DOCUMENT RESUME

ED 081 285 FL 004 597

AUTHOR Jerman, Max; Mir[illegible], Sanford
TITLE Structural and Linguistic Variables in Problem Solving.
PUB DATE 73
NOTE 23p.

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS Analysis of Variance; *Arithmetic; Arithmetic Curriculum; *Curriculum Development; *Educational Experiments; Language Research; Mathematics; Models; Prediction; Predictor Variables; *Problem Solving; Research Methodology; *Statistical Analysis; Tables (Data); Test Construction; Test Selection

ABSTRACT

This paper reports on an experiment designed to investigate the effect of structural and linguistic variables on level of difficulty in solving arithmetic word problems. Identification of such variables is intended to assist curriculum writers in preparing exercises at a specified level of difficulty for students at various age levels. The study also considers the variables under varying time conditions and seeks to devise a coding system of the linguistic variables that would improve the accuracy of a linear regression model previously used in similar investigations. Details of the theory and methodology of the experiment are provided, and the results are discussed. The significance of the structural and linguistic variables is noted. (VM)

Abstract

Structural and Linguistic Variables in Problem Solving

by

Max Jerman
Sanford Mirman
The Pennsylvania State University

Three sections of a methods course for prospective elementary school teachers were given a set of word problem exercises under different time conditions; 20 minutes; one hour; and one day. Structural variables, which accounted for a significant amount of the observed variance in the error rate in arithmetic word problems in Jerman's (1972) study using students in Grades 4-9, were not consistent in entry in a stepwise regression nor did these variables account for a significant amount of the total variance. Linguistic variables, however, which were used in Krushinski's (1973) study, showed consistency in early entry and accounted for a reasonable amount of the variance in the observed proportion correct. The time effect appeared, however, to influence order of entry more for structural than linguistic variables.

Structural and Linguistic Variables in Problem Solving

by

Max Jerman
Sanford Mirman
The Pennsylvania State University

Previous studies have attempted to identify and define structural and linguistic variables in word problem exercises which account for a large amount of the observed variance in the proportion correct (Suppes, Loftus, and Jerman, 1969; Loftus, 1970; Jerman and Rees, 1972; Jerman, 1972a; Jerman, 1972; Krushinski, 1973).

One of the goals of these studies is to identify and quantify a small set of independent structural variables which will permit curriculum writers to prepare exercises at a specified level of difficulty for students at various age levels. A primary task, in these studies is, therefore, to develop a robust set of variables.

One purpose of this study was to determine if a set of structural variables which was found to account for a significant amount of the variance in the observed proportion correct for word-problem exercises solved by students in grades 4-9 (Jerman, 1972) would also account for a significant amount of the observed variance for a different set of word problems solved by college-level students.

A second purpose of this study was to determine whether or not a modification of the coding of the linguistic variables used in the Krushinski (1973) study would improve the accuracy of the linear regression model's prediction.

A third purpose of the study was to test the robustness of the variables under varying time conditions.

The six structural variables given in Jerman (1972) and used in this study are defined as follows:

1. Conversion: A count of one was assigned if a conversion of units was required to solve the problem, zero otherwise.

   Example - If it was necessary to change hours to seconds to solve the problem, Conversion = 1.

2. Recal: The sum of the following:

   a. One count for a formula to be recalled and a count for each step in the formula.

   b. One count for each conversion to be recalled and used.

   c. One count for each fact from a previous problem to be recalled and used.

   Example - If the formula A = 2(l+w) was required but no conversions or facts from previous problems were needed,

   Recal = 1 (area formula) + 2 (addition and multiplication steps) + 0 (conversions) +0 (facts) = 3.

3. Length: The number of words in the problem.[1]

4. Operations 3 (OPER3): The sum of the following:

   a. The number of different operations.

   b. Four times the number of occurrences of the operation of division.

   c. Two times the number of occurrences of the operation of multiplication.

   d. The number of occurrences of the operation of addition.

