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THE EFFECTS OF THE PRESENCE OF EXTRANEOUS INFORMATION IN MATHEMATICAL WORD PROBLEMS ON THE PERFORMANCE OF HISPANIC LEARNING DISABLED STUDENTS

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Abstract: This study examined the effects of extraneous information on mathematical word problems on the performance of Hispanics classified as learning disabled children. The subjects ranged in ages 9 to 14 years. Two sets of mathematical word problems were presented in both languages: English and Spanish. The results of this study suggest that students demonstrated high levels of performance when solving mathematical word problems with non-extraneous information. Also, mathematical word problems that required subtraction were more difficult to solve than those problems that required addition. Implications for future research are addressed.

INTRODUCTION

Culturally and linguistically diverse exceptional (CLDE) children, encounter many difficulties when there is a lack of an appropriate mathematics curriculum that can meet their educational needs. According to the National Council of Teachers of Mathematics (1987), ". . . cultural background or difficulties with the English language must not exclude a student from full participation in the school's mathematics program." Studies suggest that children experience success in the classroom when their language and cultural background are taken into consideration (Campos & Keatinge, 1988; Willig, 1985). Cummins (1989) commented that " . . . in programs in which minority students' first language (L1) skills are strongly reinforced, their school success appears to reflect both the more solid cognitive and academic foundation developed through intensive L1 instruction and also the reinforcement of their cultural identity" (p.113). Thus, language and culture should have a central role in the design of mathematics programs for culturally and linguistically diverse exceptional children.

Mathematics has been considered a universal language. Accordingly, many educators believe that mathematics skills are easily transferable from one language into another. However, studies with language minority children have identified mathematical skills that are not transferable from one language and culture into another one. Peck & Simmons (1987) cite three specific factors they believe present difficulties to language minority children:

a. Word/Symbol Recognition:

Coyne (1981) concluded that Spanish speaking children experienced difficulties when they identified certain word-symbol patterns in their second language. For example, the speech sounds of the number word such as 15 - 50 (fifteen - fifty), 13 - 30 (thirteen - thirty) may present difficulties to Spanish speakers.

b. Processes Followed in Basic Computation And Problem Solving:

Children from some Latin American Spanish speaking countries learn different types of processes when solving problems requiring basic computation. For example, when dividing, some Spanish speaking children draw the line under the dividend instead of over it.

	28	----->quotient
2	700	----->dividend
	_______ 200	
	0	

c. Cultural Influence

In order to design a multicultural mathematics program, teachers should be creative and sensitive to cultural differences. This sensitivity will enable them to integrate cultural aspects relevant to mathematics content. At the same time, children will benefit from contributions made by their ancestors and learn the importance of those contributions to the society (Ovando & Collier, 1985).

Children with disabilities, more specifically children with learning disabilities, are often mainstreamed to mathematics education. It has been estimated that during the 1988-1989 school year, 68 percent of all children with disabilities received instruction in the regular classroom (U.S. Department of Education, 1990). Substantial research in mathematics education has examined the performance of children with learning disabilities in the area of computational skills (Cawley, Miller, & School, 1987). Less attention has been paid to mathematics word problems. Sharma (1981) noted:

. . . word problems (good examples of cognitive, linguistic and perceptual integration) are usually the least popular aspects of mathematics education programs. Even many people who solve real word problems regularly and in logical organized ways think they are unable to solve mathematics word problems (p.61).

In the *Curriculum and Education Standards for School Mathematics* , The National Council of Teachers of Mathematics (1989), proposed that, for the next decade, problem-solving should be the central focus for the curriculum at all grade levels. Cawley, Fitzmaurice-Hayes & Shaw (1988), define mathematical word problem-solving as the "interpretation of information and the analysis of the data to arrive at a simple response or to provide the basis for one or more arguable alternatives" (p.36). The solving of mathematical word problems is a complex process where a child must possess certain skills such as language understanding and strategy seeking skills (Cawley & Miller, 1986; Sharma, 1981).

