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PRIMARY LANGUAGE USE IN SECONDARY CONTENT CLASSES
AND ACADEMIC ACHIEVEMENT:
A STUDY OF ADOLESCENT IMMIGRANT MATH STUDENTS

A Project
Presented to the
Faculty of
California State University,
San Bernardino

In Partial Fulfillment
of the Requirement for the Degree
Masters of Arts
in
Education: Bilingual/Cross-Cultural

By
Michael Norman Walbridge
June 1993

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June 10, 1993
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ABSTRACT

In this thesis, the relationship between initial primary language instruction in secondary content classes and the subsequent content area academic achievement of adolescent immigrants is examined. The evidence for the successful transfer of concepts and skills learned in a student's primary language to a second language at both the elementary and secondary level is discussed. Based on this theory of linguistic interdependence, a model secondary bilingual program is proposed which promotes academic achievement.

Using this model as a guide, a district's secondary level math program is analyzed to determine if statistical evidence could be found to support the hypothesis that initial primary language use leads to long-term academic achievement. Three independent variables--initial language of instruction in math classes, years in the United States and pre-existing math abilities--are analyzed to determine their relationship with the dependent variable, high

school math proficiency scores.

Although the limited number of subjects prevented any definite conclusions about the statistically significant impact of primary language use, trends in the data coupled with student interviews indicated that initial primary language instruction at the secondary level is probably beneficial to the long-term academic achievement of adolescent immigrants. As more studies of secondary-level primary language instruction are carried out, more definitive conclusions can be made. In the meantime it is recommended that districts utilize primary language instruction to the greatest extent possible.

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Chapter One: Introduction

Background of the Study

Research in the field of bilingual education has repeatedly documented the connection between initial instruction in a student's primary language and eventual academic achievement in a second language (Cummins, 1979; Krashen and Biber, 1988). Most of this research has concentrated at the elementary level, comparing the achievement levels attained at the end of grade 6 of those language minority students (LMS) who have been enrolled in bilingual or non-bilingual programs since kindergarten (Hakuta and Gould, 1987; Dolson, 1985; Willig, 1985; Snow, 1990).

Statement of the Problem

Beyond these studies that focus on the elementary level, there has been far less attention to the effectiveness of primary language use at the secondary level. For the most part, secondary students who immigrate to the United States have a good foundation of literacy skills in their primary language. Despite this first language proficiency, many years are required to develop conversational and academic second language skills. During this

time, these students often fall behind in the increasingly demanding content areas. For this reason, primary language content instruction has been frequently emphasized as a necessary component of any secondary bilingual program.(Collier, 1989; Lucas, Henze and Donato, 1990; Friedlander, 1991) What is lacking, however, is a systematic analysis of secondary primary language programs. Such an analysis must look at primary language instruction not only as a means of continuing in-depth content learning, but also as a key to eventual academic achievement in mainstream content classes in high school and beyond.

Research Questions

The intent of this paper is to examine the connection between adolescent immigrant students' initial use of primary language in content classes at the secondary level and these same students' eventual academic achievement in their second language. In order to adequately examine this topic, a review of related literature will first answer these general questions: What is the theoretical basis for the transfer of content skills and knowledge from one language to another? How do language acquisition abilities of students

arriving in the U.S. at different ages vary? What is the comparative impact that second language and primary language approaches have on academic achievement in content classes at any level?

Having established the positive effects of primary language use in content classes in general, the applicability of this research to the secondary level will be addressed by surveying what the literature reveals about these questions: What evidence is there for the effectiveness of primary language use in secondary level content classes? What is the historical and contemporary status of secondary bilingual programs using primary language instructional approaches? Using the information compiled in this literature review, what would a model secondary bilingual program promoting academic achievement for adolescent arrivals look like?

In order to quantify the effectiveness of this model in secondary content classes for adolescent immigrants, this study will focus in on the one content area with the most readily available data, mathematics. A local district's secondary bilingual math program will be analyzed to try to answer the main question of this study: How much influence does initial primary language use in math

classes for adolescent immigrants have on subsequent second language math achievement?

Chapter Two: Literature Review

Theoretical Framework

A study of the relationship between primary language use in content classes and subsequent academic achievement in a second language rests on the question of whether skills and knowledge obtained in one language can be successfully transferred to a second language. What evidence exists for its occurrence? What are the conditions under which this transfer can occur?

To answer these questions we must begin with three key theoretical concepts: linguistic interdependence, the threshold hypothesis, and transfer of skills and knowledge. Although each of these concepts has evolved gradually over the last two decades, James Cummins is largely credited with encapsulating these theories into an easily understood framework.

Cummins' framework: Linguistic interdependence and the threshold hypothesis. In 1979, Cummins argued that "a cognitively

and academically beneficial form of bilingualism can be achieved only on the basis of adequately developed first language (L1) skills."

Two hypothesis were described in support of this position: the "developmental interdependence" hypothesis and the "threshold" hypothesis. This first hypothesis argues that the long-term cognitive and academic fruits of any bilingual program are largely determined by the degree to which the first language is developed both at home and in the early stages of schooling. The second hypotheses proposes that there is a certain point, or "threshold," of L1 development which must be reached to avoid negative, or "subtractive," bilingualism and to eventually reap the cognitive and academic rewards of bilingual education.

Adapting a model from the Finnish researchers Skutnabb-Kangas and Toukamaa (1976), Cummins actually identifies two thresholds and three potential outcomes depending on a student's position on the continuum. Below the first threshold, negative cognitive effects, or "semilingualism", occurs throughout the student's schooling. A LMS must pass this threshold to avoid negative effects, but they must reach a higher threshold in order to

reap the positive, or "additive bilingual," cognitive benefits.

Cummins (1980) later differentiated between conversational and academic language proficiency in this framework. Various researchers have suggested there was a clear distinction between these two types of language and applied labels such as "communicative and analytic competence (Bruner, 1975), "utterance and text" (Olson, 1977), and "embedded and disembedded language" (Donaldson, 1978). Cummins labelled these concepts "Basic Interpersonal Communicative Skills" (BICS) and Cognitive/Academic Language Proficiency (CALP). While these terms are often used in an either-or fashion, they are meant to be considered a continuum, not a dichotomy.

Cummins (1981a) further expanded upon the BICS-CALP conception of linguistic proficiency by proposing a more complex four quadrant diagram formed by the intersection of two continua (see Figure 1). Whereas the BICS-CALP schema helps to differentiate between the language skills necessary to function in everyday, conversational situations and the language skills necessary to function in a more cognitively demanding academic

setting, this latter construct recognizes that there are degrees of differences within both conversational settings and academic situations and that these differences are a function of context and cognitive difficulty. The vertical continuum of Cummins' diagram indicates the cognitive difficulty of the linguistic situation. It ranges from the "cognitively undemanding", or easy, situation to the "cognitively demanding", or difficult, situation. The horizontal axis indicates the context in which the linguistic situation occurs. It ranges from "context-embedded" situations with lots of visual clues to "context-reduced" situations with a minimum of visual clues.

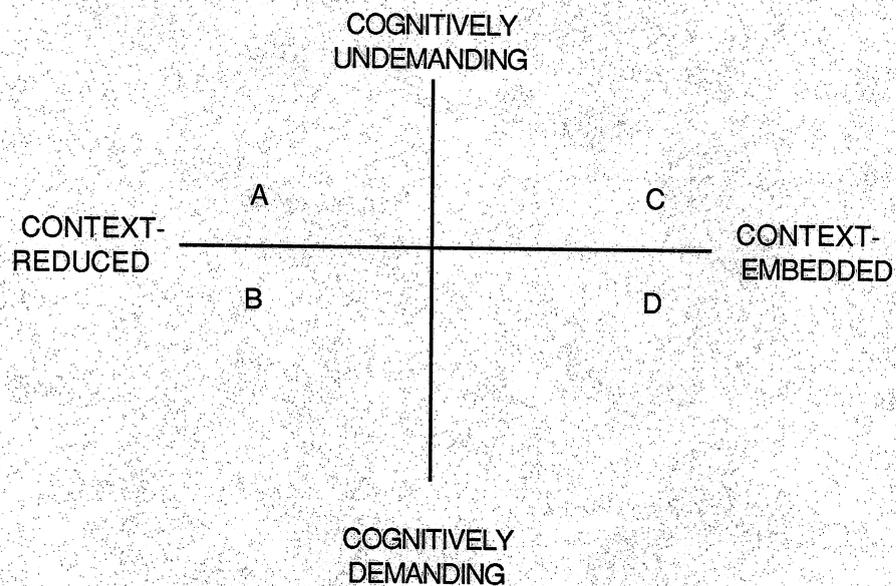


Figure 1. Range of Contextual Support and Degree of Cognitive Involvement in Communicative Activities (Cummins, 1981).