   Example - If the solution was of the form

   ([16x30)x40] ÷ 3 + 1),

OPER3 = 3(3 different operations) +1x4 (1 occurrence of division) + 2x2 (2 occurrences of multiplication) + 1 (1 occurrence of addition) = 12

5. NOMC2: A count of 1 was assigned for each time a regrouping occurred in each multiplication exercise in the problem[2].

Example -
```
 14
 38
 25
190
76
```
NOMC2 = 3

Regroupings - 1. 5x8 = 40 units = 0 units + 4 tens

2. 5x3 tens + 4 tens = 19 tens = 1 hundred + 9 tens

3. 2 tens x 8 = 16 tens = 1 hundred + 6 tens

6. Quotient (QUO): A count of 1 was given for each digit in the quotient if division was required and zero otherwise[3].

Example - 22/6666 = 303   QUO = 3

The 14 linguistic variables, given by Krushinski (1973) and derived from Golub (1971), used in the study are defined as follows:

1. Number of words (NWD): The number of words in the problem[4].

2. Number of Sentences (NSEN): The number of sentences in the problem.

3. Sentence Length (SENLTH): The ratio of NWD to NSEN.

---

[1] A whole number was given a count of 1.

[2] Regrouping in summing to obtain the product was not counted.

[3] If the quotient did not terminate after 2 decimal places, a count of 3 was given for the decimal places (2 places and round off).

Examples - 7/9.94 = 1.42   QUO = 3

7/10 = 1.42 6/7   QUO = 4

[4] A numeral was given a count equal to the number of words in the expression of the numeral in words. Example - 1226 - one thousand two hundred twenty-six (count = 5).

4. Number of Main Clauses (N): The number of main clauses in the problem.

5. Number of Subordinate Clau s (NSC): The number of subordinate clauses in the problem.

6. Number of Clauses (NC): The sum of NMC and NSC.

7. Number of Words in the Main Clauses (WDMC): The number of w ds in the main clauses (identified by NMC) in the problem.

8. Number of Words in the Subordinate Clauses (WDSC): The number of words in the subordinate clauses (ified by NSC) in the problem.

9. Clause Length (CLTH): The ratio of NWD to NC.

10. Main Clause Length (MCLTH): The ratio o C to NMC.

11. Subordinate Clause Length (SCLTH): The ratio of WDSC to NSC.

12. Number of Propositional Phrases (NPP): The number of propositional phrases in the problem.

13. Number of Words in the Question Sentence (NWQS): The number of words in the question sentence.

14. Numerals in the Question Sentence (NUMQS): Assigned a value of one if the question sentence contained a numeral and a value of zero otherwise.

Methods

Subjects

Seventy-six prospective elementary school teachers enrolled at Pennsylvania State University in three sections of Elementary Education 326, Teaching Elementary School Arithmetic, participated in the study. Most had taken only algebra and geometry in high school and a prerequisite course, Mathematics 200-Number Systems, at Pennsylvania State University. Sections I, II, and III had 29, 27, and 20 students enrolled, respectively. Students registered for the course according to how it would fit into their schedule. Scheduling was done by a computer.

Problem Set

The Mathematics Aptitude Test (MAT-R2), published by the Educational Testing Service, was the problem set used in the study. This set consists of word problems requiring arithmetic or very simple algebraic concepts only. The test, which contains two parts, each consisting of 15 items with a time limit of 10 minutes per part, is suitable for students in grades 11-16.

The problems without answer choices were mimeographed, five to a page, with work space provided for each problem. Each lab instructor administered the problem set at a time convenient to the schedule of his class. The test was administered to sections I and III in the middle of April, 1972, and to Section II at the beginning of May, 1972. Students in Section I had 20 minutes during a lab session to complete the exercises, students in Section II had 1 hour during a lab period to complete the problems, and students in Section III were allowed one day to do the problems at home. Students in Section III were asked not to collaborate or seek help in doing the exercises.

