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ABSTRACT

The purposes of this study were to assess the usefulness of a variety of readability formulas in predicting the relative difficulty of passages, and to explore the contribution of pupils' background to text difficulty. Subjects were 285 special education students in grades 1-9, 117 of whom were based in rural and suburban Minnesota (MN) and 168 of whom lived in New York City (NYC). Each student was tested twice on three passages of a Passage Reading Test (PRT). Analyses of variance applied to the data revealed an interaction between passages and student site (MN vs NYC), suggesting that text difficulty was affected by students' background. Additionally, six readability formulas were applied to the three PRT passages. There was no agreement between passage difficulty rankings derived from the formulas and those based on students' actual performance. Implications for creating readability formulas are discussed. (Author)

University of Minnesota

Research Report No. 129

THE NATURE OF INACCURACY AMONG READABILITY FORMULAS

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Abstract

The purposes of this study were to assess the usefulness of a variety of readability formulas in predicting the relative difficulty of passages, and to explore the contribution of pupils' background to text difficulty. Subjects were 285 special education students in grades 1-9, 117 of whom were based in rural and suburban Minnesota (MN) and 168 of whom lived in New York City (NYC). Each student was tested twice on three passages of a Passage Reading Test (PRT). Analyses of variance applied to the data revealed an interaction between passages and student site (MN vs NYC), suggesting that text difficulty was affected by students' background. Additionally, six readability formulas were applied to the three PRT passages. There was no agreement between passage difficulty rankings derived from the formulas and those based on students' actual performance. Implications for creating readability formulas are discussed.

The Nature of Inaccuracy Among Readability Formulas

Formulas for measuring the readability of texts have been developed and employed widely for at least four decades (Kemper, 1983). Such formulas may enjoy broad use due to their simplicity and the ease with which educators can be taught to apply them, as well as because of the appeal of such a seemingly scientific approach to describing passage difficulty.

Teachers rely on readability formulas for determining appropriate instructional reading material, and evidence (Stevens & Rosenshine, 1981) suggests that the activity of matching reading material correctly with students' skills is important to student achievement. Nevertheless, the methods by which readability formulas are derived and the type of variables they include to predict text difficulty have been criticized (Fitzgerald, 1980; Fuchs, Fuchs, & Deno, 1982; Kemper, 1983). The objective of the present study was to address two frequently cited criticisms: (a) the poor accuracy of readability formulas, and (b) the serious omission from currently available formulas of variables that describe students' background or familiarity with text. Specifically, the study had two purposes: to assess the usefulness of a variety of readability formulas in predicting the relative difficulty of passages, using students' actual reading scores to determine the criterion difficulty of the passages, and to explore the contribution of pupils' backgrounds to text difficulty.

Method

Subjects

Subjects were 285 students distributed across grades 1-9. Of this group, 117 (92 males, 23 females, 2 unreported) were in special

education programs in rural and suburban Minnesota public schools. The average grade level of these students was 3.76 (SD = 1.39). Another 168 pupils (129 males, 39 females) were in New York City Public School special education programs. The average grade level of these children was 5.62 (SD = 1.66). Statistical tests revealed that the Minnesota and New York students were similar with respect to sex, $\chi^2(1) = .60$, ns, but there was a statistically significant difference between the grade levels of the two groups, $t(283) = 10.00$, $p < .001$.

Measures

A passage reading test (PRT; Fuchs, Deno, & Mirkin, in press), comprised of three reading passages from a third grade book of the Ginn 720 series (1976), was employed. Two passages were sampled randomly from the text and one was chosen to represent the difficulty of the last 25% of the book. (See Fuchs et al., 1982, for selection procedure.) The test requires students to read aloud from each passage for one minute, while the examiner marks omissions, substitutions, insertions, and mispronunciations. Student performance was reported in terms of the number of correct words read on each passage. Test-retest reliability ranged from .93 to .96 (Fuchs, Deno, & Marston, in press). Concurrent validity with respect to the Woodcock Reading Mastery Tests, Word Identification and Passage Comprehension Tests, ranged between .89 and .92 (Fuchs, 1981). Internal consistency reliability (Cronbach's alpha) for the three passage test was .79 (Fuchs, Deno, & Mirkin, in press).

Readability Formulas

Six readability formulas were employed. Table 1 lists the developers of the formulas as well as the predictor variables employed in each.