In this paper, the BICS-CALP duality will be used for the general purposes of analysis, with the four quadrants schema being utilized for more detailed discussion. Cummins suggested that the developmental interdependence and the threshold hypothesis apply differently to BICS and CALP, regardless of the context or cognitive difficulty. In general, he found that BIC development in L2 is a function more of personality and environmental variables than the level of BICS development in L1 (Cummins, 1980). Consequently, because there is no little interdependence between L1 and L2 BICS, there is no threshold that must be reached in L1 BICS for successful acquisition of L2 BICS.

On the other hand, CALP development in L1 must reach a certain threshold to carry over into L2. Academic skills and knowledge developed in a student's primary language can be applied cognitively to a similar situation in a second language. This is known as transfer. Transfer of CALP is at the core of secondary bilingual content education and must be examined further before we proceed.

Transfer of academic skills and concepts. The transfer of

academic skills and concepts (CALP) from L1 to L2 is the fundamental assumption which is used to justify bilingual education in the U.S. Hakuta (1986) points out that despite the evidence pointing to a connection between L1 CALP development and academic success, little concrete research has been conducted to "understand the characteristics or even to demonstrate the existence of the transfer of skills." The specifics of transfer have been difficult to pin down, even by Hakuta himself in his own research.

In 1990, he conducted an experiment addressing the question of whether this transfer occurs through the "specific transfer of training" from, in this case, Spanish to English, or whether the transfer occurs on a more "global" level (Hakuta, 1990).

In Hakuta's experiment, groups of students were taught specific linguistic concepts related to time or space, first in Spanish, and then in English. Their abilities to recognize these concepts on an English test were compared to a control group of students who did not receive the initial Spanish instruction. The result was that except in the case of cognates (like temporal concepts of *pasado*, *presente*, *futuro*) there was no evidence of

specific transfer. In all groups, however, success on the English tests could be predicted by the degree of overall Spanish development as measured by a pretest of vocabulary and conceptual proficiency. In other words, those students whose general cognitive abilities in Spanish were more advanced, also demonstrated more advanced cognitive abilities on the English post-tests. These Cognitive Academic Linguistic Abilities had transferred at a more global level. This led Hakuta to conclude that transfer of knowledge and skills depends more on the overall development of native language CALP than on the teaching of a specific skill to be transferred.

Royer and Carlo (1991) devised a method for testing Cummins' hypothesis that CALP skills transfer from one language to the other (linguistic interdependence), but BICS develop independently. In their study of the transfer of comprehension skills, 49 Hispanic 6th graders were asked to read or listen to a pair of sentences written or spoken in the same language. The second sentence could either be exactly the same or slightly different from the first. If different, the student had to determine whether the new wording changed the

basic meaning of the sentence or if it was simply a paraphrase. The whole test was given separately to these students at three different times over a 1 1/2 year period. Comparisons of previous and subsequent test scores was used to measure transfer. Since the listening skills corresponded to an essentially non-academic, conversational situation, this aspect of the study was used to measure BICS. The reading skills, corresponding to a more context-reduced situation, were used to measure CALP.

The results confirmed Cummins' hypothesis. English reading (L2) on the later test was most "highly correlated" with reading skills in Spanish on the earlier tests. However, there was no significant correlation between the early abilities in Spanish listening and later tests in English listening. Thus, the authors concluded that "reading skills in L1 do transfer to reading in L2 as the second language develops"; however, "BICS acquired in one language do not seem to transfer to BICS in a second language. The transfer of reading skills thus is probably not due to general language abilities but to transfer of learned educational strategies."

(454-55)

Goldman, Reyes, and Varnhagen (1984) conducted a study to determine whether comprehension skills transfer across languages. English and Spanish versions of Aesop's fables were either read or listened to (depending on grade level) and a series of questions ranging from the cognitively undemanding to the cognitively demanding were asked. Students responded either orally (first through fourth grade) or in writing (fifth and sixth grade).

It was found that in all grades and with all types of questions (simple recall through cognitively-demanding analysis), "performance levels in the first language were positively correlated with performance levels in the other language" (p. 63). This direct relationship was attributed to the cross-linguistic transfer of knowledge:

Our speculation is that information that becomes part of a child's knowledge base, regardless of the language of input, can be transferred to a second language during comprehension and other learning activities. The degree to which this transfer occurs will depend upon the child having prerequisite parsing and vocabulary entries for the second language. (p. 63)

If CALP transfer does indeed occur, as the research suggests, when students reach a certain threshold in L1 and when L2 basic

language skills are sufficiently developed, the relevant question for a study of bilingual education in content classes at the secondary level is the following: How does the age of the student relate to the theoretical framework in general, and the concept of CALP transfer in particular?

Age on Arrival

The optimal age question. To understand how best to meet the academic needs of immigrant students at the secondary level it is necessary to ask, "How does the age of the secondary student (12-18) affect the way language is learned and acquired?"

Early research in the relationship between age and language acquisition was based on fundamental biological misconceptions. Comparing language development to other physiological processes, Lennenberg (1967) claimed that the cognitive state known as "language readiness" ends around the time of puberty. By this time, the brain's cognitive processes becomes so firmly structured that the "disequilibrium" required for linguistic development is too limited for effective second language learning to occur. Thus, he proposed that there is a "critical period" for effective language

development.

Saville-Troike (1973) stated that this neurological evidence, if taken in isolation, indicated that foreign language instruction should begin at least before age 6 and not later than puberty. She bases this statement on the assumption that the brain somehow allocates space to other functions, thus crowding out space for another language to be developed effectively.

She does, however, recognize that there are other factors which may be more important. For example, a child's self-concept may be negatively effected by the rejection of one's language and culture compounded by the frustration of early academic failure in a language which is incomprehensible.

In the early 1970's, Ramsey and Wright (1974), compared the degree of English proficiency of early and late arrivals in Canada. Most of the subjects came to Canada from less developed Southern European countries such as Greece, Italy and Portugal. Utilizing a variety of tests which measured BICS and CALP, these researchers found that students arriving after the age of seven scored significantly lower than those arriving before age seven. There was

a "clear negative relationship between age on arrival and performance" which they cited as evidence for the hypothesis that there is a critical age for second language acquisition.

At first, researchers attributed this phenomena to the fact that the students came from less industrialized countries in Southern Europe (Cummins, 1979). Then, in 1981, Cummins re-analyzed these results taking into account that vocabulary becomes more and more challenging with age. As suggested by the Interdependence Hypothesis, students arriving in the U.S. at an older age should acquire context-reduced aspects of L2 proficiency (CALP) faster than their younger counterparts. If the amount of time required to reach age-grade norms on a cognitively-demanding, context-reduced test such as the *Ammons Picture Vocabulary Test* is compared across age groups the results are found to be similar. However, as Cummins points out, since the degree of vocabulary knowledge required for academic success is significantly different for a younger and an older student, the older student's progress is more dramatic. They have a lot further to go in absolute terms than the younger immigrant students. This is consistent with findings in

similar situations involving Japanese students in Canada, Finnish students in Sweden, and Mexican students in the United States.

(Cummins, 1981b; Skutnabb-Kangass and Toukomaa, 1976; Troike, 1978)

Cummins (1981b) hypothesized that it will take a LMS approximately 2 years to reach a level of proficiency equivalent to native English-speakers in "context-embedded" situations requiring mostly BICS. However, it will take approximately 5 to 7 years to catch up to native English-speakers in "context-reduced" situations such as those found in most secondary content classes.

Snow and Hoefnagel-Hohle (1978) further challenged Lennenberg's Critical Period hypothesis. Using middle-class English speakers living in the Netherlands, the researchers conducted tests similar to those of Ramsey and Wright (1974). In all tests (except pronunciation, which does have some physiological basis for development), the post-pubescent 12-15 year old group outscored all younger age groups. These findings stood up, albeit with less clear-cut correlations, when each age group was compared with native Dutch speakers of the same age. Thus, the authors conclude that "a

critical period extending from age 2 to age 12 does not exist".

These findings are important for two reasons. First, these studies further confirm the ideas of transfer and linguistic interdependence. The older language learners who have had more time to develop L1 proficiency did better than their younger counterparts. Second, this research shows that since the "critical period hypothesis" is invalid, these theories of linguistic development in the elementary and secondary aged students are comparable. Therefore, the fundamental tenets of bilingual education described in the last section can be applied to the secondary level. Having established the applicability of these theories in general, let us now look at how they would function in the context of secondary academic achievement.

Age and academic achievement. The problem with much of this research for the purposes of this paper is that its primary focus is not necessarily the type of proficiency required for academic achievement. Rather than examining general tests of English proficiency as most of these earlier researches had done, Collier (1987) emphasized the application of English skills in academic

content areas. Thus, her data will most closely demonstrate the link between age and CALp.