In order to successfully complete the solution of a mathematical word problem, four steps have been identified (Goodstein, 1981; Polya, 1957; Shaw, 1981):

a. Understanding the problem;
b. Planning the solution;
c. Solving the problem; and
d. Reviewing the solution within the context of the problem.

Cawley & Miller (1986) suggested that children who are learning disabled do not reach the first step when solving word problems (step 1). These students may know the basic skills needed to solve mathematical word problems; however, when they apply these skills to other situations, they get confused. Given the learning problems that culturally and linguistically diverse exceptional children encounter, one might suspect that they will experience similar difficulties.

Macnamara (1966) analyzed twenty-two studies where the performance of bilingual and monolingual students were compared when solving computational and word problems. As part of the results, Macnamara found that the performance of bilingual students was inferior to the monolingual students when problems were solved in their weaker language. In light of results underlined by subsequent studies, Macnamara (1967), stated the following:

Longer decoding times in the weaker language imply greater difficulty with that task and also an added burden on a short-term memory which is extremely limited both in the quantity of information it can store and in the length of time for which it can store it (p. 131).

Mestre (1981) posited that in order to be a good problem solver, one must be proficient in language in general (e.g., English) including the technical and symbolic languages in mathematics. Therefore, the limited English proficient child may be at a disadvantage, not because he or she does not possess the necessary skills to solve the problem but because of a lack of "accessibility" in the second language. Many variables affecting the performance of children with disabilities on the solving of mathematical word problems have been considered. These variables are: reading, language skills, syntactical and semantical components, types of arithmetic operations (e.g., addition, subtraction, multiplication, and division), vocabulary difficulty, use of visual aids, and presence of extraneous information (Bessant, 1972; Cawley, 1985; DeVard, 1972; Englert, Culatta, & Horn, 1987; Goodstein, 1974; Nesher, 1982; Trenholme, Parker, & Larsen, 1978; Thibodeau, 1974). Research has identified extraneous information as causing detrimental effects on the performance of individuals who are disabled and non-disabled when solving mathematical word problems (Cawley, 1985; Englert, Culatta, & Horn, 1987). Extraneous information also know as a "distractor", is more specifically defined as ". . . information that if used will produce an incorrect response" (Cawley, Fitzmaurice-Hayes, & Shaw, 1988, p. 174).

Blankenship & Lovitt (1976) studied the performance of learning disabled children when solving mathematical word problems containing extraneous information. The data indicate that learning disabled children had more difficulties with problems that contained extraneous information. Blankenship and Lovitt also observed a decrease in accuracy and speed among the children when solving mathematical word problems.

Englert, Culatta, & Horn (1987) investigated the influence of extraneous information in a set of addition mathematical word problems. Twenty-four learning disabled children (experimental group) were compared to twenty-four children (control group) from second and fourth grade regular classes. As part of the methodology, students were tested on an individual basis and problems were read in order to minimize reading difficulties. Results supported Blankenship & Lovitt's (1976) findings. Low performance within the experimental group was due to the students' inability to recognize essential from non-essential information in the problems, resulting in the execution of rote computational strategies.

Attempts to investigate the performance of culturally and linguistically diverse exceptional children in the solving of mathematical word problems has been limited. Velez (1974) studied the performance of a group of LEP (limited-English proficient) mildly mentally retarded children. Forty-eight addition and subtraction mathematical word problems on each set (English and Spanish) contained extraneous information. Velez concluded that although children showed higher performance in mathematical word problems in Spanish, no statistical difference was found between performance in both languages. Nevertheless, the children's performance was affected when solving mathematical word problems containing extraneous information in either English or Spanish. It was also demonstrated that the presence of extraneous information in word problems requiring subtraction were more difficult than addition word problems. Velez concluded that low levels of performance were affected by poor problem-solving skills and a lack of exposure to these types of mathematical word problems.

