Sul Ross State University

A Member of The Texas State University System

Mathematics and English Language Learners:

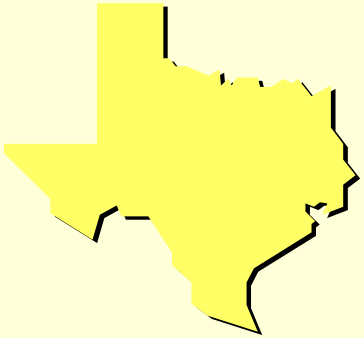
A Review of the Literature

Presented by:

Sam Roberson, Ed.D.
Assistant Professor
Department of Education

Jim Summerlin, Ed.D.
Assistant Professor
Department of Education

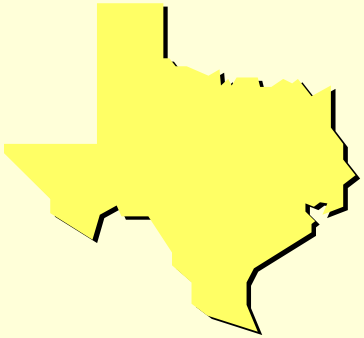
Sul Ross State University
A Member of The Texas State University System



Focus of Project:

- To review literature regarding ELL and the teaching of mathematics, particularly for secondary students
- The goal was to identify what has worked
- But, the number of research studies is minimal
- However, there is much discussion on the topic of ELL in general
- Refocus: *We know what's there. What's not there?*
- Set the this work within a greater context of ELL and pose suggestions for new directions for research and practice

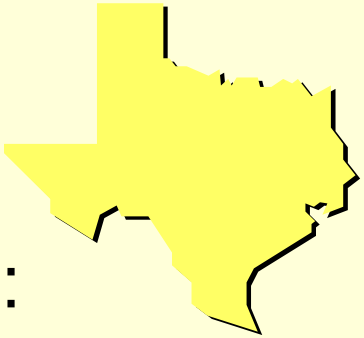
Sul Ross State University
A Member of The Texas State University System



Began with a wide net:

- Reviewed over 300 articles with any connection to “mathematics” and “ELL”
- Identified *studies*—with at least an identified sample and some specified program or procedure with “mathematics” and “ELL students” regardless of grade level
- Reviewed reports from established organizations, particularly as they serve bilingual, ELL, L2 acquisition populations
- Reviewed websites, e-documents, homepages of organizations and individuals regarding ELL research or practice
- Attended conferences on ELL students

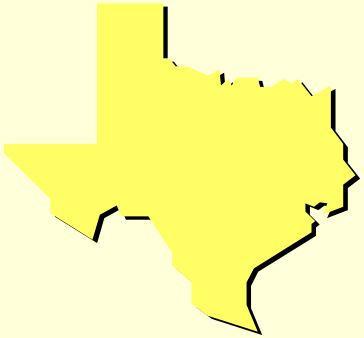
Sul Ross State University
A Member of The Texas State University System



Ended with a wider net than anticipated:

- Background of Latino/ELL students
- Challenges to Teaching ELL
- ERIC Digests Relating to MELL
- General Literature Related to MELL
- Qualitative Studies on MELL
- Quantitative Studies on MELL
- Literacy and ELL
- Ten Common Fallacies about Bilingual Education
- Dual Language Programs
- Sheltered Instruction Observation Protocol
- Instructional Conversations
- Standards for Professional Development in Effective Teaching of ELL
- Curriculum and Evaluation Standards for School Mathematics (NCTM)
- Issues Related to Mathematics Instruction
- Findings and Recommendations

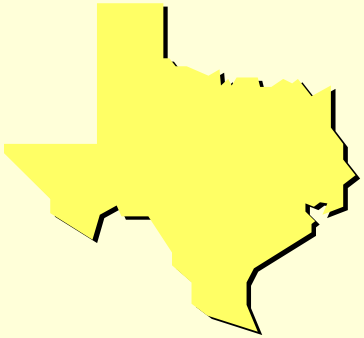
Sul Ross State University
A Member of The Texas State University System



General Statistics:

- *Latino* is a term that encompasses a multiracial, multinational, and diverse group in its educational and socioeconomic background; nationally the group is heterogeneous
- Despite signs of progress, educational outcomes for Latinos have not improved dramatically in the last 30 years. Latinos continue to have low academic achievement and the highest dropout rates in the nation, as well as low college preparatory course enrollment and post secondary attainment.
- According to NAEP, one third of Latino students perform below grade level. In the most recent NAEP results (NCES, 2003) only 11 percent of Latino eight graders scored at or above proficient in math, compared to 36 percent of white ninth graders. In reading, only 14 percent of Latino eighth graders scored at or above proficient, compared to 39 percent of white eight graders.
- Latinos have the highest dropout rates of any major ethnic group in the United States.
- One third of Latino students perform below grade level, which increases their chances of dropping out of school from 50 percent to 98 percent, depending on how far behind they are.
- Latinos tend to drop out earlier, between the eighth and tenth grades, than other students.

Sul Ross State University
A Member of The Texas State University System



Texas and LEP students:

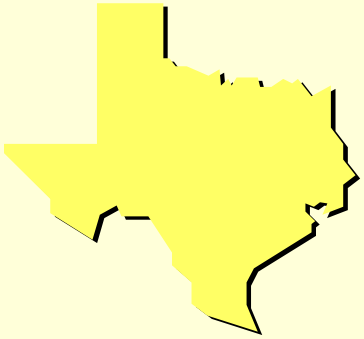
Instruction of LEP students in Texas

- More than 10 percent of Texas public school students are identified as limited English proficient. According to data collected through the TEA Public Education Information Management System (PEIMS) in the 1999-2000 school year, 555,470 LEP students were enrolled in public schools. In the nation Texas ranks second to California in terms of number of LEP students enrolled.
- LEP students are served through bilingual education or ESL programs until they are identified as English proficient based on stare-determined criteria. Once they have met the criteria, they exit these special language programs and are no longer identified as limited English proficient.

Language Groups Represented in Texas LEP Student Population

- According to PEIMS data for the 1999-2000 school year, more than 90 percent of Texas LEP students speak Spanish as their primary language. A small but significant number of LEP students speak a variety of other languages, with Vietnamese, Chinese, and Korean being the most prevalent. Responses to teacher surveys administered during the development of the RPTE suggest that there are more than 100 different home languages represented in the Texas LEP student population.

Sul Ross State University
A Member of The Texas State University System

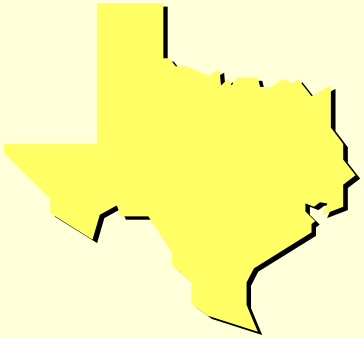


Challenges to Teaching ELL:

Abedi and Dietel (2004) assert that the challenges for English language learners are especially difficult and include both educational and technical issues, including:

- Historically low ELL performance and slow improvement: English language learners consistently perform lower than other students and frequently lower than many other subgroups.
- Measurement accuracy: Findings suggest that low ELL language ability decreases ELL performance on most tests, which influences the test with regard to its ability to accurately measure ELL content knowledge. Further, the test becomes a measure of two skills—subject and language.
- Instability of the ELL student subgroup: Instability is caused by two influences. First, in some states, as students become language proficient, they are reclassified and the ELL subgroup scores tend to drop. Second, a continuous increase of low-achieving ELL students makes it more difficult to achieve progress in improving ELL scores.
- Factors outside of a school's control: Non-school factors include such variables as parent education level or socioeconomic status and tend to outweigh school factors in their effect on student achievement.