Collier's (1987) extensive examination of data on standardized tests in language arts, math, science and social studies yields several important conclusions about age on arrival and the development of language for academic achievement. Collier uses the 50th normal curve equivalent (NCE) as a benchmark for academic achievement in the content areas. The key independent variables, Age on Arrival (AOA) and Length of Residence (LOR), influenced achievement as measured by the standardized tests (dependent variable) in this fashion:

Table 1

Age on Arrival (AOA). Length of Residence (LOR) and Academic Achievement

AOA	Schooling in L1	LOR and Academic Achievement
4 - 6	little or none	No norms reached after LOR of 6 years
7 - 11	2 or more years	Reading, language arts, science and social studies norms reached in LOR 5-7 years; mathematics norms reached in 2 years
12 - 16	7 or more years	Mathematics norms reached after LOR of 6 years; no other norms reached

Note. From Collier, 1989

Thus, Collier's study confirmed Cummins' estimate that at least five years were required to reach levels for cognitively demanding, context-reduced language proficiency. The adolescent (12-16) age results appear to contradict some of the earlier research. Scores were in fact far from the 50th NCE (31st NCE in reading, 38th in social studies, 37th in science, 42nd in language arts).

One might expect these students to do better given their solid foundation in L1. This assumption, however, fails to take into account the fact that it takes several years for these students to learn basic English and that during this time the content classes are getting more and more difficult. Since Collier focused on English Only classes, it means that NEP students were sitting in mainstream secondary content classrooms without even the minimal L2 abilities. These lost years are often never made up.

As Collier concludes:

"Adolescent arrivals who have had no L2 exposure and who are not able to continue academic work in their first language while they are acquiring their second language do not have enough time left in high school to make up the lost years of academic instruction...Consistent, uninterrupted cognitive academic development in all subjects throughout students' schooling is more important than the number of hours of L2 instruction for successful

academic achievement in a second language" (p. 527)

Collier's research suggests the following:

1. Linguistic interdependence carried out through the process of transfer exists in the CALP dimension of language acquisition, but not in the BICS dimension
2. It takes approximately 5-7 years for CALP to develop in L2; this is partially a function of the transfer of L1 CALP
3. 8-11 year old arrivals have the right combination of a sufficiently developed L1 CALP which can be transferred and a limited level of complexity in the content areas.
4. 12-16 year old arrivals usually have sufficiently developed L1 CALP for transfer; but academic progress is limited by the increasing complexity of content at the secondary level
5. Students arriving in the United States during early adolescence may not be able to effectively understand and achieve success in mainstream English content classes until they are almost out of high school unless they are given instruction in L1 in content areas for several years.

Thus, when discussing the relationship between primary language use in content classes and content area achievement at the

secondary level, it is clear that the mere transfer of linguistic skills is not sufficient to ensure success. What must be examined next is how the concepts of linguistic interdependence and transfer relate to the content areas, with particular emphasis on the use of primary language as an indicator of subsequent academic achievement.

Primary Language Use and Content Area Achievement

There are three basic approaches to teaching content to recent arrivals at the secondary level: mainstream all-English instruction, sheltered English instruction, or primary language instruction. The key question that must be addressed is the following: Which of these approaches is the most likely to lead to long-term academic success? Before considering the implications of this question for adolescent arrivals at the secondary level, it is important first to look at the effects of different language approaches to instruction in content classes at any level.

Linguistic interdependence in the content areas and academic achievement. As described above, Cummins and others have demonstrated a link between early primary language development

and long-term success in a second language. This link, of course, depends on two additional variables: effective second language instruction and sufficient time (5-7 years) for CALP to develop. The result would be an "additive bilingual" whose skills and knowledge in the first language transferred to the second language. This concept of linguistic interdependence needs to be looked at further. Specifically, it is important to address the relationship between the concepts of linguistic interdependence and content area achievement. The key question is the following: What evidence exists that additive bilinguals outperform English Only or subtractive bilinguals in content area achievement?

Kessler and Quinn (1980) considered this question in a study comparing the hypothesis-generating abilities of additive Mexican-American bilinguals, subtractive Italian-English bilinguals and monolingual English-speaking 6th graders. They found that the additive bilinguals consistently outscored the other two groups. In 18 different sessions, the students were shown a physical science problem and then asked to write as many possible hypotheses explaining the problem in 12 minutes. The answers were scored

according to the scientific quality of the hypothesis. The additive bilinguals' mean scores were 176, compared to 48 for the subtractive bilinguals and 41 for the monolinguals.

The responses were also scored for their syntactic complexity. While a positive correlation existed between hypothesis quality and syntactic complexity for all three groups, it was especially high (.98) for the additive bilingual group. This suggests that cognitive abilities in the content areas, such as hypothesis-generation, and primary language competencies are strongly connected. This further strengthens Cummins' theory of L1 CALP development as a tool for later academic success.

Content area achievement was also linked with additive bilingualism in a study of 133 undergraduate engineering and science students (Mestre, 1981). His subjects were divided into two groups: Hispanic students classified as predominantly additive bilinguals and a culturally-mixed group of monolingual students. His results showed a stronger correlation between the language proficiency and non-linguistic mathematical tasks in the bilingual group when compared to the monolingual control group. This suggests that

strong L1 and L2 proficiency can lead to academic gains even in content areas not requiring a direct use of linguistic abilities.

Myers and Milne (1988) further confirmed these results, though less conclusively, in an analysis of high school students language and achievement contained in a large government research project. After controlling for the influence of other background variables, they found that students identifying Spanish as their "primary language" had a higher level of math achievement than those claiming both English and Spanish as their "primary language." No attempt is made to differentiate whether these students are additive or subtractive bilinguals, but the fact that the Spanish Primary Language group lived in the U.S. approximately 3 years less than the English/Spanish primary language group would seem to indicate that differences in math achievement may be related to the strength of L1 and the concept of linguistic interdependence.

Finally, in an analysis of the thinking processes used to read and write in both English (L1) and French (L2), Cumming and Rebuffot (1989) documented a high correlation between thinking skills used to compose summaries of a highly complex political science text and

the level of L1 CALP. Using 14 adult Anglophone students of French, a study was set up involving English and French translations of a series of newspaper articles written by Vladimir Lenin in pre-revolutionary Russia. In accordance with Cummins' theories, the beginning French students with higher levels of L1 CALP were better able to understand and summarize the articles in both languages than could more advanced French students with low L1 CALP. While lexical and syntactic limitations are clearly present in the High-CALP, beginning French students' compositions, the ability to ascertain the main idea of extremely complex text written had transferred to the second language.

This is a skill which is essential for academic success in mainstream content classes and makes a strong case for the necessity of developing CALP to the greatest extent possible in the native language.

Sheltered content instruction and academic achievement.

Despite the compelling evidence that CALP development in L1 leads to higher math, science and social studies achievement, many schools still teach content to their LMS through what is known as

"sheltered instruction". Clearly, sheltered instruction is useful in situations where many different languages are represented and there are not sufficient numbers of one language or competent teachers to have a primary language class. It is also most helpful at the intermediate and advanced level as a bridge to success in mainstream content classes (Dubin, Eskey & Grabe, 1986; Spanos & Crandall, 1990; Fathman, Quinn & Kessler, 1992; Adamson, 1993). But to equate sheltered instruction with CALP development for non-English speaking recent arrivals is a dangerous proposition which undermines the need to remain focused on finding a way to provide the L1 content classes necessary for long-term academic achievement. Although content will clearly be more accessible than in a mainstream classroom, the student is still not receiving the same access to the curriculum through sheltered instruction as do native English-speaking students.

Primary language use in content and achievement. The studies above support the notion that the strong foundation of primary language CALP present in most additive bilinguals can result in enhanced second language content achievement. The next question to

consider then is whether primary language development in a specific content area can lead to enhanced achievement in that content area when tested in a second language.

Indirect evidence linking L1 use and content achievement can be found in the literature on effective schools, although primary language use is usually considered an extra tool to aid comprehension rather than the main vehicle for instruction.

Tikunoff (1981), for example, cited a teacher's ability to use L1 alongside L2 as a factor contributing to effective instruction for LMS. Tikunoff points out that "particularly for NES/LES who have no English or little English proficiency, this allows them access to instruction. Without this, it is unlikely that these students could learn" (p. 251).

More recently, Tikunoff et al. (1991) found native language use to be a salient feature of content lessons taking place in effective schools which were actually designed to provide instruction in English to LMS. This study of exemplary Specially Designed Academic Programs (SAIP) found that while most teachers were instructing in English, most of the time in the classroom was spent

in cooperative groups where English was used exclusively only 55% of the time. Those teachers or instructional aides who spoke the student's primary language used it extensively to help non-English speakers understand the lesson.

Saville-Troike (1984) also observed in a study of 14 high-achieving individual LMS that primary language use classes which were using English as a vehicle of instruction was an important determinant of achievement. Most students with opportunities to discuss and clarify concepts in their first language either with peers or adults achieved best in content area tests.