The authors scored each problem for each student as either correct (correct answer), incorrect (an attempt of some kind was made but there was not a correct answer given) or omit (no attempt was made in solving the problem). Problems which were omitted were not included in the analysis. The MAT-R2 test was coded first for the above set of six structural variables and then for the above set of 14 linguistic variables.

A stepwise linear regression program, BMD02R (UCLA), which was modified to include a log transform and an antilog transform to produce probabilities between 0 and 1, was applied to the MAT-R2 test. The regression program was applied for the set of six structural variables alone, the set of 14 linguistic variables alone, and the set of 20 combined variables to each of the three sections and to the three sections combined into a single group. In addition, an item analysis program, ITEMPGM1 (Stanford), and an analysis of variance program, ANOVR (Pennsylvania State University) were applied to the MAT-R2 test.

Results

The mean total score on the test was 13.00, with a standard deviation of 4.945. Cronbach's alpha was .824, with error of measurement 2.074. The range of scores was 24, from a low of zero correct to a high of 24 correct.

The means and standard deviations for each of the three sections, using for each student both the observed proportion correct of the 30 problems, disregarding omits, and the number of correct responses, are given in Table 1.

Insert Table 1 About Here

A summary of the one-way analysis of variance procedure, using both the observed proportion correct and the number of correct responses is given in Table 2.

Insert Table 2 About Here

The calculated F of 4.204, obtained by using the observed proportion correct, was significant at the .05 level. Using the number of correct responses produced a calculated F of 20.243 which was significant at the .001 level. Hence, the sample data do not support, in either application of the analysis of variance, the hypothesis that the three population means were equal. It seems clear, from the data in Table 1, that there was a direct relationship between time allowed students to solve the problems and the number of correct solutions per student. The mean of the number of correct responses for students in section III, the one day section, was almost 80 percent greater than the mean of the number of correct responses for students in section I, the 20 minute section. The number of correct responses gives a better indication of the time effect on difficulty level than does the observed proportion correct since the latter disregards omits, thus not giving a clear indication of problem difficulty if a large number of people omit the problem.

The order of entry of the variables, R, and R^2 for each of the first six steps in the regression for each of the three sections and for the three sections combined are given in Tables 3,4, and 5 for the six structural, 14 linguistic, and 20 combined variables, respectively. In addition, R and R^2 for the last step are also given.

Insert Tables 3,4, and 5 About Here

As shown in Table 3, for the three sections combined, $R_6 = .64$, with $R_6^2 = .41$. Thus these six structural variables accounted for only 41 percent of the variance in the observed proportion of correct responses. The order of entry of the variables in section I, the section with a 20 minute time limit, was decidedly different from that of sections II and III. However, the orders of entry of the first five variables that entered the regression for sections II and III were identical except that the second and third variables were interchanged.

The regression coefficients, standard errors of regression coefficients, and computed t-values for each of the three sections and for the three sections combined are presented in Tables 6,7, and 8 for the six structural, 14 linguistic, and 20 combined variables, respectively.

Insert Tables 6,7, and 8 About Here

As indicated in Table 6, the structural variables, which entered the regression, were almost never significant for any group tested.

The first six variables which entered the linguistic regression analysis for the three sections combined, as shown in Table 4, were NC, NUMQS, CLTH, NPP, NSEN, and WDSC. The multiple R at step six was .79, with $R_6^2 = .63$, indicating that 63 per cent of the variance in the observed proportion correct was accounted for by these six variables. It is interesting that three variables NSEN, NUMQS, and NC entered in the first six steps in each of the three sections. Especially noteworthy is that in addition to these three variables, CLTH and NPP entered in the first six steps in both sections I and III. Hence, the five variables, NSEN, NUMQS, NC, CLTH, and NPP entered in the first six steps in both section I, the 20 minute section and section III, the one day section.

As indicated in Table 7, the first four variables which entered the regression for the three sections combined were significant. Although the six variables which entered the regression in section I and the first four which entered in section III were significant, none of the first six variables were significant for section II, the one hour section.