Insert Table 1 about here

Procedure

Each readability formula was applied to the passages of the PRT. Then, each student was tested individually on the three passages of the PRT, in standard fashion (see Mirkin, Deno, Fuchs, Wesson, Tindal, Marston, & Kuehnle, 1981). The PRT was administered twice to each student, with seven months intervening between the administrations.

Data Analysis

The three passages of the PRT were assigned rank orders of difficulty according to (a) students' actual mean performances on each administration of the PRT, and (b) scores derived from the application of the six readability formulas. Then, a one between factor (site: Minnesota vs. New York City), repeated measures (passages 1 vs. 2 vs. 3) analysis of variance was run on scores from each administration of the PRT.

Results

Table 2 presents the formula readability scores, the actual reading scores, and the difficulty rank orderings of the three PRT passages. On both administrations of the PRT, students' average scores on the passages were ranked in the same order. However, there was consistent disagreement between these rankings and those from the application of the formulas. Among the six readability score rank orderings, the Spache formula and the Fog Index agreed with each other and the Coleman and Gilliland formulas agreed with each other.

Insert Table 2 about here

Employing the rank ordering derived from students' actual performance as the criterion difficulty rankings, the percentages of increase in difficulty between successively ordered PRT passages were computed (see Table 3). As measured by students' actual scores across the two PRT administrations, difficulty increased an average 6.5% and an average 12.0%, respectively, between passages 1 and 2 and between passages 2 and 3. The readability score estimates of difficulty increases between successive passages were variable. The average absolute value of the discrepancy between the difficulty increases indicated by students' actual scores and by the readability scores was 9.08% (SD = 6.46) across the six formulas and across the two comparisons (passages 1 vs. 2 and 2 vs. 3).

Insert Table 3 about here

Means and standard deviations of students' scores on each passage for each administration of the PRT are reported by site in Table 4. A one between (site), repeated measures (passages) analysis of variance, applied to the first PRT administration, revealed significant main effects for both site, $F(1,282) = 9.81$, $p < .01$, and passages, $F(2,564) = 76.20$, $p < .001$, as well as an F value that approached significance for the site X passage interaction, $F(2,564) = 2.71$, $p = .067$. Applied to the second administration of the PRT, the analysis of

variance revealed significant effects for passages, $F(2,538) = 55.75$, $p < .001$, and for the site X passage interaction, $F(2,538) = 16.62$, $p < .001$. There was no significant effect for the site factor, $F(1,269) = 2.89$, ns.

Insert Table 4 about here

Follow-up, orthogonal correlated t tests on the passage factor revealed that there was a statistically significant difference between performance on passages 1 and 2 vs. passage 3, $t(293) = 10.30$, $p < .001$ and $t(279) = 8.76$, $p < .001$, for the first and second administrations of the PRT, respectively. Additionally, there was a statistically significant difference between performance on passage 1 vs. passage 2, $t(292) = 4.56$, $p < .001$ and $t(279) = 5.10$, $p < .001$, for the first and second PRT administrations, respectively.

To clarify the site X passage interaction on the two PRT administrations, the percentages of increase in difficulty between successive PRT passages for the two sites were calculated (see Table 5). Figures 1 and 2 display the interactions. As suggested in Table 5 and Figures 1 and 2, the difficulty between passages 1 and 2 was similar for the two groups. However, the difference in difficulty between passages 2 and 3 was much greater for the Minnesota pupils relative to the New York City group.

Insert Table 5 and Figures 1 and 2 about here

Discussion

The first purpose of this study was to assess the usefulness of readability formulas in predicting the relative difficulty of passages, using students' actual reading scores to determine the criterion difficulty of the passages. Findings suggest that the readability formulas were inaccurate. None of the rank orderings of passage difficulty based on the formulas agreed with the one suggested by students' actual average performances on the passages. The soundness of the students' actual performance to derive a reliable criterion ranking of passage difficulty is indicated in two ways: first, by the fact that students' average scores on the passages were ranked in the same order over the two PRT administrations; second, because orthogonal *t* tests revealed significant differences in students' performances among the three passages for both PRT administrations. In addition to predicting poorly the criterion difficulty rank order of the passages, the readability formulas failed to agree meaningfully with each other. Although two pairs of formulas produced the same rank orderings, inspection of Table 1 indicates that neither the Spache-Gunning pair nor the Coleman-Gilliland pair includes the same predictor variables. Finally, the readability formulas inaccurately estimated the percentages of increase in difficulty between successively more difficult passages. On average, the formulas missed the criterion indices of difficulty increases by over 9%.