Sul Ross State University
A Member of The Texas State University System

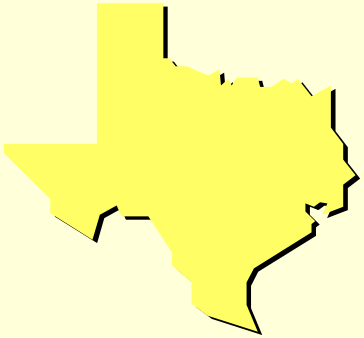


ERIC Digests Relating to MELL/ELL:

Schwartz (1991) describes two math instruction programs that hold promise for use with LEP students in bilingual and all English classrooms.

- The first, **Active Mathematics Teaching (ATM)**, is a form of "direct instruction." Its function is to convey large amounts of highly structured information to students just beginning to learn a subject. Teachers using ATM in classes with LEP students are urged to facilitate learning by providing the definitions of math language in ways that students are sure to understand.
- The second method, **Cognitively Guided Instruction (CGI)**, focuses on the student's thought processes while they solve math problems. Teachers are urged to take this information into account as they make instructional decisions. Further, teachers are urged to allow students to express themselves in the language they can use most comfortably. In doing so, the student's English language fluency is expected to increase.

Sul Ross State University
A Member of The Texas State University System



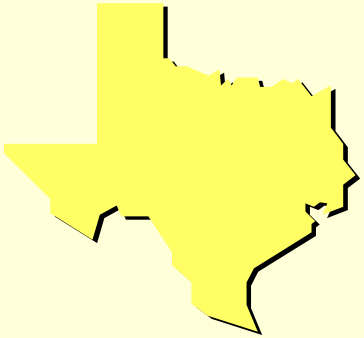
Literature Related to MELL:

The *Delaware Symposium on Language Studies 1985* produced two meaningful contributions to the mathematics & ELL literature.

Crandall, Dale, Rhodes, and Spanos (1985) discussed what they believed to be the critical factor in ELL student success in mathematics—the language of mathematics. These authors make their thinking in this regard explicit:

> *The role of language is ubiquitous. It is the medium by which teachers introduce and convey concepts and procedures, through which texts and problems are read and solved, and by which math achievement is measured. Language skills—particularly the reading skills needed to comprehend mathematics texts and word problems and the listening skills required to understand and follow an instructor's presentation of a problem's solution—are the vehicles through which students learn and apply math concepts and skills (p. 130).*

Sul Ross State University
A Member of The Texas State University System



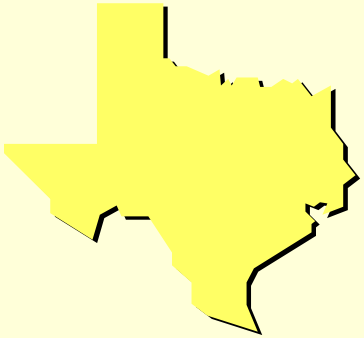
Literature Related to MELL:

The *Delaware Symposium on Language Studies 1985* produced two meaningful contributions to the mathematics & ELL literature.

Kessler, Quinn, and Hayes (1985) discussed the relationship among mathematics, language, and second-language acquisition. In particular, they focused on four areas: (a) the nature of mathematical performance, (b) the language of mathematics, (c) problems that mathematics pose for minority children learning English as a second language, (d) mathematics as a facilitator of second-language development. These authors assert that

> *processing mathematics successfully rests on the ability to utilize very precise language of mathematics in doing mathematical reasoning. The context reduced language of mathematics, the extensive use of logical connectors, the specialized vocabulary and syntactical structures, and appropriate discourse rules, all present a complex set of problems for LEP children engaged in mathematics discourse (p.152).*

Sul Ross State University
A Member of The Texas State University System



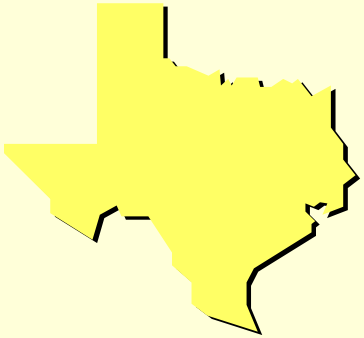
Literature Related to MELL:

Kessler, Quinn, and Hayes (1985) note that underlying the concept of mathematical thinking are the works of Cummins and Dawe on the concept of language proficiency.

Cummins supposes that there are two continua illustrating language proficiency. The first continuum relates to the range of contextual support available to the language user. At one end is Basic Interpersonal Communication Skills (BICS) in which context-embedded communication relies strongly on concrete, “visible” situational cues to meaning. At the other end is Cognitive Academic Language Proficiency (CALP) in which context-reduced relies strongly on linguistic or literary-related cues to meaning. The second continuum addresses the degree of cognitive demands imposed by specific tasks or activities from demanding to undemanding. With this formulation, Cummins asserts that BICS is the language of familiarity, of home which students bring to school while CALP is the language of the disciplines studied at school, of which students may or may not be familiar and of which students must learn to master the discipline (i.e., mathematics register).

Similarly, Dawe proposes a model for mathematical proficiency. He distinguishes between surface fluency in basic mathematical skills (BIMS) from cognitive, analytical, mathematical proficiency (CAMP). Independent of any specific natural language, CAMP is the ability to reason efficiently with the abstract deep structures of mathematics.

Sul Ross State University
A Member of The Texas State University System



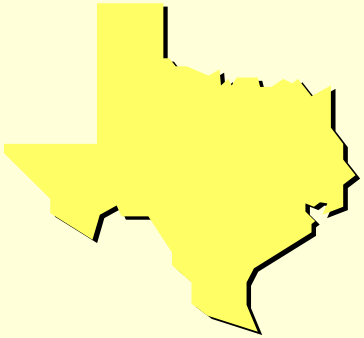
Literature Related to MELL:

Dale and Cuevas (1992) discuss integrating mathematics and language learning in a chapter of *The Multicultural Classroom: Readings for Content-Area Teachers* by Richard-Amato and Snow. In this chapter the authors seek to provide 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.

A beginning point for effective teaching is a realization that mathematics is a language and has a “register”, that is, 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.

So then, mathematics registers include unique vocabulary, syntax (sentence structure), semantic properties (truth conditions), and discourse (text) features.