Further research is needed to investigate how Hispanic learning disabled children solve mathematical word problems. More specifically, what type of metacognitive strategies are used, and to what extent the competencies involved in processing extraneous information transcends language.

Statement of the Problem

The main purpose of this study was to explore the effects of the presence of extraneous information in mathematical word problems on the performance Hispanic learning disabled children solved two sets of mathematical word problems. This enabled the researcher to investigate the performance of the children on mathematical word problems containing information in both languages: English and Spanish.

The research question posed in this study was the following:

a. Are there differences in the solutions to mathematical word problems when they vary by the type of information (e. g., extraneous and non-extraneous information), and the type of arithmetic computation (e.g. addition and subtraction)?

METHODOLOGY

Description of the Sample

This study was conducted in two school districts in the Western New York area. These school districts were similar in many ways. Both districts have a large Spanish-speaking community and they provide bilingual special education services to culturally and linguistically diverse exceptional children. The sample consisted of forty-one (N=41) Hispanic learning disabled students. According to the cumulative records, these students were receiving instructional services in self-contained and resource classrooms. The subjects ranged in ages 9 to 14 years. The average age of the subjects was 12.6 years with a standard deviation of 1.49.

The Language Assessment Scales (LAS) (De Avila & Duncan, 1981) is administered by the school districts prior to placement in bilingual programs. In the study, the range of the LAS scores in English was 1.0 to 5.0 with a mean of 3.32 and a standard deviation of 1.42 (see Table 1).

Table 1- Summary of Age and Language Proficiency of the Sample

Variables	Range	Mean	Standard Deviation
Age	9-14	12.6	1.49
Spanish Proficiency Level (LAS)	1.0-5.0	3.78	1.27
English Proficiency Language (LAS)	1.0-5.0	3.32	1.42

IQ scores and mathematical grade equivalents were derived from the students' cumulative records. Mathematical grade equivalents were based on the Woodcock-Johnson Equivalent test. The overall mean score was 2.80 with a standard deviation of 1.48. The Weschler Intelligence Scale for Children-Revised

(WISC-R) is administered in the student's dominant language in both school districts. Records showed that the overall mean Full Scale score was 81.85 with a standard deviation of 9.45. On the other hand, the average Verbal score was 75.78 with a standard deviation of 11.86 and the Performance mean score was 89.71 with a standard deviation of 11.63.

Procedures and Instrumentation

Two sets of mathematical word problems were developed by the researcher. Set A consisted of twenty-four (24) mathematical word problems in English. Set B which was the Spanish version of Set A, also consisted of twenty-four (24) mathematical word problems. Table 2 illustrates the classification and characteristics of the mathematical word problems.

Table 2 - Characteristics of the Instruments

Type of Word Problems		
Language	Extraneous	Non-Extraneous
	Addition/ Subtraction	Addition/ Subtraction
Spanish (L1)	6 6	6 6
English (L2)	6 6	6 6

N=48

Both instruments contained four subtests with six problems each. The mathematical word problems were designed taking into consideration the following factors:

a. Extraneous Information
Presence
Absence
b. Arithmetical Operation
Addition
Subtraction
c. Language
English
Spanish

Each mathematical word problem contained four sentence statements. Problems were constructed as single-step with responses that totaled less than ten (10). The vocabulary used approximated a primary grade level and was culturally appropriate. Mathematical word problems with extraneous information did not contain a quantitative characteristic on the third string. Therefore, in order to keep all the problems with four sentence statements, a sentence relevant to the information in the problem was included.

To ensure appropriate content validity and reliability, both instruments were critiqued by six bilingual individuals and one Spanish professor from a higher education institution located in the Western New York area. These individuals were selected because they have knowledge of the Puerto Rican culture and have worked with limited-English proficient populations. After revisions were made, some words and verb tenses were substituted. In addition, a final revision of the mathematical word problems was evaluated by a professor who has conducted extensive research in the fields of special education and mathematics education. In order to control for reading ability of the subjects, the mathematical word problems were tape recorded by two bilingual individuals with no discernible accent in either language. The tape recording also standardized the administration of the test. Each mathematical word problem was recorded twice with a time interval of six seconds between each problem. Headphones were used to control on-task behavior and to decrease distractible outside noises. The scoring of the test was based on the total number of correct responses out of twenty-four (24) mathematical word problems in each language: English and Spanish.