Especially significant is that the multiple R at step six for section III, the one day section, was R = .86, with $R_6^2 = .74$. The multiple R at the last step was $R_L = .96$ with $R_L^2 = .91$.

In the 20 variable combined analysis, as shown in Table 5, two of the first five variables which entered the regression for the three sections combined were structural variables, OPER3, the operations variable, and QUO, the division variable. The remaining four variables which entered in the first six steps were the linguistic variables NC, NUMQS, NPP, and MCLTH. The regression produced $R_6 = .83$, $R_6^2 = .67$ and $R_L = .96$, with $R_L^2 = .93$. Of these six variables, as is shown in Table 8, the significant variables were three linguistic variables, MCLTH, NPP, and NC, and the structural variable OPER3. CLTH and NC entered in the first six steps for each of the three sections, with NC entering first in both sections II and III. These two variables were significant each time they occurred except that CLTH was not a significant variable for section II. Zero, two, and one structural variables entered the stepwise regression for sections I, II, and III, respectively.

Interestingly, of the first six variables to enter the regression analysis, four linguistic variables, NUMQS, NC, CLTH, and NPP entered in both section I, the 20 minute section and section III, the one day section. In addition, the regression analysis produced for section III a multiple R of .86 at step 6, with $R^2 = .75$.

Discussion

There was a substantial time effect with respect to the mean number of correct responses for the three sections. This effect, however, seemed to be different for the structural and linguistic variables.

There was almost no consistency in the order of entry of the six structural variables in section I, the 20-minute section, and section III, the one day section. In fact, OPER 3, which entered first in the regression for section I, entered last for section III and QUO which entered last in section I entered second in section III.

Linguistic variables, however, were consistent with respect to early entry in the regression analysis for sections I and III. Of the fourteen linguistic variables used, five variables, NUMQS, NPP, CLTH, NC, and NSEN entered in the first six steps for both sections. In addition, these five variables entered in the first five steps in the linguistic regression for the three sections combined. Four of these five variables, NUMQS, NPP, CLTH, and NC were significant variables for section I, section III, and the three sections combined. No structural variables, however, were significant variables for any of these groups in the structural regression analysis. Three linguistic variables, NSEN, NC, and NUMQS entered in the first six steps for each of the three sections. Very possibly the time effect is not as important with linguistic variables as it is with structural variables.

There was a significant difference in the amount of variance accounted for at step six in the structural and linguistic analysis. Disappointingly, the regression, for the three sections combined, using the six structural variables, produced $R_6^2 = .41$, thus accounting for, at step 6, only 41 percent of the total variance in the observed proportion correct. The maximum value obtained for R_6^2 in any structural regression was .47, which occurred for section III. Hence, even with a full day time limit, the six structural variables alone accounted for only 47 percent of the variance in the observed proportion correct.

In the study by Jerman (1972) of students in grades 4-9, the first three variables which entered the stepwise regression, OPER3, Length, and NOMC2, produced R_3^2 = .47, thus accounting for 47 percent of the total variance in just three steps. Possibly, structural variables are not as good predictors of difficulty level in arithmetic word problems for prospective teachers as for elementary or junior high school children.

The linguistic variables accounted for a greater amount of the total variance than did the structural variables. The multiple R at step six for section III, the one day section, for which the time effect was insignificant, was .86 with R_6^2 = .75. This is a reasonably high percent of variance accounted for at step six and is much larger than the R^2 produced at step six in any regression analysis using the six structural variables alone. Perhaps linguistic variables are better predictors than structural variables in arithmetic word problems for the population in question.