These findings raise serious questions about the accuracy and usefulness of readability formulas in predicting passage difficulty,

and may at least partially be explained by the methods by which such formulas are developed. Typically, readability formulas have been derived and refined by their success in predicting difficulty estimates of basal texts or older versions of the McCall-Crabbs (1925, 1950, 1961; cited in Fitzgerald, 1980) Standard Test Lessons in Reading (Klare, 1974-1975). Although it has been assumed that basal texts and the Test Lessons were developed adequately for use as the criterion of accuracy for readability formulas (Klare, 1974-1975), there actually is little evidence to support either the correctness of text readability designations (Bradley & Ames, 1977; Britton & Lumpkin, 1977; Fitzgerald, 1980; Fuchs et al., 1982) or the integrity of the Test Lessons' standardization (see Fitzgerald, 1980).

Additionally, readability formulas have been criticized (Kemper, 1983; Pearson, 1974-1975) because they rely on surface characteristics such as word length, word frequency, sentence length, and sentence complexity (see Table 1). Formulas typically fail to account for students' familiarity with text (Fuchs et al., 1982), and therefore ignore the contributions of the reader in terms of general background knowledge or expertise. Such a reliance on the mechanics of text, rather than the content of a passage or the skills of a reader, may explain at least partially the failure of the readability formulas to predict students' actual performance on the passages.

In investigating the effect of students' background on readability, pupils' school site was designated the critical factor: Minnesota children were conceptualized as having an essentially rural/suburban experience whereas New York City youngsters were viewed

as having big city expertise. Findings of the study suggest that students' site, or background, did account for the relative difficulty of the passages. The difference in students' scores between passages 1 and 2 were similar; however, passage 3 relative to passage 2 was much harder for the Minnesota pupils than for the New York City pupils. Inspection of the content of passage 3 revealed that the text describes gang activity and a city bus ride, essentially urban experiences. This suggests that the interaction between site and passage, demonstrated on the second PRT administration and approached on the first PRT testing, may be explained by the relation between reader background and text content.

Consequently, findings of this study indicate that developers of readability formulas might consider (a) employing students' actual reading scores, rather than questionable difficulty designations of passages, as their criterion variables, and (b) developing and incorporating predictor variables that address a reader's background or expertise. A recent attempt at developing a readability formula (Kemper, 1983) included a measure of the inference load of a text, which reflects the difficulty readers have in inferring the causal connections necessary to recover the event chains underlying texts. This represents both a move beyond the surface characteristics of text and a worthwhile attempt at assessing the comprehensibility of a passage. Nevertheless, it still fails to incorporate aspects of student background into readability formulas, a variable that may be critical in determining the difficulty of reading material for students.

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Table 1

Predictor Variables Included in Readability Formulas

Developer	Predictor Variables							
	Sentence Length	Difficult Words	Prepositional Phrases	1-Syllable Words	3-Syllable Words	Pronouns	Syllables	Sentences
Dale-Chall (1953)	X	X						
Gorge (1948)	X	X	X					
Farr-Jenkins-Patterson (1951)	X			X				
Gunning (1952; The Fog Index)	X				X			
Coleman (1971)			X	X		X		X
Dilliland (1974)							X	X

Table 2

Formula Readability Scores, Actual Reading Scores, and Difficulty Rank Orders[a] of Three Ginn 720, Grade 3 Passages of the PRT

	Passage		
Formula Readability[b]	1	2	3
Spache (1953)	4.92(3)	4.36(2)	3.66(1)
Lorge (1948)	5.38(1)	5.61(3)	5.42(2)
Farr-Jenkins-Patterson (1951)*	67.17(2)	65.85(1)	71.74(3)
Gunning (1952; The Fog Index)	9.02(3)	7.65(2)	5.14(1)
Coleman (1971)*	59.47(3)	52.62(1)	58.79(2)
Gilliland (1974)	7.25(3)	6.25(1)	7.00(2)
Actual Reading[c]			
Time 1	44.13(1)	41.44(2)	35.34(3)
Time 2	61.07(1)	56.83(2)	51.57(3)

[a]Rank order assignments are indicated in parentheses (1=easiest).

