# Last Rites for Readability Formulas in Professional Communication

***Abstract—*** Some reading researchers and technical communicators assume the efficacy of readability formulas. Reading researchers use such formulas to equalize the reading difficulty of texts used in experiments. Results of an informal Internet survey indicate that some professional writers and editors use readability formulas that are integrated into software applications. This article proposes that readability formulas fail to predict text difficulty. The results of an experiment demonstrate that "text difficulty" is a perception of the reader and therefore cannot be objectively calculated by counting syllables, word length, sentence length, and other text characteristics.

## Introduction

Readability formulas are designed to predict the level of difficulty a reader will experience with a text. They are based largely upon certain assumptions of English composition inherited by professional writers and editors. These assumptions include:

- Shorter sentences are easier to read than longer sentences.
- Words with fewer syllables are easier to read than words with more syllables.
- Shorter words are easier to read than longer words.
- Active constructions are easier to read than passive constructions.

There are literally hundreds of readability formulas proposed or used to predict text difficulty [1]. According to Abram, readability formulas date back to 900 A.D. [2], but modern interest can be traced back to the 1940s, when Flesch popularized his Reading Ease Formula [3]. While preparing materials for a pilot reading experiment, I equalized three experimental texts according to the Dale-Chall formula [4] and other text characteristics, assuming the efficacy of readability formulas in objectively measuring text difficulty. During my literature search for the experiment, I discovered that reading researchers often use readability formulas to equalize experimental texts, with three formulas being the most popular: Fry [5] [6] [7], Flesch [8] [9] [10], and Dale-Chall [11] [12]. A few researchers incorporated the basic philosophy of readability prediction into homemade formulas [13] [14].

However, after conducting the reading experiment, I suspected that the texts were not at all equivalent, despite their having nearly equivalent characteristics. Voluntary comments from the subjects of the experiment also indicated that the texts were not equivalent in reading difficulty. Were all of the researchers who used readability formulas to equalize texts wrong about the efficacy of readability formulas?

I propose that readability formulas cannot predict text difficulty. Moreover, the textbooks used to prepare today's technical communicators do not sufficiently address the efficacy of these metrics. In this article, I demonstrate that some professional writers and editors as well as reading researchers faithfully use readability formulas. I present the results of an experiment to demonstrate that "text difficulty" is a perception of the reader and therefore cannot be objectively calculated by counting syllables, word length, sentence length, and other text characteristics.

## Tacit Approval

Published in places rarely visited by professional communicators, evidence is piled high against using readability formulas to match the difficulty of a text to a particular audience. For example, the U.S. Army flatly condemns formulas, stating, “Formulas cannot match material to reader” [15, p. vii]. Likewise, in a study to determine the usefulness of readability formulas in evaluating and modifying texts written for adult basic education, Taylor and Wahlstrom found readability formulas inadequate, principally because they disregard the reader [16]. About fifteen years ago, Redish and Selzer explicitly warned technical communicators that readability formulas are ineffective predictors of text difficulty [17]. Similarly, Giles applied readability formulas to technical texts and concluded that the “formulas can mislead writers by focusing on factors that may be irrelevant to writers’ needs, completely ignoring other factors” [18, p. 137].

In the past five years, even academic journals and magazines in technical communication have been silent on readability formulas, including *IEEE Transactions on Professional Communication,* the *Journal of Technical Writing and Communication, Technical Communication,* and *Intercom Magazine.* Jim Hanna, once holder of a column on editing tucked in the back pages of *Technical Communication*, has been a lone voice on this subject in the past five years. “No index is the true index,” he says. “Each is its own short cut to judging its own concept of ‘readability’” [19, p. 560]. However, Hanna goes on to instruct writers how to use Gunning’s Fog Index, the Flesch Reading Ease Formula, and the Dale-Chall Formula, despite his caveats.

It seems as if the abundant information on where to access readability formulas and how to use them far outweighs information about their efficacy. For example, on her award-winning Web site, educator and author Kathy Schrock advocates the use of Fry’s readability graph to educators [20]. In text books, caution flags wave at half-mast, or no flags wave at all. Of the dozens of technical writing text books reviewed for this article, only two mention readability formulas [21] [22]. While both books are skeptical about the efficacy of readability formulas, the few paragraphs devoted to the subject among all the reviewed text books are mere noise compared to the treatment it deserves. Is the next generation of technical communicators interpreting this silence as tacit approval to use readability formulas?

## Readability Indices Used by Professional Technical Communicators

No doubt, reading researchers in many disciplines rely on readability formulas, but what about practitioners? I put that question to the test in an informal Internet survey where professional communicators congregate. The survey instrument, shown below, was posted to two newsgroups for technical communication, a newsgroup for copy editing, and a newsgroup for usability testing. The survey asked questions not only about general knowledge and use of readability formulas but also about knowledge and use of readability indices built into word-processing programs. The most popular of these programs, Microsoft Word [23], uses four readability indices, including the Flesch Reading Ease index. To avoid influential discussions about readability formulas in these newsgroups, I instructed respondents to return their completed survey forms directly to me instead of posting them to the newsgroups.