The researcher met with each subject two times. On the average, the first session (interview and administration of the instrument) was completed in approximately fifty minutes and the second meeting approximately forty-five to fifty minutes.

RESULTS

Statistical Analysis of the Students' Responses

Subjects solved forty-eight mathematical words problems. The mathematical word problems were categorized by taking into consideration the type of information (extraneous and non-extraneous), arithmetic computation (addition and subtraction), and language (English and Spanish). Six mathematical word problems were included in each category (see Table 2).

Table 3

Means and Standard Deviations of the Responses Obtained From the Sample, N = 41

Responses	**Mean**	Standard Deviation
Extraneous/English/Addition	1.68	1.63
Extraneous/English/Subtraction	2.10	2.27
Non-Extraneous/English/Addition	5.07	1.47
Non-Extraneous/English/Subtraction	4.07	1.92
Extraneous/Spanish/Addition	2.10	1.99
Extraneous/Spanish/Subtraction	1.76	1.95
Non-Extraneous/Spanish/Addition	4.90	1.69
Non-Extraneous/Spanish/Subtraction	3.34	2.24

Table 3 depicts the means and standard deviations of the responses given by the subjects. The highest average score was obtained on mathematical word problems with non-extraneous information in both languages and in both addition and subtraction. The average score on word problems with non-extraneous/English/addition was 5.07 with a standard deviation of 1.47. The average score of word problems with non-extraneous information/English/subtraction was 4.07 with a standard deviation of 1.92. In comparing these two scores, a low standard deviation on word problems with non-extraneous information/English/addition indicates that the sample was relatively homogeneous. Thus, no differences between mathematical word problems that required addition and subtraction were detected. A similar pattern was noticed in mathematical word problems with non-extraneous information in Spanish. The average score of mathematical word problems with non-extraneous information/Spanish/addition was 4.90 with a standard deviation of 1.69. Furthermore, the average score of word problems with non-extraneous information/ Spanish/subtraction was 3.34 with a standard deviation of 2.24.

Low means were observed among mathematical word problems with extraneous information. The average score of the mathematical word problems with extraneous information/ English/addition was 1.68 with a standard deviation of 1.63. In addition, a higher average

score was disclosed in mathematical word problems with extraneous information/ English/ subtraction (X= 2.10, sd= 2.27). The average score of mathematical word problems with extraneous information/Spanish/ addition was 2.10 with a standard deviation of 1.99. Although the average score of the mathematical word problems with extraneous information/Spanish/ subtraction was lower than the previous mathematical word problems (X= 1.76), the standard deviation (sd= 1.95) revealed that the variability of the scores was relatively the same.

Table 4 summarizes the percentages of the students according to the number of correct responses obtained across the eight categories of mathematical word problems. The first column describes the possible number of correct answers in which 0 represents no correct answers, and 6 represents a perfect score. The successive columns represent the type of mathematical word problems. The stated figures in each cell represent the percentage of students that answered the section correctly. For example, 39% of the students (16 students) got 0 items correct in the category of extraneous/English/addition.