While these studies looked at schools or individuals with high academic achievement and worked backwards to determine which variables were significant, other studies compare the impact of various types of bilingual programs on academic achievement. Because of the availability of achievement test data, these studies all focus on mathematics. At first glance, mathematics seems to be the one content area which is readily accessible to even beginning English learners. However, contrary to popular belief, mathematics achievement is highly dependent on linguistic abilities, though

probably not as much as social studies or science. In fact, real success in more advanced math requires the same types of higher level thinking skills present in Cummins' theory of CALP (Kessler, Quinn and Hayes, 1985; Ovando and Collier, 1985).

Studies of comparative programs are often vague in their descriptions of the amount of primary language used in content classes. They often divide their studies into three categories: late exit bilingual, early exit bilingual and All English or Immersion. One can presume that late exit bilingual program would utilized the most sustained, intensive L1 instruction. Therefore, in analyzing which of these programs demonstrates the highest achievement levels in the area of mathematics the question of the effectiveness of primary language instruction for content area achievement is also being addressed, albeit at the elementary level.

Krashen and Biber (1988) analyzed comparative achievement results in six California school districts. Their meta-analysis of K-6 and K-8 standardized test data showed that in the one content area examined, mathematics, it was evident that strong late-exit bilingual program containing primary language content classes

eventually placed the late-exit bilingual program students at or above national grade level norms. Moreover, when controls for socioeconomic status were taken into account, these students outperformed other LEP students receiving all English instruction during elementary school.

In 1992, Ramirez completed a government-sponsored four-year longitudinal study of 2,000 elementary students enrolled in late-exit bilingual, early-exit bilingual and all English programs (Ramirez, 1990). He found that LMS in late-exit transitional bilingual programs who received "substantial" amounts of primary language instruction (which he defines as more than 40% of the time) continue to increase their math achievement levels throughout elementary school, while the students who were quickly transitioned to all-English content classes slowed down considerably. According to Ramirez, these results suggest that "providing substantial instruction in the primary language appears to help LEP students catch up to their English-speaking peers in...mathematics" (p. 45). Therefore, Ramirez recommends "LEP students should be provided with content instruction in their

primary language until such time as they are able to profit from E-O instruction" (p. 47)

Collier's 1993 synthesis of elementary-level studies focusing on the effectiveness of different languages of instruction underscored the fact that Krashen and Ramirez' conclusions are part of a vast body of literature which consistently finds L1 content instruction to be superior for LMS whose L2 BICS have not been adequately developed. What is needed, she notes, is considerably more attention to the academic progress of these students at the secondary level, "analyzing their progress in the mainstream after receiving various types of special program support" (p.203). Having established the superiority of primary language use in content classes for LMS without adequately developed L2 BICS in general, one must now turn to this issue at the secondary level.

Primary Language Use and Content Area Achievement: The Secondary Level

Evidence for effectiveness. In looking at the use of primary language in content classes for adolescent arrivals at the secondary level, it is helpful to consider, as we did at the elementary level, the research into effective schools.

Lucas et al. (1990) applied the methodology used in research evaluating the general effectiveness of different schools to the academic success of Latino LMS at six exemplary high schools. Each of these schools has been widely recognized at local, state and federal levels for their outstanding success in meeting the needs of LM students. After extensive observation and research, they identified 8 key features which they considered responsible for the academic success of these students. Two of these features are especially relevant to this research. First, these schools promoted the self-esteem of these students by clearly demonstrating respect for their language and culture. Informally, this was done through non-Latino teachers learning and using Spanish and encouraging students to speak their primary language when second language

development was not the main objective of instruction. But, more importantly, this was done through the offering of formal content and elective courses taught in Spanish. This was the second salient feature which the authors found promoted academic success.

Offering a large variety of primary language courses ensured that "those who did not yet speak or write fluent English nonetheless were given the opportunity to progress in content courses appropriate to their academic level." For example, in one school a mathematically advanced recent immigrant from Mexico was able to take a Spanish Geometry course. Had this course been only available in mainstream or sheltered English, this student would have fallen behind in math during the period she was learning basic English.

According to this study, informal and formal primary language use in secondary school clearly promotes high academic achievement in general by giving the non-English speaking immigrant student the affective and cognitive support required to further their education in their education in the United States. Melendez (1980) examined this issue more specifically in his study of the effectiveness of different languages of instruction in secondary level reading. Since

reading skills are essential to success in many text-centered content subjects such as social studies, this study has implications for the use of primary language in secondary content classes.

Melendez surveyed the type of language use offered in reading classes for Language Minority Students in grades 7-10 in districts throughout the United States. He found evidence that Spanish-dominant LMS taught reading skills in Spanish scored "significantly better" on English CTBS reading tests than LMS taught the same skills in English (mainstream) or in a combination of English and Spanish (bilingual). Sheltered English was not a variable in the study. He concludes that "instruction in the mother tongue of the linguistically distinct student [LMS] at the secondary level is essential for their continued progress in the total spectrum of the secondary-school curriculum" (p. 109).

Ovando and Collier (1985) also advocate the use of primary language in secondary content classes because of the increased access it gives LMS to the curriculum. In evaluating the effectiveness of various language approaches in secondary social studies, for example, they point out that the content offered in

sheltered, or "ESL social studies" classes must be "significantly simplified" because of the dual focus of content and language. By contrast, in primary language, or "bilingual maintenance," secondary social studies classes, there is a single goal: content achievement. In these classes, the student is able to keep on grade level in the subject area. To illustrate this point, the authors explain that several school systems have found the following:

...if they offer U.S. history taught in Vietnamese (for example) to Vietnamese students who have recently entered the United States, students may successfully master the content of the course and score at least as well or better than English-speaking students on a standardized test given in English at the end of the year, after they have had enough time to work on their proficiency in English in ESL classes (p.157).

Unlike in social studies classrooms, according to the authors, the use of native language to ensure concept acquisition in math and science is sometimes considered less imperative. At the elementary level, much content learning is dependent on manipulation of concrete objects. This learning lends itself to sheltered techniques or mixed language cooperative group activities. As the student enters the secondary level, however, these subjects become much

more context-reduced. The cognitive academic skills that are not as necessary at the elementary level become increasingly important.

In comparing bilingual and sheltered approaches to the teaching of secondary math and science, Ovando and Collier (1985) argue that native language instruction can enhance math and science achievement of LMS, especially if the concepts to be learned have not been mastered in the first language. If grade-level concepts have been largely mastered, then the authors suggest focusing on lexical and syntactic structures which will help transfer knowledge to the second language.

The choice of instructional language is rarely an either-or proposition. Language use can extend on a continuum. The key point, however, is that the degree to which new content can be mastered depends, to a certain extent, on the use of the primary language at least part of the time. If primary language instruction is used, there are many approaches to choose from. The most common methods cited are the concurrent approach (switching back-and-forth in the same lesson), the alternate language approach (clearly separating the two languages) or the preview-review approach (introducing and

concluding an English lesson in the primary language). This last approach should only be used in context-embedded science and math lessons such as a hands-on experiment or a manipulative-based word problem.

While there are many factors which inevitably influence the choice of language for math and science instruction, it must be remembered that primary language use is essential where lessons involve new concepts and/or context-reduced delivery.

Historical context and current status Despite mounting evidence for the effectiveness of primary language use in secondary content classes, advocates of this instructional approach have had a difficult time implementing it on a widespread basis. There has always been strong opposition to bilingual education since it began as primarily a K-3 program in the 1960's (Lessow-Hurley, 1990; Crawford, 1992). As the number of LMS in the secondary grades increased in the 1970's and 1980's, new programs at the secondary level were created (Sosa, 1990). This expansion to the secondary level elicited even greater opposition in some quarters.

This opposition may stem from deeply rooted prejudices about

the causes of the academic underachievement of immigrant students. Early studies of secondary achievement levels of LMS attributed this underachievement to "academic retardation" and supposedly documented how it became significantly more pronounced as a student advanced through the grades (Tireman 1948, Boyce 1960, Townsend 1961, Smith 1964).

Morris (1972) attributed these progressively worsening achievement levels to the "sudden and tremendous increase in the difficulty of vocabulary, content and concepts" that occurs as a LMS enters secondary school. In particular, she explains difficulties with reading comprehension in terms of a lack of "real or vicarious experiences". However, she asserts that these experiences necessarily must occur in English by explaining that we "must also consider that maybe they have never had the opportunity to develop the conceptual basis for abstraction in English". Developing "the conceptual basis for abstraction" in the student's primary language is not even considered an option. In fact, in 1972, at the time of Morris' article, the U.S. Commission on Civil Rights reported that 39% of the secondary schools (and 30% of the elementary schools) in

the southwest "discouraged" the use of Spanish in the classrooms. Discouragement ranged from verbal comments to strict disciplinary action.