BEGIN SURVEY
===========

1. Are you familiar with readability formulas?
2. If you are familiar with readability formulas, which ones?
3. What do readability formulas measure?
4. Did you know that some word processors, such as Microsoft Word, have built-in readability indices?
5. Do you ever use the readability index on your word processor?

6. If so, what do you do with that information?
7. Do you ever calculate by hand or other means the readability score of a document using the criteria of a readability formula, such as average sentence length, average number of letters per word, and average number of syllables per word?
8. If so, what do you do with that information?

=========

END SURVEY

Survey instruments can measure three human conditions: cognitive (what the respondent *knows)*, behavioral (what the respondent *does)*, and affective (how the respondent *feels)*. Because the purpose of this article is to increase awareness about readability formulas and thereby change the behavior of those who use them, I designed the survey to measure only knowledge and behavior. That is, what do technical communicators know about readability formulas and how does that knowledge influence their behavior?

Over a three-day period, 71 people responded to the survey. One survey response was thrown out because only one question was answered. The remaining 70 responses are summarized below.

**Question 1** Out of the 70 respondents, 62 (88.6%) indicated that they were familiar with readability formulas.

**Question 2** Out of the 62 respondents who indicated familiarity with readability formulas, most were specifically familiar with variations of the Flesch-Kincaid or Flesch Reading Ease formula (N= 40, 64.5%) and Gunning's Fog Index (N = 33, 53.2%). Eight respondents (12.9%) listed the readability indices in Microsoft Word, but not by name. Other formulas mentioned include the Technical Clarity Index, Dale, and Cloze (which is technically not a formula but an investigative procedure). Figure 1 shows the distribution.

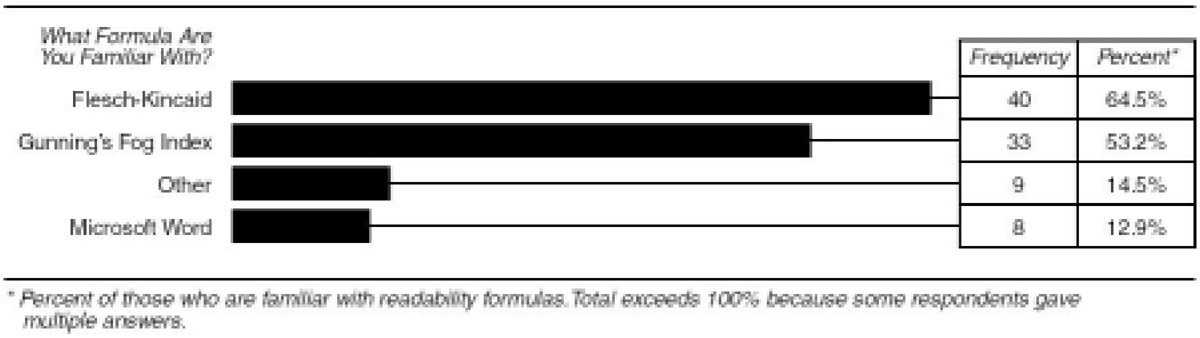


Figure 1. Distribution of particular readability formulas with which respondents are familiar.

**Question 3** Most of the respondents who were familiar with readability formulas thought that readability formulas measure the difficulty of reading or the comprehension level of a text (N = 26, 41.9%). Twenty-two (35.5%) thought that the formulas indicate the grade or age of the reader for whom a text is appropriate. Eighteen (29%) thought that readability formulas measure text attributes—such as sentence length, word length, and number passive verbs. Figure 2 shows the distribution.