Sul Ross State University
A Member of The Texas State University System

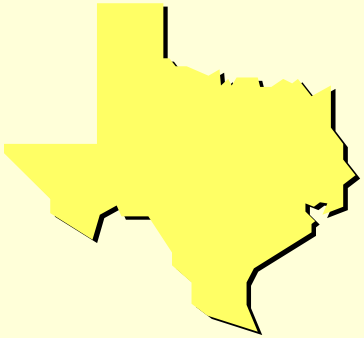


Literature Related to MELL:

Henderson and Landesman (1992) reported the effects of thematically integrated mathematics instruction on achievement, attitudes, and motivation in mathematics among middle school students of Mexican descent. Thematic instruction, it is posited in this study, may provide an effective way to contextualize instruction. It incorporates a concrete learning-by-doing orientation and has the potential to facilitate cooperative and interactive learning opportunities in the classroom. Similarly, cooperative learning can provide opportunities for hands-on activities that result in products on which students perform mental operations, and in situations that engage students in the use of concepts and materials. These features have been identified as characteristics of classrooms that have proved effective for Hispanic students with limited English proficiency.

Since it has been held that there is a substantial relationship between what schools actually teach and what students learn, it holds that fragmented and decontextualized mathematics instruction poses barriers for understanding and achievement, while a thematic, contextualized mathematics instruction provides students with opportunities to make sense of mathematics concepts and problem-solving strategies.

Sul Ross State University
A Member of The Texas State University System



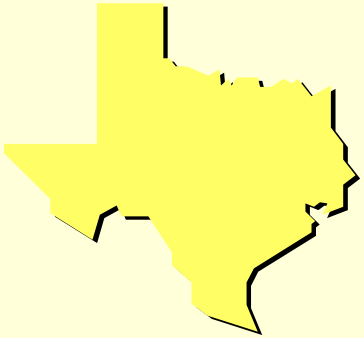
Literature Related to MELL:

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.

To illustrate that the answer to this question, the authors cite several situations.

- First, numerals are not universally interpreted the same, particularly with regard to notation (i.e., where the comma goes in large numbers and what it means to a given culture).
- Second, one's culture can interfere with the learning of mathematical concepts (e.g., one Native American culture does not have a concept for line; the Hmong culture does not have a concept for fractions, etc.).
- Third, the authors assert that research has shown that language skills (i.e., reading and comprehension) outpaced the grade level of mathematics instruction.
- Fourth, the authors assert that mathematics is deeply affected by the components of language—that is, vocabulary, syntax, semantics, and discourse.

Sul Ross State University
A Member of The Texas State University System



Literature Related to MELL:

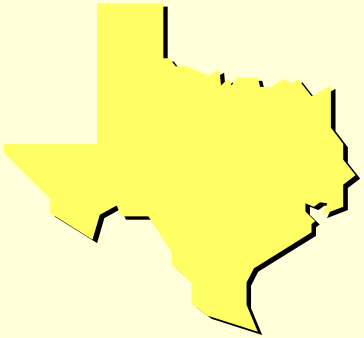
Moschkovich (2002) aims to explore three perspectives on bilingual mathematics learners. She asserts that research needs to address the relation between language and mathematics learning from a perspective that combines current perspectives of mathematics learning with current perspectives of language,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

The author notes that mathematics and ELL research has progressed from looking at the problems bilingual Latino students have faced in solving word problems, understanding vocabulary, or translating from English to mathematical symbols to how students construct knowledge, negotiate meanings, and participate in mathematical communication. For students now in reform oriented mathematics classrooms, students are expected to communicate mathematically in written and oral forms and participate in mathematical practices, such as explaining solution processes, describing conjectures, proving conclusions, and presenting arguments.

The three perspectives described by the author include:

- The first perspective is to say that students are acquiring vocabulary
- The second perspective is the notion of mathematics register
- The third perspective is a situated sociocultural perspective

Sul Ross State University
A Member of The Texas State University System



Qualitative Studies on MELL:

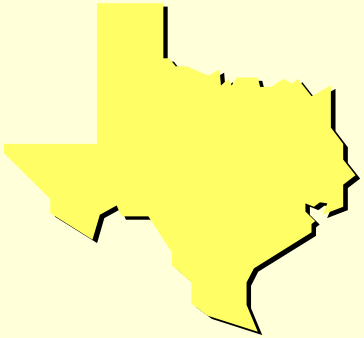
Hewlett-Gomez and Solis (1995) reported on the *Literacy Program for Recent Immigrant Students*, which is a English/Spanish program of instruction for recently immigrated secondary students located in a south Texas school district. This program was utilized in two middle school campuses serving grades 6, 7, and 8.

Five features of the program are noteworthy the authors state because most secondary programs lack them:

- *a sensitivity to students with the most limited English skills and mainstream experiences,*
- *instruction in two languages,*
- *comprehensive instruction which extends horizontally to the four literacy skills—listening, speaking, reading, and writing, and vertically to address all language proficiency levels,*
- *both language and content instruction, and*
- *the incorporation of student's cultural experiences into the curriculum*

The program featured five components, including (a) identification, assessment, and placement; (b) curriculum, instruction, and materials; (c) staffing; (d) staff development; and (e) parental involvement.

Sul Ross State University
A Member of The Texas State University System



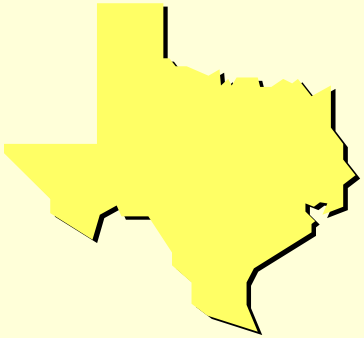
Qualitative Studies on MELL:

Reyes and Fletcher (2003) citing 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. These campuses met the standards set for their criteria of at least 70 percent of test-taking migrants students who passed all areas (math, reading, and writing) of the Texas Assessment of Academic Skills (TAAS) state mandated test.

Reyes and Fletcher found four major themes emerged from their interviews and observations regarding math programs and how they worked with migrant students:

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

Sul Ross State University
A Member of The Texas State University System

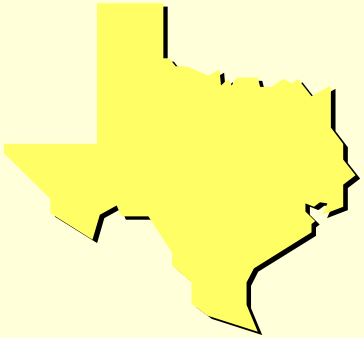


Quantitative Studies Related to MELL:

Leon (1994) reported on a study which examined the effects of extraneous information on mathematical word problems on the performance of Hispanics classified as learning disabled children. To set up the study, two sets of mathematical word problems were developed incorporating addition and subtraction with extraneous wording and without extraneous wording.

The results of the study suggest that students appeared to experience difficulties in discriminating between essential from non-essential information in order to arrive at a correct solution. Thus, based of the responses given, the 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. In addition Leon proposes that the results of this study are relevant to the fields of bilingual special education and mathematics education. From an instructional point of view, these results have important implications in the educational programming of Hispanic learning disabled children at all grade and age levels. The building of mathematics concepts and vocabulary is crucial; therefore, both should be somehow related to the experiences the child brings into the classroom. This approach may facilitate the thinking process in order to get a correct answer.