[b]Readability scores are in terms of grade level except where indicated with an asterisk(*), raw scores are reported.

[c]N=280.

Table 3

Percentages of Increase in Difficulty Between Successive PRT Passages as Indicated by Readability Scores and Actual Reading Scores

Formula Readability	Percentage Increase Between Passages 1 and 2	2 and 3
Spache (1953)	11.4	16.1
Lorge (1948)	-4.3	3.4
Farr-Jenkins-Patterson (1951)	2.0	-8.9
Gunning (1952; The Fog Index)	15.2	32.8
Coleman (1971)	11.5	-11.7
Gilliland (1974)	13.8	-1.2
Actual Reading		
Time 1	6.1	14.7
Time 2	6.9	9.3

Table 4

Students' Scores on PRT Passages for Each Testing by Site

	Site			
	Minnesota		New York	
	M	SD	M	SD
Time 1[a]				
Passage 1	38.45	26.02	49.58	41.44
Passage 2	35.66	24.95	46.99	41.38
Passage 3	28.09	19.44	42.28	40.01
Time 2[b]				
Passage 1	57.75	31.99	64.13	48.02
Passage 2	54.79	31.83	58.71	43.78
Passage 3	44.26	26.56	58.31	50.79

[a] N=284.

[b] N=271.

Table 5

Percentages of Increase in Difficulty Between Successive Passages by Site

	Site	
	Minnesota	New York
Time 1		
Passages 1 vs. 2	7.3	5.2
Passages 2 vs. 3	21.2	10.0
Time 2		
Passages 1 vs. 2	5.1	8.5
Passages 2 vs. 3	19.2	.7