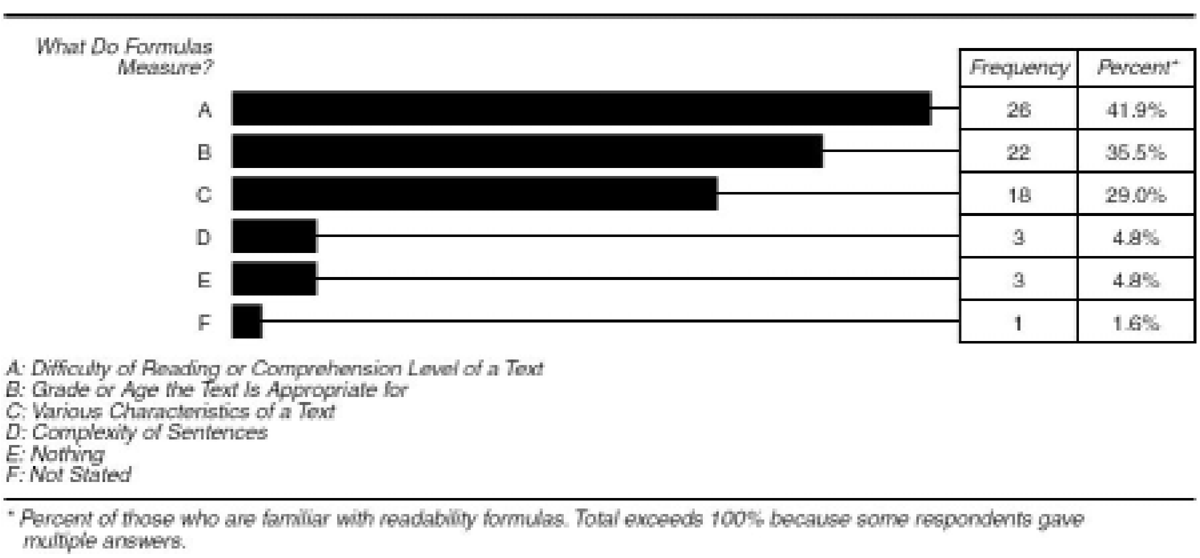


Figure 2. Distribution of what respondents say readability formulas measure.

**Question 4** The vast majority of respondents knew that some word processors, such as Microsoft Word, have built-in readability formulas (N = 64, 91.4%).

**Question 5** Three responses to this question were thrown out because of ambiguous wording. Of the remaining 67 respondents, 39 (58.2%) use readability formulas, while 28 (41.8%) do not. Of the 39 respondents who use readability formulas, 41% (N = 16) indicated that they use the indices routinely. About one fourth (N = 10) of this group of respondents indicated that they rarely use the formulas. However, only serious users were counted as answering “Yes” to Question 5. Respondents who indicated that they use the indices playfully or out of curiosity were not counted as users but were instead counted as answering “No” to Question 5. Figure 3 shows the distribution of how frequently the respondents use the indices.

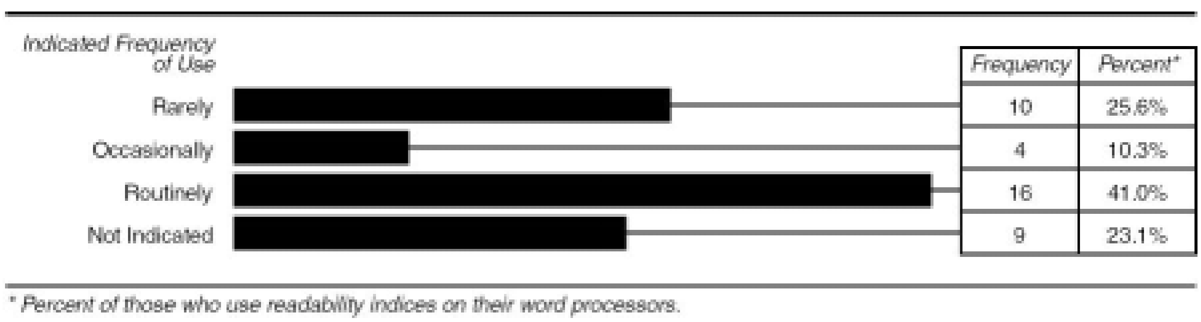


Figure 3. Distribution of how frequently respondents use readability indices.

**Question 6** Of the 39 respondents counted as using readability indices on their computers, more than one third (N = 14, 35.9%) revise texts to match a particular index value, such as a particular Flesch-Kincaid Grade Level. For example, consider the following typical response from this group of users:

> Manuals targeted at a general audience I strive for a reading level of 7 or 8. Manuals targeted at an audience of college graduates I strive form a reading level of 10 or lower.

This finding indicates that some writers and editors are taking readability formulas seriously. Such a serious treatment means that writers and editors may be conveniently using the indices on their computers to make editorial decisions, which should be based upon training and experience.

Almost another third of index users use the indices to verify the difficulty of a text, but these respondents did not elaborate on any activity beyond verification. Four of the respondents (about 10%) stated that a corporate contractor, government agency, or the military required that texts be written to match specific grade-level indices. This finding may be worth investigating to determine the root source, prevalence, and influential power of businesses and government in shaping the use of readability formulas. Figure 4 shows the distribution of what the respondents do with readability indices.