Table 4

Percentages of Correct Responses by Number of Items According to Type of Mathematical Word Problems

Correct Number of Items	Extraneous English Addition	Extraneous English Subtraction	Extraneous Spanish Addition	Extraneous Spanish Subtraction	Non-Extraneous English Addition	Non-Extraneous English Subtraction	Non-Extraneous Spanish Addition	Non-Extraneous Spanish Subtraction
0	39.0 (16)	43.9 (18)	34.1 (4)	44.0 (18)	4.9 (2)	12.2 (5)	7.3 (3)	19.5 (8)
1	12.2 (5)	9.8 (4)	12.2 (5)	9.8 (4)	2.4 (1)	2.4 (1)	0	9.8 (4)
2	9.8 (4)	4.9 (2)	9.8 (4)	14.6 (6)	0	4.9 (2)	0	2.4 (1)
3	22.0 (9)	4.9 (2)	19.5 (8)	7.3 (3)	0	4.9 (2)	7.3 (3)	14.6 (6)
4	14.6 (6)	17.1 (7)	7.3 (3)	7.3 (3)	4.9 (2)	17.1 (7)	12.2 (5)	17.1 (7)
5	2.4 (1)	9.8 (4)	12.2 (5)	17.1 (7)	41.5 (17)	39.0 (16)	19.5 (8)	12.2 (5)
6	0	9.8 (4)	4.9 (2)	0	46.3 (19)	19.5 (8)	53.7 (22)	24.4 (10)

The data suggested that a high percentage of the subjects solved more mathematical word problems with non-extraneous information in both English and in Spanish. A high percentage of the students did not obtain correct responses in mathematical word problems with

extraneous information/English/addition, 39%;
extraneous/English/subtraction,44%;
extraneous/Spanish/ addition ,34%;
and extraneous/ Spanish/subtraction, 44%.

Research Question: Are There Differences in the Solution to Mathematical Word Problems When they Vary by the Type of information (e.g. Extraneous and Non-Extraneous), and Type of Arithmetic Computation (e.g. , Addition and Subtraction)?

A t-test within-subjects was performed to compare the mean scores of the variables related to the mathematical word problems: type of information, type of arithmetic computation, and language. As presented on Table 5, the mean scores for the mathematical word problems with non-extraneous/addition, and extraneous/addition were 10.38 (sd= 1.86), and 4.90 (sd= 2.57) respectively. As determined by the t-test, these means were significantly different (t= 9.89, $p < .05$).

Table 5

t Test for the Inclusion of Extraneous and Non-extraneous Information (N= 41)

	Mean	Standard Deviation	Standard Error	t
Non-Extraneous/Addition	10.38	1.86	.35	9.98*
Extraneous/Addition	4.90	2.57	.48	
Non-Extraneous/Subtraction	8.72	2.64	.49	6.27*
Extraneous Subtraction	5.59	3.78	.70	

A high mean score was also found in mathematical word problems with non-extraneous information/subtraction, 8.72 (sd= 2.64). The mean for mathematical word problems with extraneous/subtraction was 5.59 (sd= 3.78). A t-value of 6.27 ($p < .05$) indicated significant differences between the means. These results suggest that overall, students performed better in mathematical word problems with non-extraneous information than in mathematical word problems with extraneous information.

Table 6 illustrates that significant differences were not found between type of arithmetic computation and mathematical word problems with extraneous information. The mean score of mathematical words problems with extraneous information/subtraction (X= 5.93, sd= 3.69), and extraneous/addition (X= 5.41, sd= 2.29) were similar, and the standard deviations indicated that the responses obtained were heterogeneous on word problems with extraneous/subtraction. In contrast, a statistically significance difference was found in word problems with non-extraneous information/addition, and non-extraneous/subtraction was 10.46 (sd= 1.84), and 8.23 (sd= 2.83) respectively. These means were significantly different. These results suggested that solving mathematical word problems with non-extraneous information/addition were not as difficult as solving mathematical word problems with non-extraneous information/subtraction.