Sul Ross State University
A Member of The Texas State University System



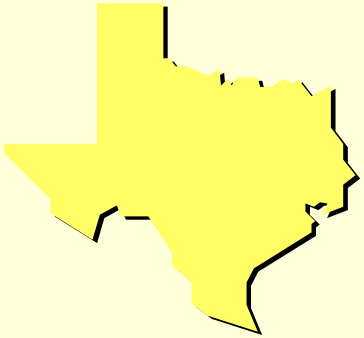
Quantitative Studies Related to MELL:

Greene (1998) performed a meta-analysis on the effectiveness of bilingual education and found that despite a limited number of studies that met a strict selection process (quality of research design) 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.

The limited number of studies for review makes it difficult, according to the author, to address other important issues, such as the ideal length of time students should be in bilingual programs, the ideal amount of native language that should be used in instruction, and the 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.”

Sul Ross State University
A Member of The Texas State University System



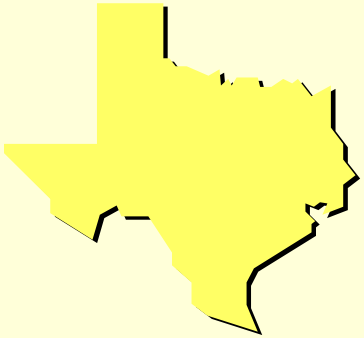
Quantitative Studies Related to MELL:

Bernardo (2002) conducted 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 that having either Filipino or English as a first language did not effect an ability to understand word problem texts in arithmetic. The results also revealed that there was a significant interaction between a student's first language and the language of the problem. Students with Filipino as a first language got more problems in Filipino correct than in English and students with English as a first language got more problems in English correct than in Filipino. Further, the results showed that the 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.

> *"The results show that at least for word problem solving, a task that has a clear linguistic component, the application of mathematical knowledge and skills is affected, possibly even constrained, by whether the student is able to effectively undertake the requisite linguistic processes. Moreover, the results of the study show that for bilingual students, all these processes seem to be more effective when the problem to be solved is presented in the first language rather than the second language."*

Sul Ross State University
A Member of The Texas State University System

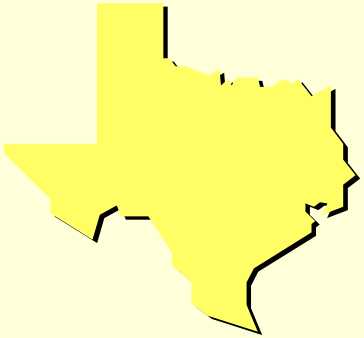


Quantitative Studies Related to MELL:

Bernardo and Calleja (2005) in a follow-up study examined mathematical word problems. Word problems are an integral part of mathematics education and allow students to apply their mathematical knowledge and skills to real world situations. Specifically, the authors 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.

The results also showed that 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 texts, readings, and word problems). Despite what seems to be obvious—that students perform best in their native language—the authors assert that the language used in math word problems might not always be an important factor. It could be that certain problems or difficulties that bilingual students have with solving word problems, such as the tendency to not consider or apply real world knowledge, might not be associated with language at all. These issues might rather be associated with instructional issues, such as poorly developed learning experiences that give rise to the acquisition of problem solving strategies—the lack of experience with real life situation based problems versus straightforward simplistic word problems and the lack of teacher modeled strategies for solving real world problems.

Sul Ross State University
A Member of The Texas State University System

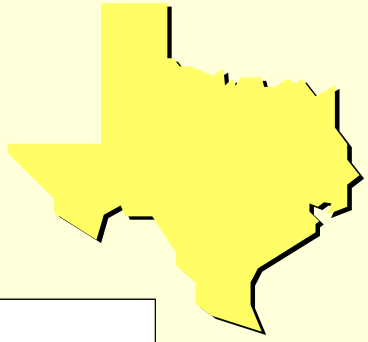


Quantitative Studies Related to MELL:

Thomas and Collier (2002) conducted a national study built on fourteen years of related research on language minority students and their academic achievement. The study, *National Study of School Effectiveness for Language Minority Students' Long Term Academic Achievement*, collected data from five school districts throughout the US and attempted to understand how effective were various programs serving language minority students. Four distinct theoretical program designs were included:

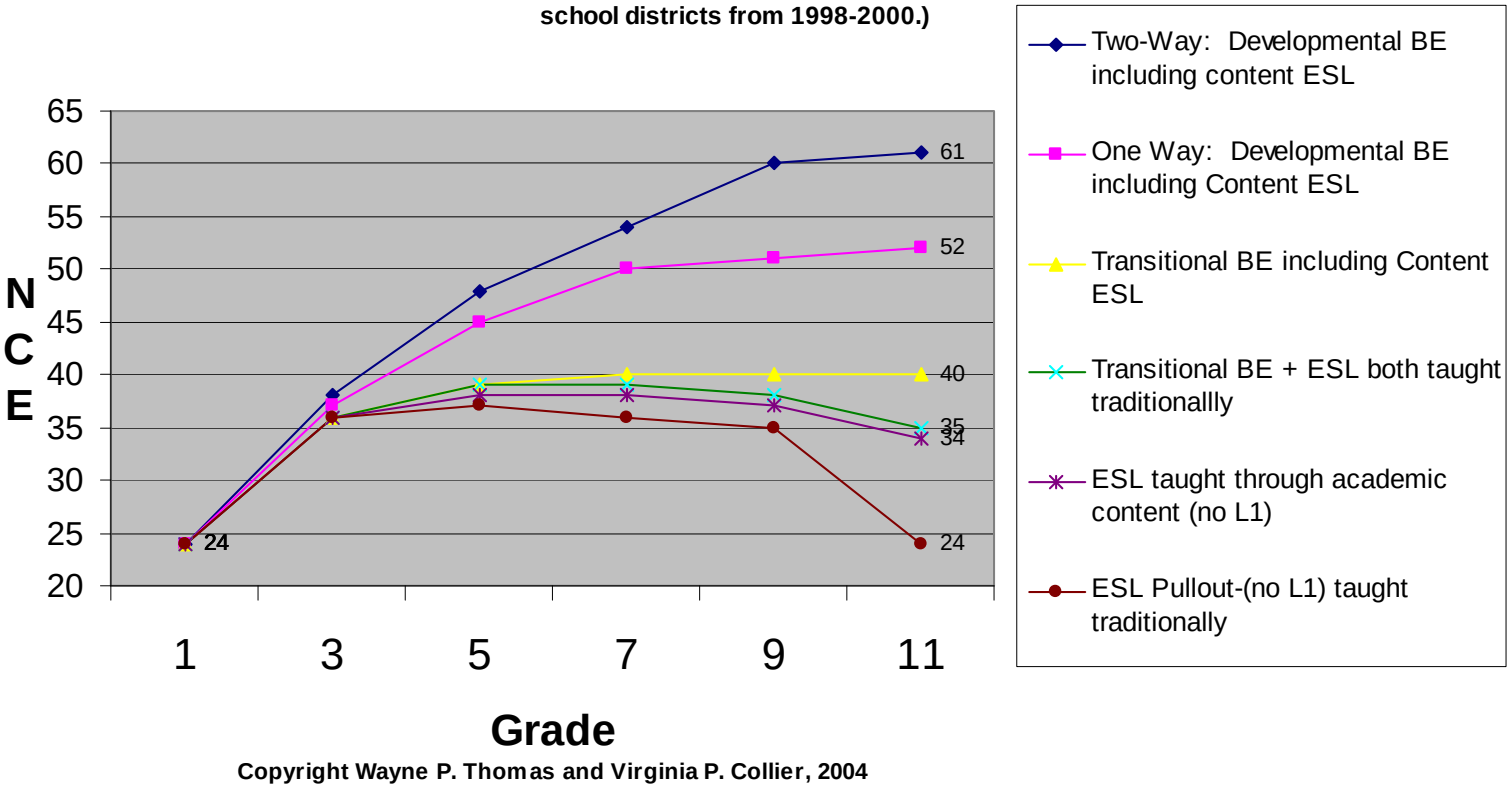
- Two-Way Bilingual Immersion programs: these promote academic achievement, bilingualism, and biliteracy for ELLs and native English speakers and typically last for five to six years,
- One-Way Developmental Bilingual Education programs: offer instruction only to language minority students of one language 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, and
- English as a Second Language programs for ELLs: teach English to ELLs through academic content areas.