An analysis of the 20 combined variables also indicates the possible importance of the linguistic variables. Although two structural variables, OPER3 and QUO, entered the regression in the first six steps for the three sections combined, only OPER3 was significant whereas three of the linguistic variables which entered in the first six steps, MCLTH, NPP, and NC were significant. Only two structural variables, NOMC2, which was significant the one time it occurred, and QUO, which was not significant, entered in the first six steps for any of the three sections in the combined

20 variable analysis. In fact, only zero, two, and one structural variables entered the regression in the first six steps for sections I, II, and III, respectively. Two linguistic variables, however, NC and CLTH, entered in the first six steps for each of the three sections. In addition, although there was no structural variable which entered the regression analysis, for the 20 combined variables, in the first six steps for both sections I and III, four linguistic variables, NUMQS, NC, CLTH, and NPP, did.

Perhaps the importance of the linguistic variables may best be seen by observation of the results of the 20 combined variables for section III, the one day section. QUO was the only structural variable among the first six variables which entered the regression. Although QUO was not significant, the five linguistic variables which entered in the first six steps were all significant at the .005 level, except NWDQS, which was significant at the .025 level.

This study should be looked upon only as investigatory in nature. Future studies must be better controlled with respect to uniformity in administration of problem sets, a greater ratio of problems to variables should be included if at all practical, the order of problems should be randomly assigned to students in order to minimize the interaction effect of problem order and difficulty level, and possibly, if enough time is given so that students have ample opportunity to try each problem, the observed proportion correct could be redefined to be the ratio of correct responses to total number of students so that omitting a problem would reflect not being able to do it and not simply the lack of sufficient time to attempt the problem.

The results of this study are encouraging but not satisfactory. The percent of variance accounted for at step six, in any regression, was not sufficiently large. In addition, there obviously is a great deal of dependency between the variables, especially the linguistic variables. Hence, a refinement and further development of these variables is needed. A basic objective for future study is to produce a set of five or six independent variables which account for a significant amount of the variance in the difficulty level of the arithmetic word-problems and which possess the following characteristics:

1. Each variable permits unambiguous, unique, quantitative coding.
2. Each variable permits easy coding; i.e., it will not be difficult for an untrained person to apply the definition of the variable to the coding of problems.
3. Each variable is comprehensive in its applicability to elementary arithmetic word-problems.
4. There is a direct, although not necessarily linear, relationship between the numerical value of the variable and the difficulty level of the problem.

Given that such a set of variables could be constructed, then problems with a specified difficulty level could be written so that curriculum developers and teachers would be in a much better position to control the difficulty level of arithmetic word-problems when preparing instructional materials.

Bibliography

Golub, L. and Fredrick, W. Linguistic structures in the discourse of fourth and sixth graders. Technical Report. No. 166, July, 1971, University of Wisconsin, Wisconsin Research and Development Center for Cognitive Learning.

Jerman, M. and Mirman, S. Predicting the relative difficulty of problem-solving exercises in arithmetic. (Project No. 2-C-047). Washington, D.C.: United States Department of Health, Education, and Welfare, 1972a.

Jerman, M. Structural variables in arithmetic problems. Mimeographed paper, 1972.

Jerman, M. and Rees, R. Predicting the relative difficulty of verbal arithmetic problems. Educational Studies in Mathematics, 1972, 4, 306-323.

Krushinski, J. An analysis of linguistic structural variables that contribute to problem-solving difficulty, Masters Paper, Pennsylvania State University, March, 1973.

Loftus, E. An analysis of the structural variables that determine problem-solving difficulty on a computer-based teletype. Technical Report No. 162, December 18, 1970, Stanford University, Institute for Mathematical Studies in the Social Sciences.

Suppes, P.; Loftus, E.; and Jerman, M. Problem-solving on a computer-based teletype. Educational Studies in Mathematics, 1969, 2, 1-15.