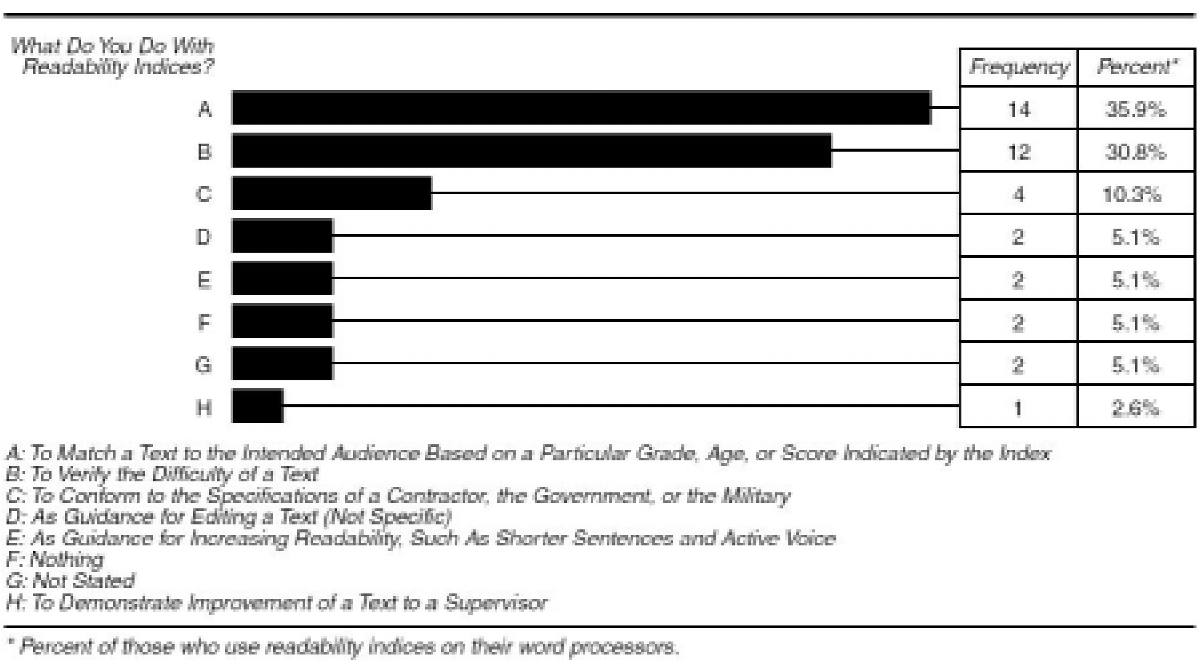

Figure 4. Distribution of how respondents use readability indices

**Question 7** Only 13 (18.6%) of the respondents calculate readability scores by hand or other means. Respondents generally did not indicate how frequently they perform such calculations.

**Question 8** About one quarter of the respondents who calculate readability scores by hand revise texts to match a particular index, such as a particular Flesch-Kincaid Grade Level. The same number use the indices to verify the difficulty of a text or to conform texts to the requirements of a corporate contractor, government agency, or the military. Figure 5 shows the distribution of what the respondents do with hand-calculated readability scores.

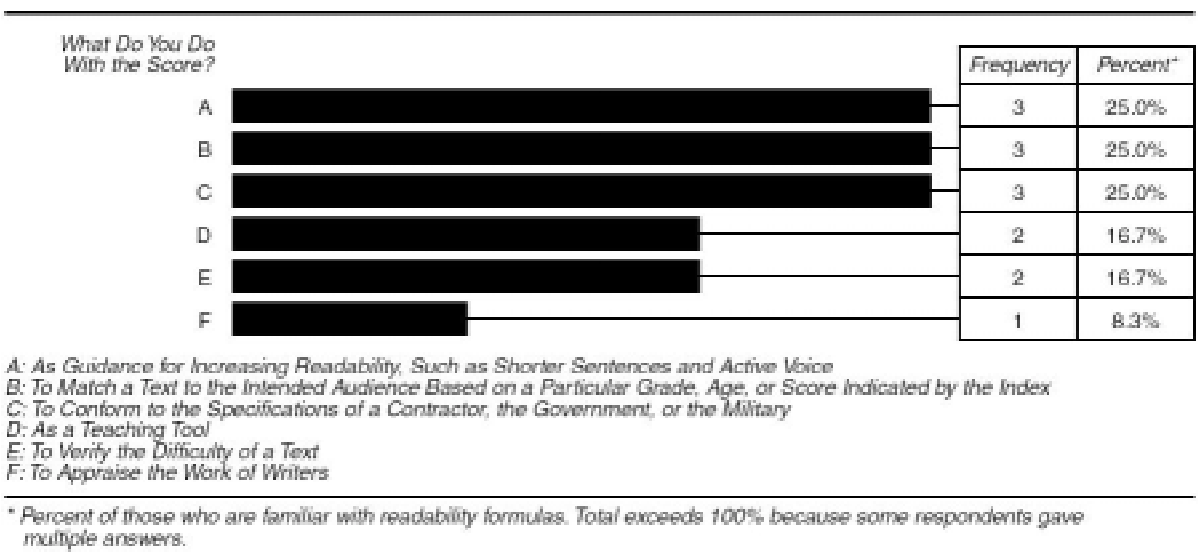


Figure 5. Distribution of how respondents use readability scores

The results of the survey are meant to be taken as an indication of how widely readability indices are used, not as scientific data fit for inferential statistics. As such, the survey results indicate that some technical communicators are using readability formulas, especially the indices built into word processors.