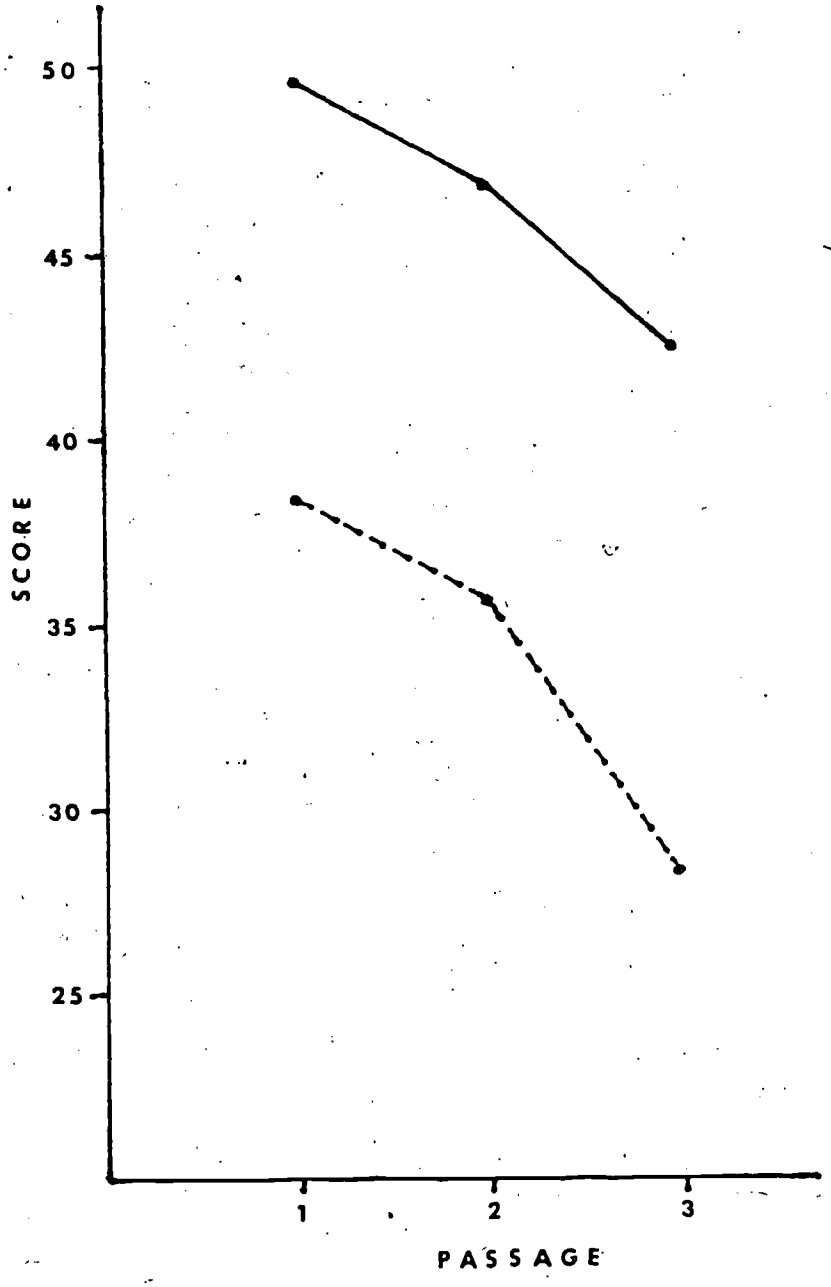

Figure 1. Scores on passages 1, 2, and 3 for New York (——) and Minnesota (---) students on the first PRT administration.

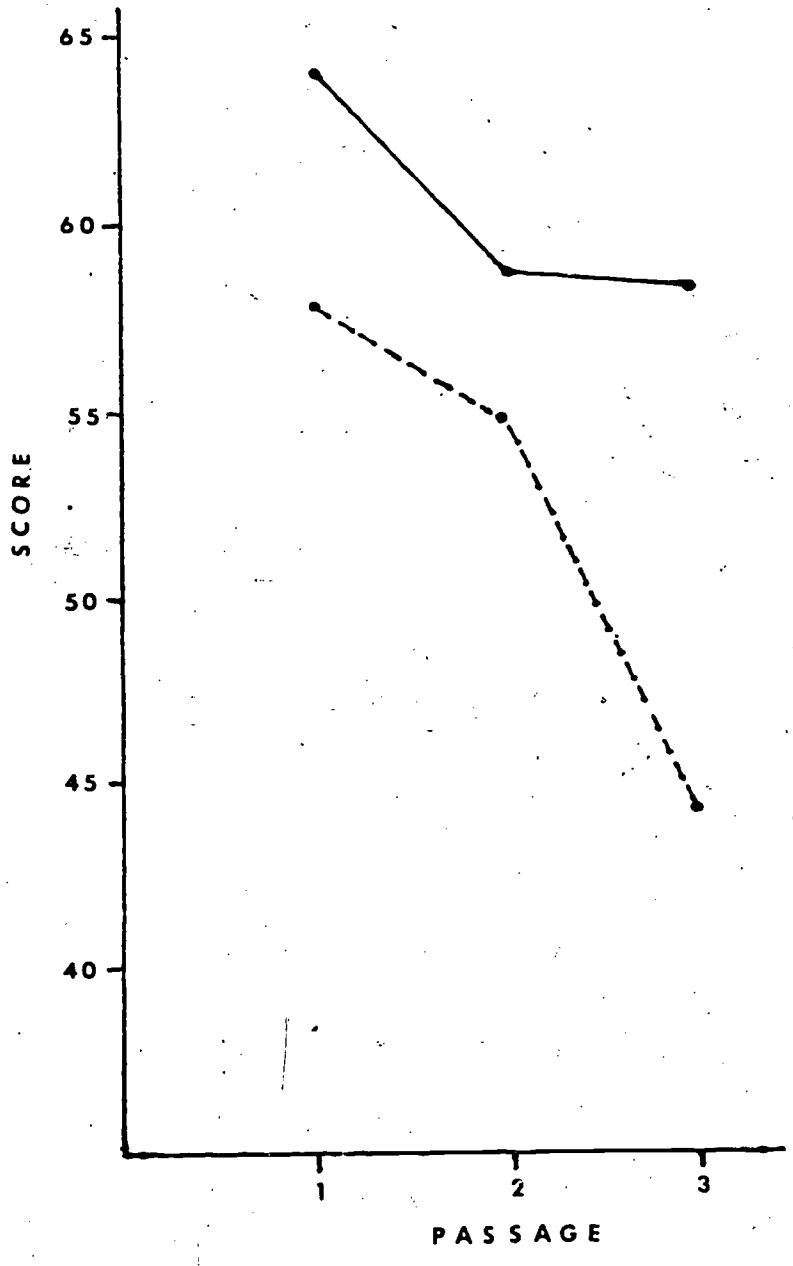

Figure 2. Scores on passages 1, 2, and 3 for New York (——) and Minnesota (---) students on the second PRT administration.

PUBLICATIONS

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