TABLE 1

Means and Standard Deviations for Each Section Using Observed Proportion Correct and Number of Correct Responses for Each Student

Section	Observed Proportion Correct		Number of Correct Responses	
	$\bar{X}$	S	$\bar{X}$	S
I	.546	.1999	10.207	4.126
II	.654	.1405	13.148	4.148
III	.662	.1291	17.950	4.334

TABLE 2

Summary of Analysis of Variance
Using Observed Proportion Correct
and Number of Correct Responses
for Each Student

Source of Variation	Observed Proportion Correct				Number of Correct Responses			
	Sum of Squares	Mean Squares	d.f.	F Ratio	Sum of Squares	Mean Squares	d.f.	F Ratio
Between Sections	.223138	.111569	2	4.204*	710.56	355.258	2	20.243**
Error	1.93751	.0265413	73		1281.12	17.5495	73	
Total	2.16065				1991.63			

*$p < .05$ **$p << .01$

TABLE 3

Order of Entry, R, and R^2 For First Six Steps R_L, and R_L^2 for Six Structural Variables

Step	I-20 Minutes			II-1 Hour			III-1 Day			Combined		
	Variable	R	R^2	Variable	R	R^2	Variable	R	R^2	Variable	R	R^2
1	OPER3	.4183	.1749	Length	.4894	.2395	Length	.5532	.3060	OPER3	.5467	.2988
2	Length	.4790	.2294	NOMC2	.6498	.4223	QUO	.6472	.4189	Length	.6304	.3974
3	Conversions	.5094	.2595	QUO	.6784	.4602	NOMC2	.6796	.4618	Conversions	.6393	.4087
4	NOMC2	.5305	.2814	RECAL	.6793	.4614	RECAL	.6834	.4670	RECAL	.6420	.4122
5	RECAL	.5360	.2873	OPER3	.6795	.4617	OPER3	.6840	.4678	QUO	.6425	.4128
6	QUO	.5403	.2919	CONVR	.6797	.4620				NOMC2	.6427	.4131
Last		.54	.29		.68	.46		.68	.47		.64	.41

TABLE 4

Order of Entry, R, and R^2 For First Six Steps R_L, and R_L^2, for 14 Linguistic Variables

Step	1-20 Minutes			II-1 Hour			III-1 Day			Combined		
	Variable	R	R^2	Variable	R	R^2	Variable	R	R^2	Variable	R	R^2
1	NMC	.4524	.2046	NC	.4940	.2441	NC	.5685	.3231	NC	.5433	.2952
2	NSEN	.5667	.3212	NUMQS	.5422	.2940	CLTH	.6887	.4742	NUMQS	.6158	.3793
3	NUMQS	.6086	.3704	SENLTH	.6070	.3684	NPP	.7441	.5537	CLTH	.6529	.4263
4	NC	.6414	.4114	NWDQS	.6371	.4059	NUMQS	.7920	.6273	NPP	.7506	.5634
5	CLTH	.6710	.4502	MCLTH	.6532	.4267	NWDQS	.8508	.7238	NSEN	.7866	.6187
6	NPP	.7336	.5382	NSEN	.6665	.4443	NSEN	.8618	.7428	WDSC	.7915	.6265
Last		.78	.61		.71	.50		.91	.83		84	.71

TABLE 5

Order of Entry, R, and R^2 For First Six Steps

R_L, and R_L^2 For 20 Combined Variables

Step	I-20-Minutes			II-1 Hour			III-1 Day			Combined		
	Variable	R	R^2	Variable	R	R^2	Variable	R	R^2	Variable	R	R^2
1	NMC	.4524	.2046	NC	.4940	.2441	NC	.5685	.3231	OPER3	.5467	.2988
2	NSEN	.5667	.3212	NOMC2	.6487	.4208	QUO	.7082	.5051	NC	.7037	.4952
3	NUMQS	.6086	.3704	QUO	.7009	.4912	CLTH	.7500	.5625	NUMQS	.7227	.5223
4	NC	.6414	.4114	MCLTH	.7226	.5222	NPP	.7843	.6151	QUO	.7436	.5529
5	CLTH	.6710	.4502	CLTH	.7478	.5592	NUMQS	.8232	.6776	NPP	.7638	.5833
6	NPP	.7336	.5382	NSEN	.7557	.5711	NWDQS	.8647	.7477	MCLTH	.8277	.6851
Last		.82	.87		.87	.76		.96	.91		.96	.93