## Text Difficulty Is a Perception: Some Empirical Evidence

Some reading researchers and technical communicators continue to use readability formulas to determine text difficulty. With little evidence to contraindicate the effectiveness of readability formulas, this practice cannot be too readily condemned. To demonstrate that "text difficulty" is determined by individual differences (perception) and not by the objective qualities of a text, I conducted a reading experiment with texts equalized according to 15 text characteristics.

### Subjects

Fifty-seven college students from the University of Tennessee and Pellissippi State Technical Community College in Knoxville, Tennessee were invited to participate in a within-subjects experiment. All subjects were notified about the experiment about two weeks before the experiment was conducted. Participation was voluntary, and subjects were informed that they could withdraw from the study at any time.

### Materials

Three experimental texts—a short story, news story, and technical description—were equalized according to the 15 characteristics shown in Table 1. "Rosary," a short story by Robert Kelly, was selected from *Sudden Fiction* to represent the short story [24]. A straight news story from the *Knoxville News-Sentinel* was modified to represent the news story [25]. Text from pages 30 to 38 of London and Upton's *Photography* was used to create the technical description [26].

The short story was used as the reference text. The news story and technical description were revised until they matched as closely as possible the short story in all fifteen characteristics. All four texts were conformed to *The Chicago Manual of Style* to prevent correctness from becoming a nuisance variable [27]. To verify equality of the texts, a Pearson product-moment correlation procedure was conducted to yield a Pearson's correlation coefficient for each pair of texts. As shown in Table 2, the correlation coefficients are near unity, indicating a high degree of correlation.

Table 1. Characteristics of Each Text

| | *Genre* | | |
|---|---|---|---|
| *Text Characteristic* | *Fiction* | *News* | *Technical* |
| 1) No. of Words | 359 | 359 | 359 |
| 2) No. of Syllables | 463 | 473 | 466 |
| 3) No. of Characters | 1469 | 1498 | 1475 |
| 4) No. of Lines | 22 | 22 | 22 |
| 5) Vocabulary Difficulty | 1405 | 1376 | 1399 |
| 6) No. of Different Words | 174 | 166 | 169 |
| 7) No. of Pronouns | 41 | 27 | 31 |
| 8) No. of Dependent Clauses | 12 | 18 | 13 |
| 9) No. of Compound Sentences | 3 | 3 | 3 |
| 10) No. of Terminal Marks | 16 | 16 | 16 |
| 11) No. of Colons | 0 | 0 | 0 |
| 12) No. of Commas | 18 | 15 | 17 |
| 13) No. of Semicolons | 3 | 3 | 3 |
| 14) No. of Hyphens | 5 | 4 | 4 |
| 15) No. of Dashes | 0 | 0 | 0 |

Table 2. Pearson Correlation Coefficient for Each Text Pair

| | *Short Story* | *News Story* | *Tech Description* |
|---|---|---|---|
| Short Story | 1.00000 | 0.9997 | 0.99997 |
| News Story | 0.9997 | 1.00000 | 0.99983 |
| Tech Description | 0.99997 | 0.99983 | 1.00000 |

Word difficulty of each text was determined by the *Living Word Vocabulary* and its supplement [28] [29]. Each of the 44,000 words in the *Vocabulary* was included in a twenty-five-year study to determine the percentage of students who can correctly define the word. Students were given three definitions from which to choose, one of which was the correct definition. The study yielded a grade level and percent of students selecting the correct definition for each of the 44,000 words tested. The *Living Word Vocabulary* was selected over word-frequency lists to measure word difficulty because word-frequency lists do not differentiate between multiple meanings. For example, in the *Vocabulary*, the word *point* has eight different entries reflecting eight different meanings. A word-frequency list includes one entry for the word *point.*

To render a word-difficulty measure from a word's grade level and percent score, Scott's pi was used. By chance, a person will choose the correct definition of a word from three options thirty-three percent of the time. Scott's pi takes this chance into account:

$$\pi = \frac{P_o - P_e}{1 - P_e}$$

where Po is the percent of observed correct answers and Pe is the percent of correct answers expected by chance [30, p. 148]. Therefore, the difficulty of each word was calculated using the following formula:

$$\text{Word Difficulty} = \text{Grade Level} * [(P_o - 0.333)/0.666]$$

The higher the percent score recorded for a word, the lower the word difficulty. All auxiliary words, such as *to* in infinitives and *had* in past perfect tense, were assigned a grade level of 4 and a percent of 67. The aggregate word difficulty of each text was determined by simply summing all word-difficulty calculations.