Sul Ross State University
A Member of The Texas State University System

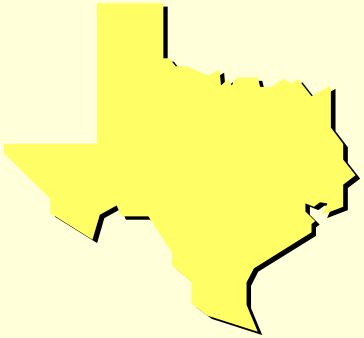


English Learners=Long-Term K-12 Achievement in Normal Curve Equivalents (NCEs)

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



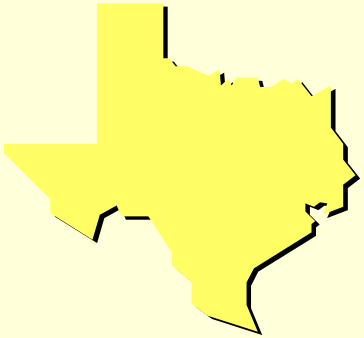
Sul Ross State University
A Member of The Texas State University System



Quantitative Studies Related to MELL:

Thomas and Collier (2002) Based on these findings, the authors propose that in order to close the average achievement gap between ELLs and native English speakers (non-ELLs), language support programs must be well implemented, not segregated, sustained for five to six years, and demonstrate achievement gains of more than the average yearly progress of the non-ELL group each year until the gap is closed. The problem here is that the achievement gap is at best a moving target since non-ELLs progress academically each year for their grade level, while ELLs typically fall further behind with each grade level. Thus, even the most effective language support programs can only close half of the achievement gap in two to three years.

Sul Ross State University
A Member of The Texas State University System



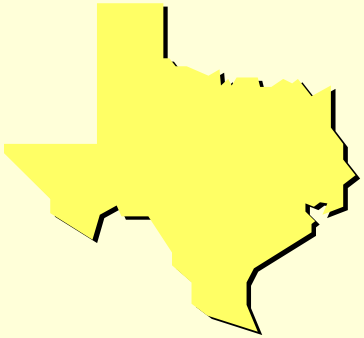
Literacy and MELL:

Montano-Harmon (1991) presented a study that identified differences in discourse features of compositions written in Spanish by secondary school students in Mexico with those written in English by Anglo-American students in the United States. Noting that past studies of discourse patterns in written texts in various languages indicate that the logical development of text varies depending on the native language of the writer, Montano-Harmon sought to contribute to the understanding of how native speakers of Mexican Spanish organize their expository writing.

The results of the study confirmed that the discourse features in Mexican Spanish were significantly different from those in Anglo-American English. Compositions written by Mexican students in Mexico were longer with longer sentences, repetition, flowery poetic language, and the flexible sentence structures created formal, complex presentation of ideas, which differs from the linear, deductive, enumerative compositions written by Anglo-American students.

Montano-Harmon warns that “since the logical development of texts is not universal but language/culture specific, it is imperative that language teachers be aware of differences in discourse features and teach these to students developing literacy skills in a second language. Otherwise, students cannot proceed beyond the sentence level in their understanding of authentic materials.”

Sul Ross State University
A Member of The Texas State University System



Literacy and MELL:

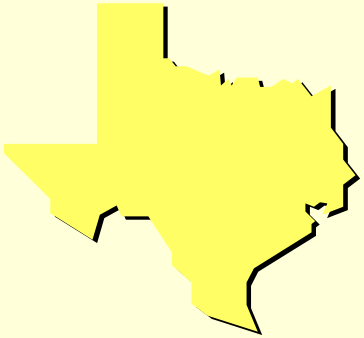
Cardelle-Elawar (1992) describes a metacognitive approach for teaching mathematics to bilingual students that responds to two concerns: (a) a lack of knowledge about how to use existing skills and strategies, and (b) instruction that focuses student's attention on what is the right answer rather than on the process of finding answers on their own.

Cardelle-Elawar reports that metacognitive strategies serve three purposes: (1) they stimulate and develop students' thinking by providing insights into their own mental processes; (2) they redirect students' activities during the act of problem solving by helping students appraise their thinking; and (3) they transform the classroom into an environment where interaction and inquisitiveness are encouraged by allowing explicit discussion between teacher and student of not only what to learn, but also how and why.

The model used to teach students how to solve mathematical problems is based on the work of Meyer (1987) and holds four processes or knowledge is required to solve mathematical problems:

- Translation
- Integration
- Planning & monitoring
- Solution execution

Sul Ross State University
A Member of The Texas State University System



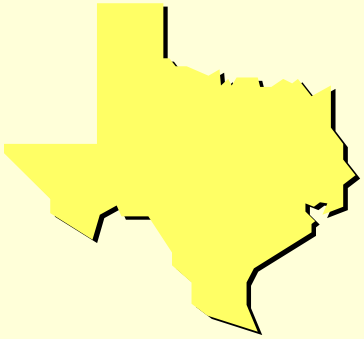
Literacy and MELL:

Raborn (1995) states that linguistic factors must be considered when teachers plan and present mathematics instruction.

As a consequence, Raborn suggests teachers utilize the following recommendations:

- Appraise math abilities
- Select the language of instruction
- Proceed from concrete to abstract
- Use strategies to help students develop concepts
- Use math for language development
- Take student strengths into consideration

Sul Ross State University
A Member of The Texas State University System

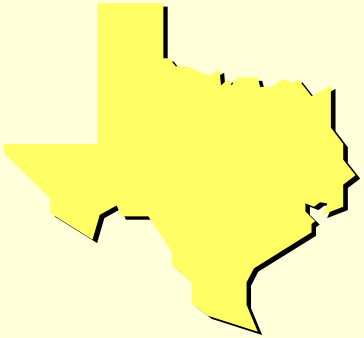


Literacy and MELL:

Jarrett (1999) presented strategies currently identified in mathematics and science education reform effective for all students. By linking these strategies with principles of second language acquisition, teachers can target the needs of second language students. The strategies are as follows.