TABLE 6

Regression Coefficients, Standard Errors of Regression Coefficients, and Computed t-Values For Six Structural Variables

Variable	I-20 Minutes			II-1 Hour			III-1 Day			Combined		
	Coeff.	S.E.	t	Coeff.	S.E.	t	Coeff.	S.E.	t	Coeff.	S.E.	t
RECAL	.128	.239	.533	.048	.202	.238	-.055	.128	-.427	.035	.116	.304
Length	.029	.023	1.273	.053	.019	2.757*	.039	.012	.319	.023	.011	2.035
Conversion	-.479	.588	-.816	.052	.497	.104	–			.160	.286	.561
OPER3	.081	.078	1.040	.009	.066	.129	.008	.041	.197	.060	.038	1.59
NOMC2	.161	.244	.660	.436	.206	2.114*	.125	.131	.951	.013	.119	.106
QUO	-.067	.172	-.387	.105	.146	.723	.130	.091	1.421	.015	.084	.175

*$p < .05$ **$p < .01$ 2 tail test

TABLE 7

Regression Coefficients, Standard Errors of Regression Coefficients, and Computed t-Values for 14 Linguistic Variables

Variable	I-20 Minutes			II-1 Hour			III-1 Day			Combined		
	Coeff.	S.E.	t	Coeff.	S.E.	t	Coeff.	S.E.	t	Coeff.	S.E.	t
NWD												
NSEN	-1.663	.584	-2.847**	-.683	.803	-.852	-.336	.258	-1.30	-.490	.254	-1.933
SENLTH				.081	.108	.748						
NMC	1.199	.427	2.809*									
NSC												
NC	.657	.268	2.454*	.778	.382	2.037	.776	.131	5.922***	.723	.181	3.99***
WDMC												
WDSC										-.015	.022	-.693
CLTH	.261	.109	2.405*				.244	.052	4.727***	.179	.052	3.421**
MCLTH				.117	.093	1.260						
SCLTH												
NPP	-.281	.134	-2.093*				-.211	.068	-3.096**	-.169	.065	-2.615*
NWDQS				-.068	.065	-1.059	.042	.025	1.687			
NUMQS	-1.152	.540	-2.133*	-.572	.706	-.810	-1.145	.308	-3.715**	-.703	.265	-2.651*

*p < .05 **p < .01 ***p < .001 2 tail test

TABLE 8

Regression Coefficients, Standard Errors of Regression Coefficients, and Computed t-Values For 20 Combined Variables

Variable	I-20 Minutes			II-1 Hour			III-1 Day			Combined		
	Coeff.	S.E.	t	Coeff.	S.E.	t	Coeff.	S.E.	t	Coeff.	S.E.	t
RECAL												
Length												
Conversion												
OPER3										.050	.023	2.142*
NOMC2				.472	.151	3.126**						
QUO				.179	.094	1.818	.074	.050	1.476	.032	.059	.055
NWD												
NSEN	-1.663	.584	-2.847**	-.314	.393	-.797						
SENLTH												
NMC	1.199	.427	2.809*									
NSC												
NC	-.657	.268	2.454*	.555	.239	2.322*	.620	.095	6.507***	.387	.079	4.916***
WDMC												
WDSC												
CLTH	.261	.109	2.405*	-.304	.218	-1.392	.200	.055	3.601**			
MCLTH				.327	.175	1.872				.116	.042	2.726*
SCLTH												
NPP	-.281	.134	-2.093*				-.216	.065	-3.302**	-.181	.061	-2.990**
NWDQS							.053	.021	2.528*			
NUMQS	-1.152	.540	-2.133*				-1.082	.312	-3.470**	-.434	.223	-1.944

*p <.05 **p <.01 ***p ≤.001 2 tail test