## Procedure

Each subject was given all three texts—the order of which was randomized—and asked: “On a scale of one to ten, with one representing ‘extremely easy to understand’ and ten representing ‘extremely hard to understand,’ rate the difficulty of the text you just read. (Circle a number from one to ten.)” “Text difficulty” was defined as “how hard is it to understand what the text is talking about?” There was no time limit placed upon the exercise.

## Results

Table 3 shows the results of two repeated-measures analyses of variance (ANOVAs), which compared the mean of the news-story group and the mean of the technical-description group to the mean of the short-story group. The results of the ANOVAs indicate a consensus among the college students. They found the news story easier to understand than both the short story and the technical description. However, they perceived the short story and the technical description about equally difficult to read.

Table 3. Means for Perceived Text Difficulty and Two-Tailed Probabilities for Mean Differences between

Short Story and News Story, Short Story and Technical Description

| *Prime* | *N* | *Mean* | *SD* | *p Value* |
|---|---|---|---|---|
| Short Story | 57 | 4.61 | 2.09 | |
| News Story | 57 | 3.18 | 2.35 | 0.0007* |
| Tech Desc | 57 | 4.77 | 2.54 | 0.7016 |

*p < 0.01.

## Discussion

Because they are created by the reader, concepts cannot be measured. Readers become aware of a concept only after they create meaning from a text. The textual characteristics we *can* measure—such as vocabulary (semantics)—do not tell us much about intelligibility or complexity of concept. Consider the following sentence from Noam Chomsky, which demonstrates how syntax and semantics function independently from meaning: “Colorless green ideas sleep furiously.” This sentence rates a good readability score, yet a reader will fail to yield a concept from it at all. A readability formula will tell us that the sentence is fairly simple, while our sense-making faculty tells us that it is extraordinarily complex. The syntax of the sentence is impeccable, but like combining water and oil, the general concepts represented by the words cannot be synthesized to create a specific concept.

Text difficulty simply cannot be determined from a surface structure. Consider the two texts below. Version 2 was created from Version 1 by randomly scrambling all the nouns. Table 4 shows how the two texts match up. Even though a Pearson product-moment correlation procedure indicates nearly equal text characteristics ($r = 0.99999$), it is hard to deny that the differences are immense, with Version 1 representing a reasonably readable text and Version 2 representing gibberish.

*Version 1*

We must control light if our eyes, or our cameras, are to form images of objects. You cannot simply place a square piece of film in front of a person and hope that an image of him will appear on the film. The rays of light bouncing off the person would disperse all over the film, which will cause a featureless exposure on the surface of the film rather than the likeness of the person. What one needs to form the likeness of the person on the film is some sort of device that refracts the rays of light from an object onto the film. All lenses do this basic job; they collect light-rays coming from a scene in front of the camera, then project them as an image onto a sheet of film at the back. To render sharp photographs, a lens is thicker in the middle than at the edges. Lenses can merge many rays of light from a single point and bend them straight toward each other, so that light converges at a focal point.

*Version 2*

We must control persons if our likenesses, or our objects, are to form likenesses of persons. You cannot simply place a square exposure of film in front of an image and hope that a device of him will appear on the film. The light of edges bouncing off the job would disperse all over the person, which will cause a featureless middle on the point of the rays rather than the image of the film. What one needs to form the lens of the rays on the objects is some eyes of sort that refracts the film of photographs from a light onto the scene. All backs do this basic camera; they collect pieces coming from a film in front of the light, then project them as a lens onto a camera of point at the sheet. To render sharp light, a film is thicker in the light-rays than at the light. Surfaces can merge many persons of rays from a single image and bend them straight toward each other, so that film converges at a focal lens.

Table 3. Comparison of Text Characteristics

| *Text Characteristic* | *Version 1* | *Version 2* |
|---|---|---|

| | | |
|---|---|---|
| No. of Words | 179 | 179 |
| No. of Syllables | 231 | 232 |
| No. of Characters | 724 | 727 |
| No. of Lines | 11 | 11 |
| Vocabulary Difficulty | 698 | 698 |
| No. of Different Words | 99 | 96 |
| No. of Pronouns | 11 | 11 |
| No. of Dependent Clauses | 6 | 6 |
| No. of Compound Sentences | 1 | 1 |
| No. of Terminals | 7 | 7 |
| No. of Colons | 0 | 0 |
| No. of Commas | 6 | 6 |
| No. of Semicolons | 1 | 1 |
| No. of Hyphens | 1 | 1 |
| No. of Dashes | 0 | 0 |

Figure 6 shows the readability indices for the two texts from Microsoft Word. Note that although Version 2 is incomprehensible, the Flesch-Kincaid Grade Level indicates that it is appropriate for a person with an eighth-grade reading skill.