1. Thematic Instruction
2. Cooperative Learning
3. Inquiry and Problem Solving
4. Scientific Inquiry
5. Mathematical Problem Solving
6. Vocabulary Development
7. Classroom Discourse
8. Affective Influences
9. Assessment

Sul Ross State University
A Member of The Texas State University System



Literacy and MELL:

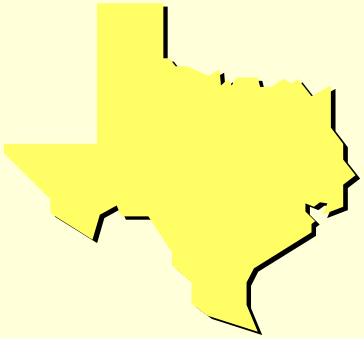
Kotsopoulos (2004) discussed mathematics education and the need for literacy. She noted that the complexities of literacy development in content-based disciplines such as mathematics are frequently underestimated.

Kotsopoulos refers to mathematical literacy as including these points:

- To engage in problem solving skills
- To make judgments
- To engage in communication about mathematics
- To derive understanding for mathematics in real contexts
- To pose problems in a variety of settings
- To recognize relationships
- To make mathematical decisions based on these relationships

Given these skills, it becomes apparent that literacy underpins any sense-making in mathematics. The challenge then is to make sure that students are able to develop literacy skills in order to be successful in learning mathematics.

Sul Ross State University
A Member of The Texas State University System



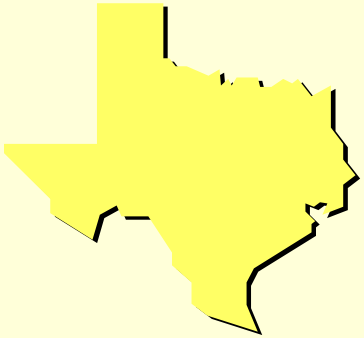
Dual Language Programs:

Torres-Guzman (2002) writing in *Directions in Language and Education* describes dual language programs and specifically attempts to delineate salient features of dual language programs for educators to keep in mind when making program and policy decisions, and to highlight the educational results ascribed to dual language programs in light of the broader debate surrounding bilingual education.

Dual language refers to an enriched bilingual/multicultural education program in which language equity is structurally defined as equal time exposure to two languages (i.e., typically the 50/50 model though some programs begin with a heavier emphasis on the native language as in the 90/10 model and then switch to the 50/50 model). Dual language programs are developmental—*psychological, social, and cognitive developmental issues are taken into account*—and enrichment—*a second language is added to the one students already know*—oriented.

Dual language programs foster the goals of academic achievement in English and another language, development of bilingual/biliterate skills, and positive, cross-cultural attitudes. The major theoretical principals that undergird the academic and language goals are embedded in the relationship between language, learning, and cognition.

Sul Ross State University
A Member of The Texas State University System



Dual Language Programs:

Linguistic Features

- Strict language separation
- Equality in language distribution
- Avoidance of simultaneous translation
- Language taught through content
- Whole language instruction
- Goals of bilingualism and biliteracy
- Heterogeneous language grouping

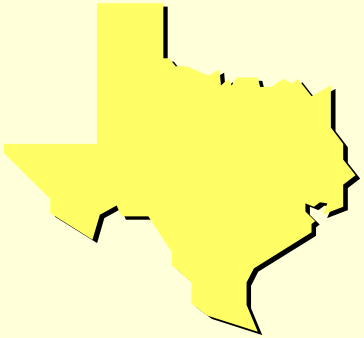
Sociocultural Features

- Appreciation of cultural diversity
- Culturally relevant teaching
- Development of self-esteem
- Mix of language minority with English-speaking & mainstream students
- Cooperative group learning structure
- Parental involvement
- School/community support structure

Pedagogical Features

- Academic achievement for all children
- Math and literature follow district linguistic policy
- Developmental level team teaching structures
- Thematic organization of units of study
- Teachers as monolingual models
- On-going staff development

Sul Ross State University
A Member of The Texas State University System



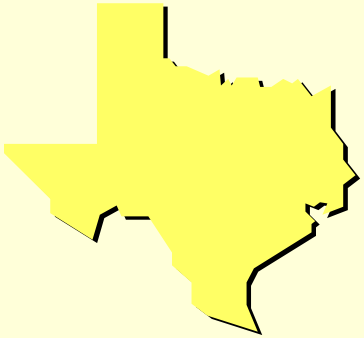
Dual Language Programs:

Lindholm-Leary (2004) provides an excellent overview of two-way immersion programs. She asserts that two-way programs successfully educate native learners and English Language Learners within the same classroom and fulfill for both groups the goals of full bilingualism and biliteracy, grade-level academic achievement, and multicultural competency.

Lindholm-Leary also presents six factors that influence the achievement of linguistically diverse students in bilingual programs:

- School environment
- Curriculum and instruction
- Program planning
- Assessment and accountability
- Teacher quality and familiarity with bilingual education
- Family involvement

Sul Ross State University
A Member of The Texas State University System



Dual Language Programs:

Short and Echevarria (1999) developed an explicit model of sheltered instruction that teachers could use to improve the academic success of their LEP students.

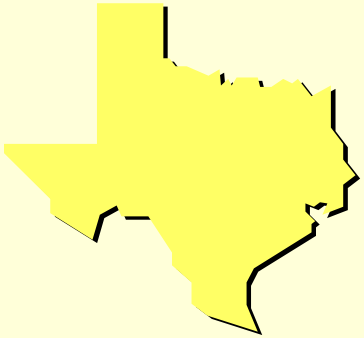
The Sheltered Instruction Observation Protocol (SIOP)

I. Preparation

II. Instruction
- Building Background
- Comprehensible Input
- Strategies
- Interaction
- Practice / Application
- Lesson Delivery

III. Review / Evaluation

Sul Ross State University
A Member of The Texas State University System



Instructional Conversations:

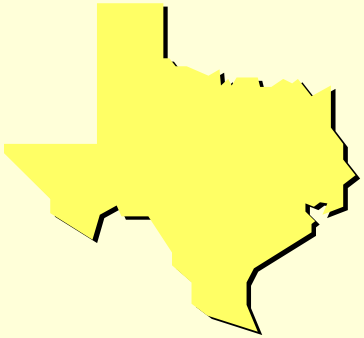
Tharp and Gallimore (1991) presented the topic of *Instructional Conversations*, which these authors believe is the key to "awakening and rousing to life the mental capacities of learners" (p. i).

The need for instructional conversations is based on the realization that "recitation" is the dominant instructional practice present in schools. This practice is described as

> *Consisting of the teacher assigning a text (in the form of a textbook or a lecture) followed by a series of teacher questions that require students to display their mastery of the material through convergent factual answers. Recitation questioning seeks predictable, correct answers. It includes up to 20% "yes/no" questions. Only rarely in recitation are teacher questions responsive to student productions. Only rarely are they used to assist students to develop more complete or elaborated ideas, (p. 1).*

According to these authors, recitation, as an instructional practice, needs to be replaced with teaching strategies that engage students in "conversation" or dialogue the critical form of assisting learners to develop thinking skills—the ability to form, express, and exchange ideas in speech and written form—though the questioning and sharing ideas and knowledge that happens in classroom conversations between teachers and students. Simply put, the authors state "to truly teach, one must converse; to truly converse is to teach."