These mean scores and standard deviations of mathematical word problems in English are presented on

Table 7. The mean scores of mathematical word problems with non-extraneous information/English/addition was 5.20

Table 6

t Test for the Type of Arithmetic Computation in Mathematical Word Problems With Extraneous and Non-extraneous Information

	Mean	Standard Deviation	Standard Error	t
Extraneous/Subtraction	5.93	3.69	.71	.96
Extraneous/Addition	5.41	2.29	.44	
Non-Extraneous/Addition	10.46	1.84	.31	4.12*
Non-Extraneous/Subtraction	8.23	2.83	.48	

Table 7

t Test for the Inclusion of Extraneous and Non-extraneous Information, Type of Arithmetic Computation, and Language

	Mean	Standard Deviation	Standard Error	t
Non-Extraneous/Spanish Addition	5.32	.85	.17	7.57*
Extraneous/Spanish/ Addition	3.08	1.53	.31	
Non-Extraneous/Spanish Subtraction	4.82	1.37	.29	5.25*
Extraneous/Spanish Subtraction	3.36	1.62	.35	

(sd=1.04),and extraneous/English/addition was 2.60 (sd=1.24). These means were statistically different (t=9.19,p <.05). A similar pattern was found in the same type of mathematical word problems that required subtraction. The average score for non-extraneous/English/subtraction was 4.83 (sd= 1.01), and extraneous/English/subtraction was 3.58 (sd= 1.84). The previous means also reached a statistically significant difference of (t= 3.71, p < .05).

Mathematical word problems in Spanish were also significantly different (see table 8). A mean score of 5.32 was obtained from mathematical word problems extraneous/Spanish/addition indicated a mean score of 3.08 (sd=1.53). The means were statistical significant different (t=7.57, p , .05). A high mean score was also found on mathematical word problems with non-extraneous information/Spanish/subtraction, 4.82 (sd=1.37). The average score of mathematical word problems with extraneous information/Spanish/subtraction was 3.36 (sd=1.62). There was statistical difference between the means (t=5.25, p, .05).

Table 8

t Test for the Inclusion of Extraneous and Non-extraneous Information, Type of Arithmetic Computation and Language

	Mean	Standard Deviation	Standard Error	t
Non-Extraneous/Spanish Addition	5.32	.85	.17	7.57*
Extraneous/Spanish/ Addition	3.08	1.53	.31	
Non-Extraneous/Spanish Subtraction	4.82	1.37	.29	5.25*
Extraneous/Spanish Subtraction	3.36	1.62	.35	

CONCLUSIONS

The solving of mathematical word problems has been considered one of the least popular topics of the mathematics curricula among teachers and students. The literature has suggested that schools need to put more emphasis in the development of reasoning and thinking skills. Many variables have been taken into consideration in the development of mathematical word problems. In this study, the inclusion of extraneous information and subtraction as the arithmetic operation, affected both negatively, the performance of the subjects. Moreover, similar results were detected across languages. A ceiling effect (high performance) was observed on mathematical word problems with non-extraneous information/addition. Although the subjects demonstrated a high performance in Spanish, a similar pattern was also observed in mathematical word problems in English and Spanish.

These results suggest that students appeared to experience difficulties in discriminating between essential from non-essential information in order to arrive at a correct solution. Thus, based of the responses given, the majority of the students knew how to execute the arithmetic computations but they did not know how to apply them to mathematical word problem-solving solutions.

The results of this study are relevant to the fields of bilingual special education and mathematics education. From an instructional point of view, these results have important implications in the educational programming of Hispanic learning disabled children at all grade and age levels. The building of mathematics concepts and vocabulary is crucial; therefore, both should be somehow related to the experiences the child brings into the classroom. This approach may facilitate the thinking process in order to get a correct answer.

The way in which mathematical word problems are presented posed influence on the performance of culturally and linguistically diverse learning disabled children. Although reading was controlled in the study, mathematical word problems do not necessarily have to be presented in written contexts. Cawley, Fitmaurice-Hayes, and Shaw (1988) state that ". . . reading is only a prerequisite to a problem solving when the problems are written" (p. 171). This statement implies that mathematical word problems should be presented in a multimodal format in order to facilitate the acquisition of the problem-solving process.

This study should be used as a point of reference to initiate further investigations on the performance of language minority children that exhibit different types of disabilities.

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