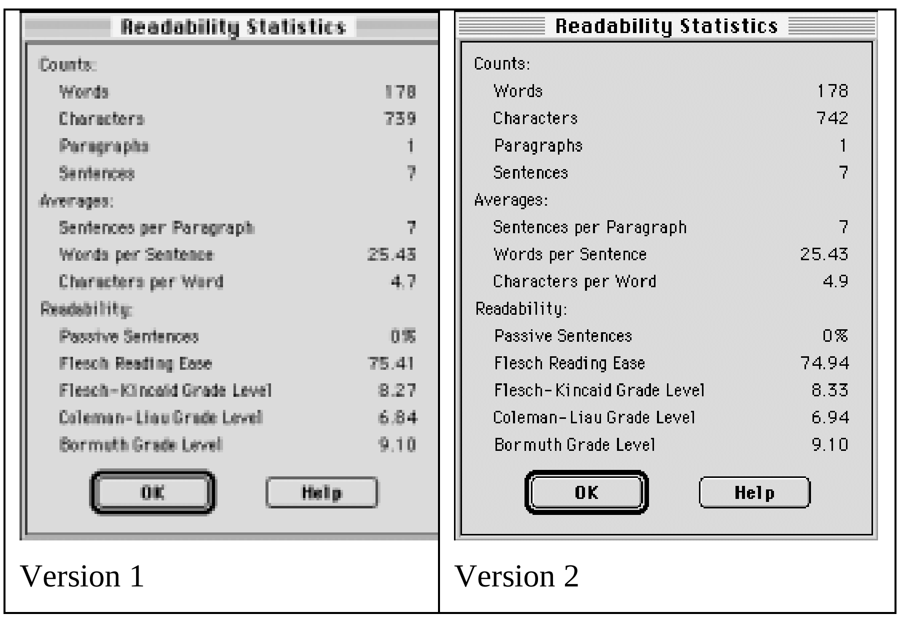


Figure 6. Readability indices from Microsoft Word.

To adequately measure sentence difficulty, one would have to discriminate between content and non-content words, abstract and concrete words [31], technical and non-technical words. But even if someday we innovate an adequate measuring stick for sentence-level difficulty, we will probably never devise an objective method for measuring the difficulty of an entire composition. Because readers are the meaning makers, the difficulty of understanding a composition—that is, text difficulty—is in the eye of the reader, not in the digits of a formula. Meaning is always construed through the prism of a personal psychology [32], and the concept of “readability” has social and cognitive elements that formulas cannot resolve [33, p. 171]. Therefore, any index of text difficulty would have to be qualified by individual or group characteristics.

The content of a text may be the most elusive and confounding of its elements, defying quantification altogether [34]. Readability predictions based upon formulas do not involve the content and vary widely from formula to formula [35]. The premise behind most of these formulas is the equation between sentence length and reading difficulty. However, short sentences may be a false characteristic of a readable text. According to Pinker, as “long as the words in a sentence can be immediately grouped into complete phrases, the sentence can be quite complex but still understandable” [36, p. 203]. For example, “The House That Jack Built,” a well-known nursery rhyme, concludes with a 71-word sentence with 13 relative clauses [37]. Although this nursery rhyme would rate a low readability score by most readability formulas, it nevertheless remains in the canon of pre-school treasures. Also, assigning a level of difficulty to a word based upon its frequency of use may be a faulty metric. For example, “many words that [are] infrequent, like bow-wow and popcorn, [are] not that hard to understand” [38].

McEneaney suggests that predicting text difficulty may require a neural network, which is “an approach to computing that attempts to make computers more brain-like in the way they operate and are constructed” [39, p. 81]. But whose brain will this network emulate? Whose judgment will the computer bring to bear upon a text? Objectively predicting text difficulty is likely forever insurmountable.

## Implications for Researchers and Practitioners

The inadequacy of readability formulas to measure text difficulty implicates both researchers and practitioners. For researchers, the problem extends deep into methodology. For example, researchers who conduct reading experiments sometimes need to create several texts that are equal in reading difficulty. No readability formula will give the researcher such an assurance. One alternative is to use the Cloze procedure. Ponderous indeed, this procedure involves deleting every fifth word of each text and distributing the texts to experimental subjects, who must then fill in the missing words. The goal of this procedure is to get the same average percentage of correct answers for each experimental text. However, a perfect match on the first drafts is highly unlikely. A single Cloze procedure is expensive and time-consuming, and successive procedures conducted after revisions of the texts simply add to the cost in time and money.

Perhaps the only reliable way to precisely match texts for a reading experiment is to use the same text in each treatment group, to find a text that can serve all treatment groups without denying the readers' expectations. It is a rare technique, but it is not without its supporters [40].