Sul Ross State University
A Member of The Texas State University System

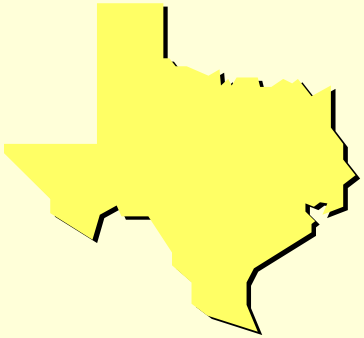


Instructional Conversations:

Goldenberg (1992) advocates the use of *Instructional Conversations* (ICs). He notes that instructional conversations are instructional in intent and are designed to promote learning. They are conversational in quality in that they appear to be natural and spontaneous language interactions. While engaging in instructional conversations teachers and students are responsive to what others say, so that each statement or contribution builds upon, challenges, or extends a previous one. Both teacher and students present provocative ideas or experiences, to which others respond.

Instructional conversations, according to Goldenberg, are in line with "constructivist" thinking. Therefore, students are expected to actively construct their own knowledge and understanding by making connections, building mental schemata, and developing new concepts from previous understandings. To this end, teachers encourage expression of students' own ideas, builds on information students provide, and generally guides students to increasingly sophisticated levels of comprehension.

Sul Ross State University
A Member of The Texas State University System



Instructional Conversations:

Goldenberg provides the following model, which includes two important parts: the instructional component and the conversational component.

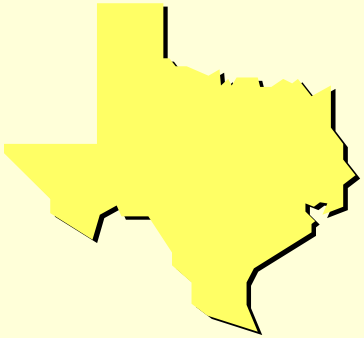
Instructional

1. Thematic Focus
2. Activation and Use of Background and Relevant Schemata
3. Direct Teaching
4. Promotion of More Complex Language and Expression
5. Promotion of Bases for Statements or Positions

Conversational

6. Fewer Known-Answer Questions
7. Responsiveness to Student Contributions
8. Connected Discourse
9. Challenging, but Non-threatening Atmosphere
10. General Participation, Including Self-selected Turns

Sul Ross State University
A Member of The Texas State University System



Instructional Conversations:

Dalton and Sison (1995) conducted a study utilizing *Instructional Conversations (ICs)* to help increase the participation of seventh grade students who were ordinarily excluded from classroom participation by the teacher. By using ICs, the authors hoped to increase the participation in teaching and learning activities for teachers and language minority students though the active use of language and communication.

Language minority students may lack experience in classroom social interactions and are less likely to understand the rules (both implicit and explicit) of successful participation or strategies for achieving lesson goals. The result is that these students are excluded from interactive instruction and are thus unable to participate in the activity and language that build common understandings, self-esteem, and shared perspectives.

The results of the study indicate that the ratio of teacher talk and student talk shifted during the course of the study and that IC lessons encouraged students to talk. The results indicated an increase in students' comfort and skill in conversation; they were getting better with time. Students were using more content lexicon as the lessons progressed, which indicates that students' grasp of the concepts increased. Further, the language use strongly suggests that students' points of view shifted from those of an excluded outsider to those of the included member, the math student.

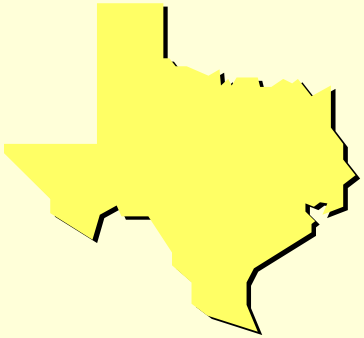
Sul Ross State University
A Member of The Texas State University System

Standards for Professional Development in Effective Teaching of ELL Students:

The ***Center for Research on Education Diversity and Excellence*** has identified five standards for effective teaching of ELL students. In a research brief **Rueda (1998)** discusses the five standards in terms of sociocultural theory and explains how each standard can support the learning process underlying professional development efforts.

1. Facilitate learning and development through joint productive activity among leaders and participants
2. Promote learners' expertise in professionally relevant discourse
3. Contextualize teaching, learning, and joint productive activity in the experiences and skills of participants
4. Challenge participants toward more complex solutions in addressing problems
5. Engage participants through dialogue, especially the instructional conversation

Sul Ross State University
A Member of The Texas State University System



Curriculum & Evaluation Standards for School Mathematics (NCTM):

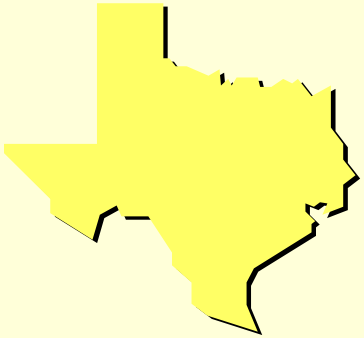
NCTM standards established five goals for mathematical literacy:

1. that students learn to value mathematics,
2. that they became confident in their ability to do mathematics;
3. that they become mathematical problem solvers;
4. that they learn to communicate mathematically; and
5. that they learn to reason mathematically.

NCTM Professional Standards for Teaching Mathematics

1. Select mathematics tasks that engage students' interests and intellect.
2. Orchestra classroom discourse in ways that provide the investigation and growth of mathematical ideas.
3. Use, and help students use, technology and other tools to pursue mathematical investigations.
4. Seek, and help students seek, connections to previous and developing knowledge
5. Guide individual, small group, and whole class work.

Sul Ross State University
A Member of The Texas State University System

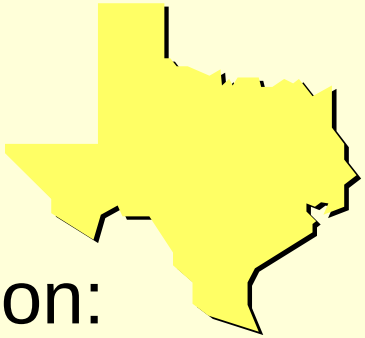


Curriculum & Evaluation Standards for School Mathematics (CREDE):

Tharp, Estrada, Dalton, and Yamauchi (2000) propose the five standards for Effective Pedagogy as critical for improving learning outcomes for all students, and especially those of diverse ethnic, cultural, linguistic, or economic backgrounds. The five standards are:

1. **Standard One**: Teachers and Students Producing Together
   - *Facilitate learning through joint productive activity among teacher and students*
2. **Standard Two**: Developing Language and Literacy Across the Curriculum
   - *Develop competence in the language and literacy of instruction across the curriculum*
3. **Standard Three**: Making Meaning—Connecting School to Student's Lives
   - *Contextualize teaching and curriculum in the experiences and skills of students' homes and communities*
4. **Standard Four**: Teaching Complex Thinking
   - *Challenge students toward cognitive complexity*
5. **Standard Five**: Teaching Through Conversation
   - *Engage students through dialogue, especially the Instructional Conversation*

Sul Ross State University
A Member of The Texas State University System



Issues Related to Mathematics Instruction:

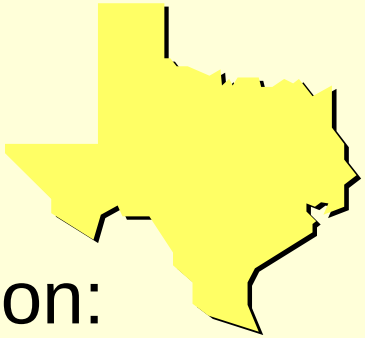
Clement, Lochhead, and Monk (1981) discuss a common problem among all students of mathematics—difficulties students face in translating stated (word) problems into mathematical notation (equations) so the problem can be solved.