This misconception about the cause of secondary underachievement among LMS stills lingers today. A prevailing philosophy seems to be that at the secondary level recent arrivals require the maximum number of hours of intensive experiences in English, even if this means missing years of content area knowledge and skills.

Halcon's 1983 study of federally funded Title VII bilingual programs revealed that although the majority of programs are at the elementary level, less than 8% of the programs begin in Kindergarten and extend through high school. Indeed, there is very little continuity even between upper elementary grades and junior high or middle school. The author concludes that it is clear secondary level programs are "intended primarily for students entering and not for those continuing." Since it is these recently-arrived "entering" students that we are most concerned with, let us look at how current secondary programs serve their needs for receiving primary

language instruction.

A recent report published by the California Department of Education (Minnicucci and Olsen, 1992) analyzed the instructional language approaches of 26 regionally and demographically diverse secondary programs. The report identifies four basic approaches for teaching content: mainstreaming, sheltered English, sheltered English with primary language, and primary language. Only 5 of the 27 schools have a primary language content program in place; 6 others use the mixed sheltered and primary language approach, and the majority rely entirely on all-English instruction (13 sheltered English and 3 mainstream regular English). Unfortunately, there is no attempt to relate the number of recent arrivals or non-English speakers with the approach offered.

A closer examination of the language approach used in content classes reveals a few differences between the intermediate and high school level. At the intermediate level (which could include upper elementary grades in certain middle schools), sheltered English is clearly the preferred mode of instruction in math, science and social studies. However, primary language (in all cases, Spanish) is used in

almost one third of the surveyed intermediate schools. At the high school level, however, sheltered English or combined sheltered English/Primary language approaches dominate, while exclusive L1 instruction is used in only 2 of 13 math, science and social studies classes.

Regardless of which approach is used, almost half of the schools surveyed had "big gaps" in the content area coverage offered. In addition to the three schools which offer absolutely no special program for even the NEP students, 10 schools only offer "sparse content coverage. This is defined as a situation in which:

...One whole subject area is not scheduled for LEP students, such as science or math, and/or entire grade levels are missing often 11th and 12th grade classes. LEP students in sparse content programs are enrolled in ESL and electives. They do not take science or math, and are limited to course offerings in grades 9 and 10 only (p. 29).

If these surveyed schools can be considered statistically representative of California, and if California is assumed to be at least as progressive as other states in the use of primary language in secondary schools, then it can be concluded that the overwhelming majority of LMS nationwide are being denied access to the content

areas. Consequently, many do not receive the preparation necessary for long-term academic achievement.

While the primary language approach to delivering instruction in secondary content classes is quite uncommon, steps are being taken to move to encourage it. A new California report which is to be a blueprint for bringing secondary schools into the next century (California High School Task Force, 1992) envisioned a school where LMS are given full access to content courses. The report recommends that "the student's primary language is used as a powerful learning tool. If significant numbers of students are from the same language group, instruction is in that particular language" (p. 41).

It has always been always easier to design a strong bilingual-bicultural secondary program than to actually implement one. The lack of bilingual teachers and good Spanish-language materials have always been the major obstacles to implementation. So far most of these limited resources have been concentrated at the elementary level. Carrillo (1977) and others have proposed teacher-training programs to specifically prepare potential bilingual teachers in the

skills necessary to meet the linguistic and cultural needs of secondary Language Minority Students. Little progress, however has been made in this direction.

Others have suggested setting up Newcomer Centers which would cluster the recently arrived non-English speaking students with the limited number of bilingual teachers available. While it would seem like these centers would be an excellent way to deliver primary language instruction, at least initially, the use of primary language actually varies widely for center to center (Friedlander, 1991). Even at these specialized schools-within-schools, sheltered approaches are often considered to be adequate for teaching content.

Despite these problems, one can at least try to envision what a model secondary bilingual program, with primary language content for beginning English learners, might look like.

A model secondary bilingual program promoting academic achievement. A strong secondary bilingual program promoting academic achievement for non-English speaking adolescent arrivals must start with this primary language component. As these students progress in their acquisition of English, sheltered courses

designed to develop the academic competencies required for success in mainstream courses can be introduced. Cognitive Academic Language Learning Approach (CALLA) has been proposed as a means of developing the essential "procedural and declarative knowledge" required in the mainstream (Chamot and O'Malley, 1987). A program model which most closely resembles this configuration would look like Figure 2:

Beginning (2 years)**CALP Development**

L1 in Social Studies

L1 in Science

L1 in Math

BICS Development

Natural Approach ESL

Context-embedded Electives in L2

PE in L2

Intermediate (1-2 years)**CALP Development**

CALLA Model Science

CALLA Model Math

L1 in Social Studies

BICS Development

Natural Approach ESL

Context-embedded electives in L2

PE

Advanced (1-2 years)**CALP Development**

CALLA Model Science

CALLA Model Math

CALLA Model Social Studies

Literature-based ESL

Context-reduced electives in L2

BICS Development

PE

Mainstreamed**CALP Development**

All content classes

AP Spanish

Cultural Enrichment in L1

BICS Development

Fully developed

Figure 2. A Model Secondary Bilingual Program Promoting Academic Achievement

This model would account for all of the theoretical assumptions related to BICS and CALP development for adolescent arrivals. Primary language would be used initially for all of the content classes to allow for intensive CALP development. This would continue longer for social studies, the most context-reduced subject, while modified sheltered techniques would be phased in sooner for science and math. Ideally, these classes would be available at different levels so that adolescent immigrants could continue their L1 CALP development uninterrupted. For example, L1 math classes would include basic skills classes as well as Pre-Algebra, Algebra and Geometry. BICS development would occur through ESL classes utilizing Natural Approach techniques to foster communication in a low-anxiety environment, as well as through PE and context-embedded electives like art, music and woodshop.

The question of how much time should be spent in L1 classes at the secondary level is complicated. Though both Cummins' and Collier's research found that 5-7 years were necessary for CALP to reach age-grade norms, at the secondary level the imperatives of graduation make this time frame for L1 content instruction

impractical. Two things are required for graduation in most states: credits and passage of minimum competency tests known as "Proficiency Tests". Since not all immigrant secondary students have the minimum 5 years to spare graduation, passing these English language, math, reading, and writing tests often necessitates that the student be given English instruction earlier than theoretical models suggest. Since Cummins found that it took 2 years just to develop L2 BICS, it would seem that a minimum of 2 years L1 content instruction is essential to long-term academic achievement. Of course, students arriving in the 11th or 12th grade would not have the time to go through all of the recommended theoretical stages.

Primary Language Use and Secondary Math Achievement

It is the contention of this paper that a bilingual secondary program for adolescent-arrival non-English students that most closely resembles the above model will be the most effective at promoting eventual academic achievement. To test this hypothesis this study will be limited to mathematics, which has the most readily available content achievement data. According to this

model, at least 2 years of L1 math classes at the student's ability level and another 1 to 2 years of cognitively-demanding sheltered math classes are necessary for the typical adolescent immigrant to succeed in mainstream English math classes, as long as the student is concurrently enrolled in an English Language Development (ELD) program.

As a student progresses through the grades at the secondary level, math achievement becomes increasingly reliant on a student's CALP. Much of the math curriculum becomes less computational and more analytical. Kessler, Quinn and Hayes (1985) explain that the language of math that is required for achievement involves specific lexical, syntactical and comprehension skills. The vocabulary that represents concepts like "quotient", "dividend", "least", "greatest", etc. frequently stump LMS in mainstream math programs. Similarly, the syntax of key "logical connectors" like "if...then", "because", "either... or" are, according to the authors, especially difficult for LMS students at all levels and thus must be well developed for success. In addition, reading comprehension is an essential skill required to work word problems which "exemplify the context-

reduced language of mathematics" (p. 15). Furthermore, the advanced math reasoning used in problem solving often involves metacognition, the process of thinking, planning and monitoring how to approach a particular math problem. Since math success requires these types of advanced thinking skills, and these functions can be best developed in L1, the authors suggest using primary language instruction at least initially to ensure long-term math success.

At the secondary level, however, initial L1 instruction in itself is not enough to achieve academic success. In accordance with the theory of linguistic interdependence, this initial instruction in the United States must build upon a foundation of native language cognitive abilities developed during the pre-adolescent years. Merely instructing an adolescent age student in a language they can understand does not necessarily mean the student will be able to understand the skills and concepts. Pre-existing math abilities developed in the primary language during pre-adolescent years must have reached the grade level norms of the math being taught in these initial United States math classes. (Or, conversely, numerous levels of L1 math classes must be offered).

Furthermore, it is imperative that the student have enough time to develop the second language skills required to successfully transfer these primary language math abilities into a second language math situation.

