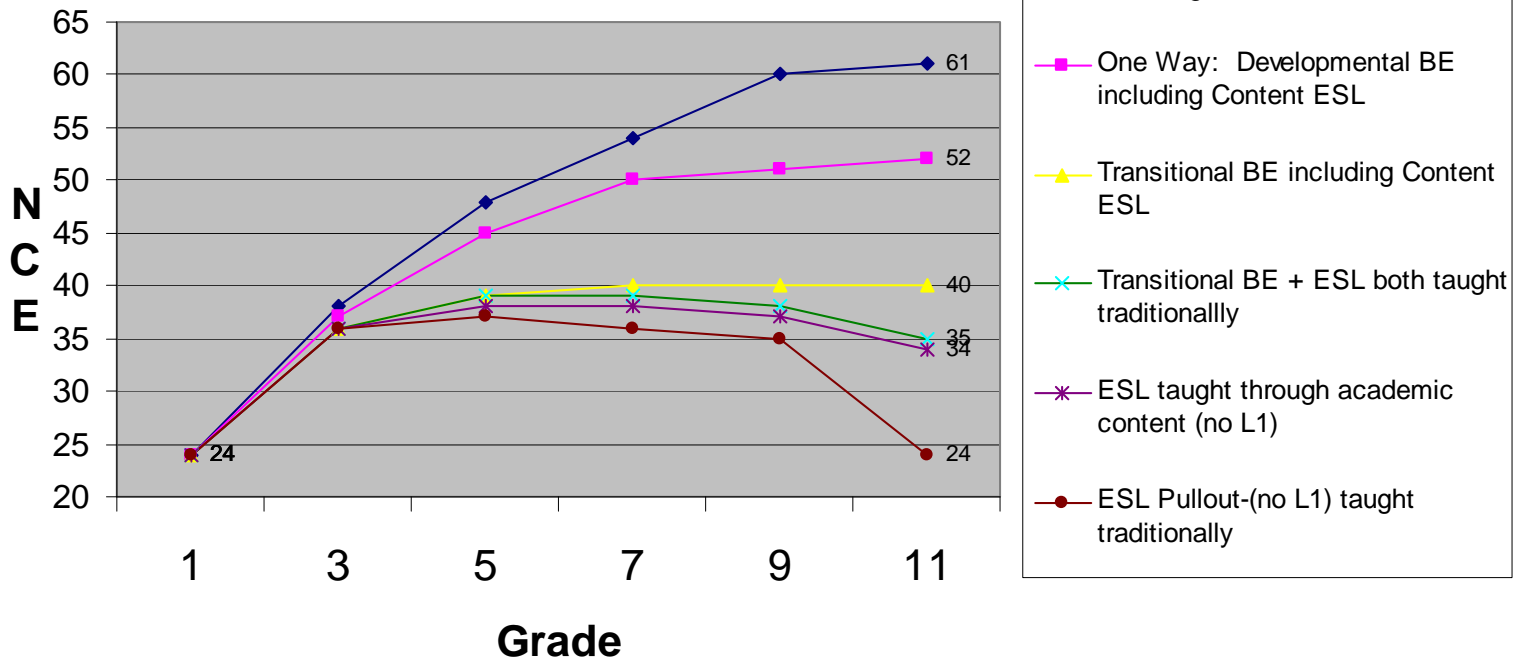
- **Two-Way Bilingual Immersion programs:** these promote academic achievement, bilingualism, and bi-literacy for ELLs and native English speakers and typically last for five to six years
- **One-Way Developmental Bilingual Education programs:** offer instruction only to language minority students of one language background (including ELLs) and typically last for five to six years,
- **Transitional Bilingual Education programs** offer classes presented in the ELLs native language for two to three years and then receive all English instruction
- **English as a Second Language programs for ELLs:** teach English to ELLs through academic content areas.



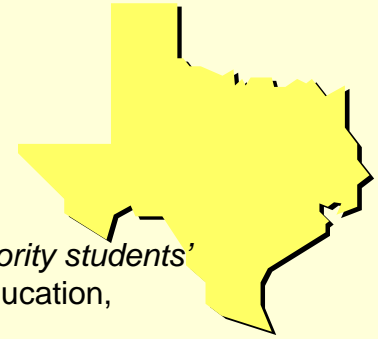
## English Learners=Long-Term K-12 Achievement in Normal Curve Equivalents

(NCEs)

(Results aggregated from a series of longitudinal studies of well-implemented, mature programs in five school districts from 1998-2000.)