In a study with freshman engineering college students the authors found that fewer than 50 percent of the students could solve a series of written problems by translating the word problem into and out of algebraic notation. The authors believed that the challenge for students is not one of simply misunderstanding English.

Rather, one source of the challenge is that secondary students are not getting exposure to such types of problems, but that teachers have tended to deemphasize such problems because students find them difficult.

A second source is that students perform two types of errors in attempting to solve these problems: the first is word order matching, which is a literal, direct mapping of the words of English into the symbols of algebra; the second is the static-comparison method, which is a literal attempt to symbolize the static comparison between two groups.

Sul Ross State University
A Member of The Texas State University System



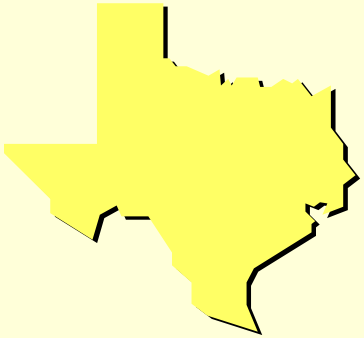
Issues Related to Mathematics Instruction:

In a similar study, **Lochhead and Mestre (1988)** examined the same challenge of students having difficulties in solving algebraic word problems, particularly in regard to translating written language into mathematical language. Citing the previous study, these authors note that the source of the error stems from misconceptions concerning the structure and interpretation of algebraic statements and of the process by which one translates between written language and algebraic language.

Lochhead and Mestre offer several suggestions for overcoming these difficulties.

- First, teachers should provide students with ample practice at the translation process itself, isolated from all other aspects of problem solving.
- Second, the authors propose a three step process for solving word problems that includes qualitative understanding, quantitative understanding, and conceptual understanding.
- The goal is not necessarily to have the students write the appropriate equation but to have them grapple with, and dislodge, their misconceptions. These types of discussions are able to not only airing the different misconceptions students may have but also help students resolve their misconceptions through peer interactions.

Sul Ross State University
A Member of The Texas State University System

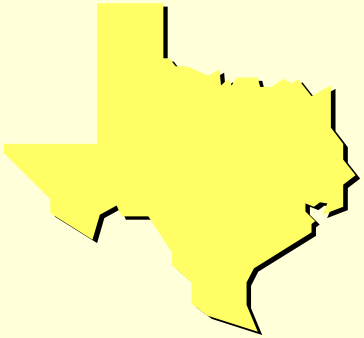


Findings & Recommendations:

Findings in the Literature:

- 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
- Math scores statewide are below acceptable levels in all student categories, particularly at Algebra I
- 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

Sul Ross State University
A Member of The Texas State University System

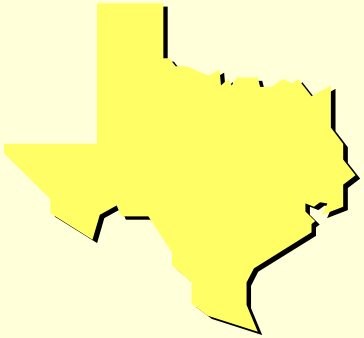


Findings & Recommendations:

Findings Hinted at, but Not Discussed in the Literature:

- The compartmentalization of contexts so that students fail to see connections across subject areas; this is particularly true in secondary education environments
- Teaching for understanding as a goal of instruction for all content areas
- Teachers, particularly elementary teachers, may not be skilled in the technical aspects of mathematics register and how to teach it effectively
- The power relationship effects inherent in US school classrooms—English is dominant, all other languages are secondary; with the exception of dual language programs, all programs seek to change minority students to be like the majority
- The role and influence of the principal
- The role and influence of the teacher

Sul Ross State University
A Member of The Texas State University System

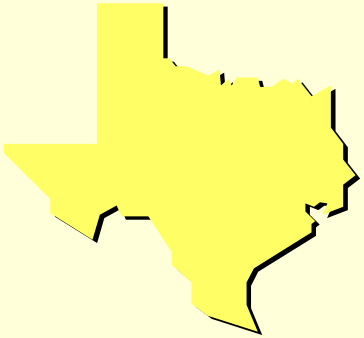


Findings & Recommendations:

What's Not in the Literature:

- The difference between how mathematics is taught in other countries and how it is taught in the US (i.e., conceptually-based vs. process-based; see TIMSS studies)
- The acknowledgement that math scores statewide in particular may be indicative of ineffective teaching strategies for all students and that the math curriculum needs to be revamped to reflect a different mode of instructional focus (i.e., cover less more deeply)

Sul Ross State University
A Member of The Texas State University System

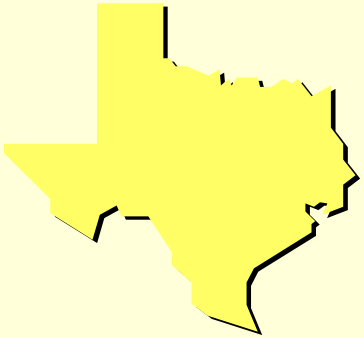


Findings & Recommendations:

What's Not in the Literature:

- The difference between how mathematics is taught in other countries and how it is taught in the US (i.e., conceptually-based vs. process-based; see TIMSS studies)
- The acknowledgement that math scores statewide in particular may be indicative of ineffective teaching strategies for all students and that the math curriculum needs to be revamped to reflect a different mode of instructional focus (i.e., cover less more deeply)

Sul Ross State University
A Member of The Texas State University System



Findings & Recommendations:

Recommendations:

- Support and fund research to continue defining programs that tie literacy to content instruction, particularly as it concerns mathematics, such as SLAMS (Cuevas, 1981, 1984, 1992)
- Support and fund the development of Two-way dual language programs at all school levels
- Support and fund programs to teach and implement instructional strategies such as Instructional Conversations, Concept/thematic instructional practices, etc.
- Support and fund professional development for teachers regarding needs of ELL students and instructional practices that support ELL students (see CREDE Five Standards for Effective Pedagogy and Student Outcomes)
- Examine teacher preparation programs; require elementary teachers to have formal training in math instruction, particularly in math register, and/or in instructional strategies that facilitate development of literacy and math skills
- Support changes in math instruction from process to conceptual foundations, particularly from K-8 and possibly for Algebra I students
- Rewrite math TEKS to support depth rather than breadth in instructional focus