In conclusion, long-term math achievement in a second language depends on three things:

- 1) The level of pre-existing math abilities in L1
- 2) Continual development of math abilities in L1 during the initial English learning period
- 3) Sufficient time exposed to comprehensible input in L2 through an ELD program

In the next section, these three concepts will be operationalized and analyzed to determine their impact on the long-term math achievement. A local district which has recently begun providing content instruction in the primary language (Spanish) will be the focus of the research. The instructional language approaches (Spanish or English-whether sheltered or mainstream) in a student's initial math courses will be used as the main independent variable and math achievement (district math proficiency tests) as the dependent variable. Pre-existing math ability and the number of

years in the United States taking ESL classes will also be included as independent variables.

This data analysis will suggest some answers to our main research question: How much influence does initial primary language instruction in math classes for adolescent arrivals have on subsequent second language academic achievement?

Chapter Three: Design/Methodology

In order to analyze the impact of primary language use on academic achievement at the secondary level, a district had to be located which could provide the necessary data. However, as the review of recent studies indicates, the use of primary language to teach content to adolescent immigrants at the secondary level is a relatively new practice. The scarcity of long-term programs posed serious research problems. There are a few isolated districts (such as Calexico Unified in California) which have had L1 classes offered in the middle and high schools for the last decade. However, because their program is so thorough, this would make it difficult to do an intra-district analysis comparing different types of language

approaches used with adolescent arrivals. Conversely, districts that have only sheltered or regular English content classes for adolescent arrivals would not be helpful either. A district had to be found which has been using different approaches at different middle schools or that had only been using L1 for a couple years. In this case, there would be a pool of students who may have begun their schooling within different approaches. Their recent achievement levels could then be compared and analyzed. Several districts fit this criteria. One, Fontana Unified School District, was chosen for this study because of its relatively large LMS population, its proximity to this author, and the cooperation of district personnel.

Fontana is a medium-sized school district located 50 miles east of Los Angeles. It has 2 high schools and 5 middle schools. One of the high schools, Miller, just opened last year. Therefore, it was decided to focus on the high school with a long-term program in place, Fontana High School, and its three feeder middle schools (Sequoia Middle, Fontana Middle, and Southridge Middle).

Data Needed

In order to answer the question of how much influence primary

language instruction in the initial math classes of adolescent immigrants has on subsequent second language math achievement, data had to be found which would measure four things: initial language of instruction in math classes, number of years in the United States (while enrolled in ESL classes), pre-existing math abilities and current math abilities in the second language.

Measurement of the independent variable initial language of instruction in math classes required a permanent record of adolescent immigrants' math classes which specified the initial language of instruction. Initial language of instruction, when measured as a nominal variable, could be either English or Spanish. Initial math instruction in Spanish was defined as taking at least one semester of math in a student's first documented year in the U.S. taught by a certified Spanish-speaking teacher who used Spanish as the primary vehicle of instruction. This was determined through interviews. Any other approach, including sheltered English with a Spanish-speaking aide offering supplementary assistance, was classified for the purposes of this analysis as initial math instruction in English.

This data was available in Fontana mostly by obtaining copies of high school transcript which were kept for all students. However, since these transcripts only covered the 9th-12th grades, they had to be supplemented for students who arrived in the United States in 7th or 8th grades. Since this data had been erased from the district's central database, these records had to be obtained by looking for report cards in the students' cumulative record.

A second independent variable, years in the US receiving ESL instruction, was used to represent how much L2 comprehensible input the student had received prior to being tested for second language math achievement. According to the theory of linguistic interdependence, the development of L2 BICS alongside L2 CALP was needed for transfer to succeed. Therefore, data was needed which would indicate how long a student had been in the U.S. and it had to be confirmed that the student was enrolled in a program of English language development. This data could be obtained from district records which include U.S. entry dates and student schedules.

The third independent variable required for this analysis was a measurement of pre-existing math ability. This could be derived

from any Spanish-language math achievement test administered upon a student's entry into US schools. Finding this data proved to be problematic. In Fontana, all immigrant students are given test measuring their reading, writing and speaking abilities in English and the student's first language, usually Spanish. Unfortunately, no math abilities were measured in any language. It was found, however, that some recently immigrated Spanish-speaking students who began their secondary years in 7th, 8th or 9th grade did take a standardized math test called the Spanish Assessment of Basic Education (SABE) during their first year in the U.S. This test is a Spanish language assessment test which is comparable to the English California Test of Basic Skills (CTBS). Percentile scores from the math sections could be used as an indicator of pre-existing abilities, even though it would be preferable if some data existed on math ability prior to any math instruction in U.S. schools. Since this test was only administered in some of the middle schools, not all of the immigrant students to be included in this study would have this data. Still, this information could be used to lend some insight into the relative impact of this variable. In fact, because the test

results are divided into the categories computation and concepts and applications, this variable could actually be divided into two independent variables. "Computation" scores would measure basic non-linguistic math skills while "concepts and applications" would give a better measure of pre-existing L1 math CALP.

Measurement of the dependent variable, math achievement in English, could be derived from a recent, objective content area standardized test score. This type of data was difficult to find. Because achievement tests rarely measure social studies or science abilities, math was chosen to be the content subject to be analyzed. This also would help to control for--but not eliminate--the effects of language abilities in measuring content achievement. The best indicator of academic achievement was the CTBS math section. However, for a variety of reasons, most of the students to be studied had not taken the CTBS in recent years.

It was decided to focus instead on the district's own proficiency, or competency, test. This is a minimum competency test which must be passed (70%) for a student to graduate. A comparison of percentage scores in math with their permanent

record of math classes could then be conducted. The math section of the proficiency contains 60 questions; 25 questions require no reading whatsoever, while the remaining 35 require at least some knowledge of math-related English vocabulary. Of these 35 questions requiring English, 12 could be classified as word problems. The other 23 contain basic instructions in English ("Answer in lowest terms", "Find the volume of the cube", etc.). Thus, there is enough English CALP being measured to make this test an acceptable measurement of the dependent variable- content area achievement in English.

When combined with an examination of the type of language used in their initial math classes, years in the U.S. and pre-existing math abilities, this math proficiency data would help to shed light on the relationship between the initial language of instruction and academic achievement in content classes.

Subjects

The focus of this study is the potential academic benefit adolescent arrivals with limited English skills would derive from being taught content (math in this case) initially in their primary

language. The key question is how to identify these adolescent arrivals from among the 4,300 students currently attending Fontana High School.

First, only students who were currently classified as Limited English Proficient (LEP) or had been redesignated Fluent English Proficient (FEP) were selected. This narrowed the search down to 1,218 students (408 LEP and 810 FEP). The next step--identifying those who arrived during their secondary school years--was more difficult. An adolescent arrival could be a 12th grader who arrived as early as 7th grade. Unfortunately, the district only began keeping computer records on immigrant's date of arrival 4 years ago. There was no way of identifying 11th or 12th graders arriving in the 7th or 8th grade. Therefore, it was decided to limit the analysis to the arrivals during the last four years. This narrowed the search down to 223 9th through 12th graders.

Since the data on U.S. entry dates had been entered in June, 1992 and this study was conducted in May, 1993, all of these students were in the United States for at least one year. So, all of the subjects had between one and four years to develop their English

BICS and math CALP (either in L1, L2 or a combination).

Next, the 9th graders who arrived 4 years ago were eliminated because they would have arrived during the 6th grade, which was not a part of Fontana's secondary system. Furthermore, since the only primary language math classes offered in Fontana were conducted in Spanish, non-Spanish speaking students were also excluded. This narrowed the list down to 182 subjects. After eliminating those students who had not taken the math proficiency test (see reasons below), the number of available subjects was reduced from 182 to 95. Having identified the school's adolescent-arrival Spanish-speaking immigrants, the next step was to begin gathering data on these student's secondary math classes and proficiency scores.

Data Collection

The first and most difficult task was to identify the language of instruction used in math classes at Fontana High School, Sequoia Middle School, Fontana Middle School, and Southridge Middle School. Transcripts and cumulative grade records contained over twenty-five different labels for math classes.

Classes taught in L1. It was initially assumed that "ESL Math

P1" or "ESL Math Prime" denoted classes taught in the primary language. However, interviews with the site coordinators and math instructors revealed that this was not necessarily true. A major difference was found in the instructional approaches used at Sequoia and Fontana Middle Schools, though each labelled their classes "ESL MATH P1." Sequoia Middle has had several different teachers over the last four years teaching this course, but all were BCC certified teachers who conducted the class entirely in Spanish. At Fontana Middle the teacher was bilingual and taught the course for each of the last four years. However, he has been teaching the class, according to his own estimate, "85% in English using an English language text." Spanish is used to "supplement on an individual basis." A Spanish language text was available for the students to keep at home for reference. Since sheltered classes also provide some supplemental support in the primary language (usually through paraprofessionals), this class was determined to be more accurately classified as a sheltered math class. The other feeder middle school, Southridge, had no primary language classes listed and had very few LEP students who eventually went on to Fontana High

School.