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**Thomas, W. & Collier, V. (2002).** *A national study of school effectiveness for language minority students' long-term academic achievement (CREDE Research Brief # 10)* Center for Research on Education, Diversity and Excellence.

**Based on these findings, the authors propose that in order to close the average achievement gap between ELLs and native English speakers:**

- language support programs must be well implemented
- not segregated programs
- sustained for five to six years
- demonstrate achievement gains of more than the average yearly progress of the non-ELL group each year until the gap is closed.

**Problem: the achievement gap is a moving target since non-ELLs progress academically each year for their grade level, while ELLs typically fall further behind with each grade level.**

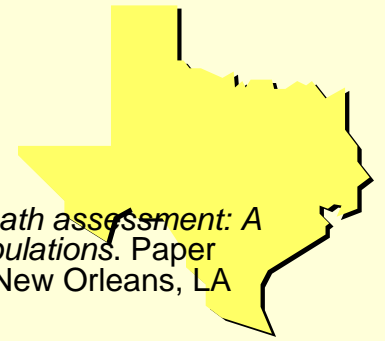


**Mahoney, K., Thompson, M., & MacSwan, J.** (2004). The Condition of English Language Learners in Arizona: 2004. In *The Condition of Pre-K-12 Education in Arizona: 2004*. Tempe, AZ: Arizona State University, Education Policy Studies Laboratory.

**Study investigated the effects the State of Arizona's Proposition 203 has had on English language learners since the passage of the bill. Proposition mandated the use of structured English immersion only.**

- ELL with negative change in English proficiency was 71%
  - ELL with positive change in English Proficiency was 29%
  - 89% failed to achieve oral English language proficiency in one year's time as promoted by Proposition 203.

**The data indicated that the majority of the students did not experience an increase in proficiency level and now run the risk of developing academic deficiencies in content areas.**



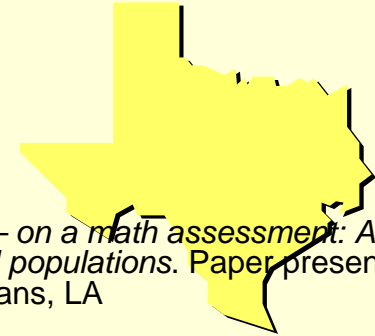
**Kiplinger, V.L., Haug, C.A., & Abedi, J.** (2000, April). *Measuring math – not reading – on a math assessment: A language accommodations study of English Language Learners and other special populations.* Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA

The Study evaluated math ability on a math test rather than reading ability. Through two accommodations - extra time and a glossary of non-mathematical terms. The present study was focused on elementary students, particularly the fifth grade students to be tested in Colorado's statewide assessment.

## Three separate mathematics tests

- (1) original English, no changes
- (2) simplified English, changes made to linguistic structures and non-mathematics vocabulary
- (3) original English with a glossary of non-mathematical vocabulary



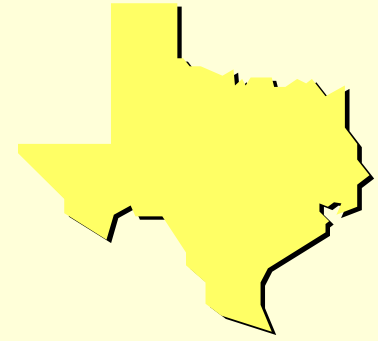


**Kiplinger, V.L., Haug, C.A., & Abedi, J.** (2000, April). *Measuring math – not reading – on a math assessment: A language accommodations study of English Language Learners and other special populations.* Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA

The results of that study indicated that the two accommodations had an impact on ELL and non-ELL student scores.

- Students performed better on the simplified English test than on the original English test.
- Students performed better on the original English with a glossary provided form than on the original English test.
- Students performed at the lowest achievement level on the original English test.

**Academic achievement for ELL students on a mathematics test is directly related to proficiency in reading English.**



## Findings in the Literature from these and other studies:

- There is a paucity of research specific to mathematics and ELL students
- Even in the literature present on mathematics and ELL students, the consensus is that content mastery and the principles of literacy are tied together—content and literacy go hand-in-hand
- Two-way dual language programs hold the most promise for all content delivery (see Thomas & Collier, 2002)
- The translation of word problems is universal (K-16), not just limited to ELL students in particular
- That mathematics has a natural language register and a formal content language register and the teaching of these registers is critical to student's understanding of math, beginning in the elementary school

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## Mathematics Initiative for English Language Learners

A search for Scientific-Based studies