Fontana High School, like Sequioa Middle, was found to have true primary language math classes. They have been taught by two different teachers, but both have been BCC-certified and conducted their classes entirely in Spanish. These classes began in September, 1990. The class, however, is only open to 9th and 10th graders and follows the curriculum of English language "Math A" classes. Some non-English speaking students, according to the instructor, should be in an L1 Algebra class, but none is offered so they are given the lower math. Other students, it was found, were put in more advanced English language classes with limited primary language support.

Thus, only the classes from Fontana High School and Sequioa Middle that said "P1" or "Prime" were counted as classes taught in L1. Most adolescent immigrants who attended Fontana High School since September, 1990 and those attending Sequioa Middle School would largely comprise the "initial Spanish language approach" group, while earlier Fontana High School immigrants and Fontana Middle School immigrants would make up the "initial Spanish

language approach" group.

Classes taught in sheltered or regular English. Any ESL math class which was not labelled "P1" or "prime" was assumed to be taught in sheltered English. These classes may or may not have contained the "SHL" or "S" code, but the fact that they were denoted as "ESL Math" and were not taught in L1 led me to believe they were sheltered classes. Interviews determined this was the case at all of the sites. Almost all teachers had received at least some training through a number of district programs, county classes, university credential courses, or conferences. Thus, these codes were all counted as courses taught using a sheltered English approach.

All remaining math classes--ranging from a remedial class called "arithmetic" to calculus-- were counted as classes taught by teachers using regular English in a mainstream setting.

This classification of data became more problematic when students began their secondary schooling in other districts in the United States. Eight students had taken at least one class in another district. Because of the relative rarity of L1 math classes in other districts (see Minnicucci and Olsen, 1992), these classes were

assumed to be taught in English if they contained the word "ESL", "Sheltered" or its abbreviations. One class, labelled "BIL" was not counted in the analysis because it was unclear how much Spanish instruction was used. No other math classes contained any code which would seem to indicate a class taught through the primary language.

Once the language of instruction represented by each scheduling code was determined, each student's transcripts and cumulative records had to be examined. Language of instruction was determined according the criteria described above and the number of L1 and L2-instructed math classes was then entered into a spreadsheet.

Data related to the subject's years in the United States and pre-existing math abilities (if available) were collected from the district's central database. As mentioned, the district had been recording data about immigrant students for the last four years. At the end of each school year in June these records are updated. Since this data was collected in April and May, students actually had been in the United States up to 11 months longer than the data base

showed. Therefore, the codes "1", "2" and "3" actually refer to student in the U.S. "1-2 years", "2-3 years" and "3-4 years".

The information about pre-existing math abilities, as measured by the SABE test, was included in the database as part of a file of all the students' standardized test scores. The earliest SABE tests taken were used for the purposes of this analysis. Only 17 of the 96 subjects had taken this exam during their first year in the United States. Some caution, therefore, had to be exercised when suggesting the impact that pre-existing math ability might have on the dependent variable

The final data collection task involved analyzing the Math Proficiency scores as an indicator of academic achievement. This information was also in the student testing file included in the district's central database. The test is offered at different times of the year to different grade levels. Since it is required for graduation, everyone in 11th and 12th grade, regardless of their English abilities, is encouraged to take the exam as many times as possible. 9th and 10th grade students are generally offered the test once, but LEP adolescent arrivals are not encouraged to take the

exam unless they feel they have improved their English enough to have a chance of passing. This is why only 96 of the 182 identified adolescent immigrants could be included in this study.

Printouts from the districts data processing center showing the latest math proficiency scores were obtained in May, 1993. Most of the 11th and 12th graders had taken the test within the last month. These scores were then entered into the same database used to record the initial language of instruction in each student's math class.

Thus, the database used for the analysis of data listed each of the 96 subjects' initial language of instruction, number of years in the US, SABE math scores (where available) and recent math proficiency scores. The research question could then be answered by dividing the students according to whether they had received initial math instruction in Spanish (L1) or English (L2) and analyze the comparative proficiency scores of these two groups taking into account years in the U.S. and pre-existing math ability.

Hypothesis

The main hypothesis of this study is that when pre-existing

math ability and time in the U.S. are factored in, the mean scores of the initial Spanish instruction group will be significantly higher than the scores of the initial English instruction group. The null hypothesis is that after pre-existing math ability and time in the U.S. are factored in, there will not be a significant difference in the mean scores of the two groups.

Chapter Four: Analysis and Results

Type of Analysis

In order to test the hypothesis about the influence that L1 instruction in initial math classes has on subsequent L2 academic achievement two types of analysis were done: a series of mean comparisons using a two-way analysis of variance and a multiple regression to determine the relative influence of several independent variables.

To run these analyses, the 96 subjects scores were entered into a statistical analysis software program called SISTAT. 46 students were classified under the initial Spanish (L1) language of instruction group and 50 under the initial English (L2) language of

instruction group.

Mean comparisons of math proficiency scores of the Spanish (L1) and English (L2) initial language of instruction groups were conducted which took into consideration the two main factors affecting achievement outcomes: time in the U.S. and pre-existing math abilities. Once means were calculated, the two groups overall scores were evaluated for significance by carrying out a two-way analysis of variance. Then, an analysis of variance was run while controlling for years in the U.S. Finally, SABE mean scores, where available, were compared to determine if there was a statistically significant difference which may interfere with the direct comparison of math proficiency results. In each of these cases, an alpha level of .05 was used to determine significance.

The second step was to run a multiple regression using all of these independent variables to determine the relative impact of L1 use on the dependent variable, math proficiency.

Results

As shown in Table 2, the overall mean scores of the two treatment groups, without accounting for time or math abilities,

were not found to be significantly different (probability = .56). The initial English instruction group, in fact, had a slightly higher mean (71.8% to 73.5%).

This was not surprising since these groups include students who have been in the United States for too short a time to develop the English language skills necessary for successful transfer as well as students beginning with vastly different math abilities. In comparing the mean proficiency scores of the groups which were here the longest (3-4 years) it was found that the initial Spanish

Table 2

Initial Language of Instruction in Math Classes and Subsequent English Math ProficiencyMeans

Spanish (L1)	English (L2)
(Percentage Score)	
(49) 71.8	(46) 73.5
probability = .56	

Table 3

Initial Language of Instruction in Math Classes and Subsequent English Math ProficiencyMeans by Years in the United States

Years in the U.S.	English Math Proficiency Means (Percentage Score)		
	Spanish (L1)	English (L2)	Total
1-2	(19) 74.8	(10) 78.4	(29) 76.1
2-3	(24) 68.6	(11) 75.7	(35) 70.8
3-4	(6) 74.8	(25) 70.5	(31) 71.4

instruction group outscored the initial English instruction groups 74.8% to 70.5% (see Table 3). However, the broad difference in frequencies (6 and 25) made it difficult to draw conclusions about the significance of this difference.

The next step was to determine the impact of pre-existing math abilities as measured by first year SABE math scores. If the initial English instruction group were found to possess significantly greater initial math abilities, then this could account for the closeness of the overall mean scores. In comparing the 11 initial Spanish instruction students who took the SABE with the 6 initial English instruction students who took the SABE it was found that the English group's SABE scores were significantly higher--38.0% to 25.3% on the SABE Math Computation section, 45.5% to 32.5% on the SABE Math Concepts and Applications, and 44.8% to 28.4% on the SABE Total Math section (See Table 4). Focusing just on the Total Math SABE score (since the dependent variable is also an aggregate score) it was found that a large 16.4% difference in favor of the L2 treatment group existed. This indicates that lower pre-existing

Table 4

First Year SABE Math Means and Initial Language of Instruction in Math Classes

	Spanish (L1)	English (L2)
	(Percentile Score)	
Math Computations	(11) 25.3	(6) 38.0
	probability = .23	
Math Concepts/Applications	(11) 32.5	(6) 45.5
	probability = .31	
Total Math	(11) 28.4	(6) 44.8
	probability = .16	

Table 5

Subsequent English Math Proficiency Means of Students who took SABE Math Test

	Spanish (L1)	English (L2)
	(Percentage Score)	
	(11) 57.8	(6) 64.3
	probability = .37	

math abilities may be overshadowing the positive effects of initial L1 instruction on long-term achievement.

To examine this possibility more closely, the subsequent math proficiency scores of the students who took the SABE were examined (see Table 5). Although it must be noted that Math Proficiency scores are given as percentage of correct responses while the SABE scores reflect a percentile rank, some tentative conclusions can be reached by comparing these two scores. As shown in Table 6, the gap between the initial Total Math SABE and subsequent Math Proficiency scores of the two treatment groups were quite different. The gap was 29.5 points for the initial Spanish instruction group and 19.5 points for the initial English instruction groups. This statistic suggests that L1 use in initial math classes was having a greater impact on students long-term academic achievement than the straight mean comparison indicated. Unfortunately, the small number of subjects who took the SABE during their first year (17) undermined the significance of this gap. (probability = .44)

Table 6

Comparison of First Year SABE Total Math Means and Subsequent English Math Proficiency Means of Students who took SABE Math Test

	Spanish (L1) (Percentile Score)	English (L2)
SABE Total Math (Percentile)	(11) 28.4	(6) 44.8
Math Proficiency (Percentage)	(11) 57.8	(6) 64.3
Difference	+29.4	+19.5
	probability = .44	

Table 7

Multiple Regression Showing the Relative Impact of the Number of Semesters of Initial Spanish Instruction in Math Classes, SABE Math Total Scores, and Number of Years in the United States on Math Proficiency Scores

Variable	Probability
# Semester of L1 Math	.514
SABE Math Total Scores	.597
# Years in the U.S.	.700

To examine this relationship more closely, a multiple regression was run which measured the relative influence of the three main independent variables (Initial language of instruction, years in the U.S. and SABE Math Total) on the dependent variable (subsequent math proficiency). In order to make this analysis work the nominal variable "initial language of instruction" had to be converted into an interval variable. The number of semesters of L1 instruction, ranging from 0 to 5, were entered into a new column in the SISTAT database. The problem with this new way of looking at language use is that the L1 classes were generally offered only for two semesters at one level. This means that the eleven students who had more than two semesters of L1 instruction probably were repeating the same course for one or more semesters. This must be kept in mind in analyzing the results of the regression. As Table 7 shows, the results showed that while none of the three variables came close to the level of statistical significance, the "semesters of L1" variable was ranked first in relative influence among the three variables. This suggests that L1 initial language use may be having a beneficial effect on academic achievement.

Chapter Five: Discussion

Interpretation

The original hypothesis of this study was that the adolescent immigrants receiving initial math instruction in Spanish would have higher English proficiency scores than the adolescent immigrants receiving initial math instruction in English when time in the United States and preexisting math abilities were factored in. To adequately test this hypothesis the data set used for analysis would have needed to include a substantial number of students who both took the SABE math test during their first year and later took the English math proficiency (this would measure pre-existing L1 and current L2 math abilities). However, the SABE was only offered in 7th through 9th grade and the math proficiency was taken mostly by immigrant students in 11th and 12th grade. The relatively recent practice of compiling data on immigrants (four years) combined with the fact that L1 classes were only begun three years ago made it difficult to find enough subjects in each treatment group who took both achievement tests. As the district's database matures in the next year or two, a more comprehensive analysis would be possible. Based on the data available at the time of this study, the hypothesis

must be rejected. No statistically significant relationship was found between the initial use of L1 math instruction and subsequent L2 achievement. However, since the trends suggestive in the results are consistent with the hypothesis, some tentative, though inconclusive, answers to the research question can be presented.

As discussed in the review of the literature, the successful transfer of first language math abilities to a second language could only be accurately measured if three variables were considered: the language of instruction during a student's initial years in the U.S., time in the U.S. receiving comprehensible input in ESL classes and pre-existing math abilities in L1. The results of this study must be interpreted with these three elements in mind.

First of all, it must be noted that the L1 math program did not completely match the theoretical model of a program promoting academic achievement. According to the model, at least two years of L1 instruction at the students level of ability were considered necessary so that math CALP development could continue during the time needed to bring English language skills up to a minimally acceptable level for transfer. But, only 10 of 45 students enrolled

in L1 instruction continued for more than one year. Usually, they were moved on to a sheltered math class even if they lacked the minimal English skills needed to fully comprehend the content. In addition, the two schools offering L1 instruction only offered a basic math class even though a number of students were ready for Algebra or other higher math classes. Taking these caveats into consideration, the fact that L1 group actually kept up with the L2 group in the overall mean scores suggests that their progress was impressive.

The students in the study were enrolled in a comprehensive ESL program alongside their math instruction. However, none of the students studied had enough time to fully develop their English skills. Collier (1989) had found that adolescent immigrants needed 6 years to reach grade level norms in math; while the subjects of this study all had less than 4 and in most cases less than a couple years of schooling in the U.S. Even though the dependent variable used in this study was measuring basic competency and not grade level skills, it seems that the L1 group may have benefitted from more time in the U.S. to develop the English skills required for the

initial L1 instruction to transfer over. While the results of the study did not show statistically significant differences as the number of years in the U.S. increased, the L2 group's 4.6% mean score advantage (78.4% to 74.8%) among the 1-2 year students had changed to a 4.3% mean score deficit (70.5% to 74.8%) among the 3-4 year students. Since the L1 group's scores stayed the same in the 1-2 year and 3-4 year groups, the long-term benefits of initial L1 are not evident (though this is inconclusive because of the limited data). However, the sharp drop in the L2 group's scores from 78.4% to 70.5% indicates there is some evidence that the L2 initial instruction may have detrimental long-term effects. Future data on fifth or sixth year immigrants who began U.S. schooling in middle school would be needed to confirm whether this trend continues as well as whether the L1 groups mean would rise.

Pre-existing math abilities was a crucial variable because it had the potential to override any beneficial effects of the L1 math instruction and time in the United States. Students starting with a lower level of math abilities would not be expected to outperform students starting with high math abilities regardless of the mode of

instruction or the time in the United States. Based on the limited data available from the students who took the SABE test, the results suggest that the L1 initial instruction group started out at a lower level (28.3% to 44.8% on the Total SABE math score). Therefore, long term gains would have to be interpreted in terms relative to these initial abilities. So, though the L1 group students who had SABE scores was lower than the L2 group's, the overall gain was greater (+29 to +19). Though the small number of subjects analyzed precluded any definitive claims to significance, this nonetheless suggests that the L1 instruction may have helped to close the gap between these two groups and that pre-existing math ability may be overshadowing the positive long-term effects of L1 instruction in the rest of the data set.

The results of the multiple regression analysis further indicated that the L1 instruction may have been having more of an influence on the subsequent achievement data than the SABE math data or the number of years in the United States. The results of this test, though far from the accepted level of significance required to make any definite conclusions, showed that the math proficiency

scores were more closely correlated with the number of semesters of initial Spanish instruction (.51 probability) than either the SABE Math Total scores (.60 probability) or the number of years in the United States (.70 probability).

In order to look more closely at the question of whether adolescent immigrant students may have been benefitting from initial L1 instruction, an L1 math class was observed and several students were interviewed. The class observed for this paper was a 9th and 10th grade primary language "Math A" class at Fontana High School. The class was conducted entirely in Spanish by a fluent Spanish-speaking teacher. The content of the lesson observed was a cognitively-demanding introduction to graphing functions.

Throughout the lesson the students responded openly and frequently in Spanish to the teacher's explanation of various problems. It was evident that these Spanish language interchanges enabled most of the students to grasp the lesson. Had the teacher been explaining the new material in sheltered or regular English this complex material could not have been adequately taught in one class period. With the main focus on content and not language, the entire class

period could be utilized to teach and reinforce the material.

Afterwards, several students were selected at random and asked about the lesson. One student, a non-English speaking 9th grader explained in Spanish: "...since this is a new concept, if this class were in English I wouldn't understand it...". Another similarly commented that if the class were in English "...for me it would be very difficult to understand it..Next year I will be in [sheltered] English and I will try to understand. There is only one year of Spanish so I have to take advantage of it..." This last remark also underscores the inadequacy of having only one year of L1 instruction. Students who clearly could benefit from primary language concept development are forced to take sheltered English or repeat the same material again.

Conclusion

Even if the data available for this study does not offer any clear-cut answer to the question of how much influence L1 instruction can have on long-term achievement, the student's receiving the instruction are quite adamant in their advocacy of primary language content classes. The trends indicated by the data

together with these student's comments makes it clear that primary language instruction at the secondary level is probably just as beneficial as it has been shown to be at the elementary level. As more secondary schools move towards primary language instruction more data will become available for further analysis. This data should be scrutinized as closely as the data from elementary programs has been to try to determine the exact nature of the relationship between L1 instruction and long-term L2 achievement.

Implications for Education

If L1 initial content instruction is shown to be beneficial to student's long-term academic achievement then it would seem that more emphasis should be placed in secondary schools on content acquisition and less on the language used to teach. Just as teachers use technology, for example, as a tool to assist in comprehension of complex secondary-level content, a student's primary language should be used to the greatest extent possible to also facilitate learning. This paper has shown that this is definitely not harmful, and probably helpful, to the long-term academic achievement of the growing number of adolescent immigrants in our secondary schools.

These languages should be considered tools and resources to be utilized to give these students the maximum possible chance of succeeding in the cognitively challenging content classes in high school and beyond.

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