Professional communicators face yet another problem: matching the difficulty level of their texts to their intended audiences. Beyond using the executive vocabulary of the intended audience, writers and editors may best serve their audiences by systematically reducing barriers to fluid reading, rather than whittling texts to match a readability index. However, as professional writers and editors know all too well, detecting problems with a text is no simple matter. De Jong and Lentz conclude from the results of an experiment that "technical writers appear to overlook many problems that readers detect," and that technical writers seldom agree on what constitutes a problem for the reader [41, p. 516]. Given that the job of a technical communicator is plagued with uncertainties, some systematic method of discovering text difficulty certainly seems in order. However, readability formulas simply do not fit the bill.

## Conclusion

The inclusion of readability indices in word-processing programs may account for the use of readability formulas to assess text difficulty in corporate environments. Most audiences of technical documents *read to do.* Therefore, usability testing of a document seems much more appropriate for measuring how effectively a text conveys technical information than a formula. However, usability testing may be considered elaborate, time-consuming, and expensive. To save time and money, technical communicators may be tempted to click a mouse to invoke an index of readability. For the same economic reasons, reading researchers may be tempted to use a published readability formula to equalize texts for reading experiments.

The fact that readability indices can be generated by a few mouse clicks makes their use, and misuse, that much more seductive. However, evidence against using readability formulas indicates that such indices may be less useful than the "gut feelings" of trained writers and editors. Perhaps teachers and authors of textbooks in technical communication can include more information about readability formulas in their curricula and products.

## References

1. C. Tekfi, Readability Formulas: An Overview, *Journal of Documentation, 43*:3, pp. 261–273, 1987.

2. M. J. Abram, Readability: Its Use in Adult Education, *Lifelong Learning, 4*:5, pp. 8–9, 30–31, 1981.

3. R. Flesch, *Marks of Readable Writing: A Study in Adult Education Style,* Columbia University, Bureau of Publications, Teachers College, New York, 1943.

4. E. Dale and J. S. Chall, A Formula for Predicting Readability, *Educational Research Bulletin, 27*, pp. 11–20, 1948.

5. P. DiStefano and M. Noe, Measurement of the Effects of Purpose and Passage Difficulty on Reading Flexibility, *Journal of Educational Psychology, 73*:4, pp. 602–606, 1981.

6. C. M. Herren, *The Effect of Three Levels of Reading Speed on Recall and Recognition and the Relationship between Reading Rate and Trail Making Part B,* Doctoral Thesis, East Texas State University, December 1992.

7. A. Munro, K. A. Lutz, and L. Gordon, On the Psychological Reality of Text Types, Department of Psychology, Behavioral Technology Laboratories, University of Southern California, Technical Report No. 91, February 1979.

8. J. H. Spyridakis and C. S. Isakson, The Influence of Text Factors on Readers, in *Proceedings of the 45th Int. Technical Communication Conference,* Society for Technical Communication, Anaheim, California, pp. 259–261.

9. C. T. Letson, The Relative Influence of Material and Purpose on Reading Rates, *Journal of Educational Research, 52*:6, pp. 238–240, 1959.

10. W. Witt, Effects of Quantification in Scientific Writing," *Journal of Communication, 26,* pp. 67–69, 1976.

11. Sister M. Herculane, A Survey of the Flexibility of Reading Rates and Techniques According to Purpose, *Journal of Developmental Reading, 4,* pp. 207–210, 1961.

12. D. Ramsel and M. Grabe, Attention Allocation and Performance in Goal-Directed Reading: Age Difference in Reading Flexibility, *Journal of Reading Behavior, 15*:3, pp. 55–65, 1983.

13. D. P. Birkmire, Text Processing: The Influence of Text Structure, Background, Knowledge, and Purpose, *Reading Research Quarterly*, pp. 314–326, Spring 1985.

14. R. P. Carver, Is Reading Rate Constant or Flexible, *Reading Research Quarterly, 18*:2, pp. 190–215, 1983.

15. Richard P. Kern, Usefulness of Readability Formulas for Achieving Army Readability Objectives: Research and State-of-the-Art Applied to the Army's Problem, U.S. Army Research Institute for the Behavioral and Social Sciences, Alexandria, Virginia, January 1980.

16. M. C. Taylor and M. W. Wahlstrom, Readability as Applied to an ABE Assessment Instrument, at Web site for the *National Adult Literacy Database,* http://www.nald.ca/fulltext/report4/rep31-35/REP34-01.HTM, July 16th, 1998.

17. J. Redish and J. Selzer, The Place of Readability Formulas in Technical Communication. *Technical Communication, 32*:3, pp. 46–52, 1985.

18. Timothy D. Giles, The Readability Controversy: A Technical Writing Review, *Journal of Technical Writing and Communication, 20:*2, pp. 131–138, 1990.

19. J. Hanna, Writer Worksheets: Test STC's Readability, *Technical Communication*, *41:*3, pp. 555–561, 1994.

20. K. Schrock, Fry's Readability Graph: Directions for Use, at Web site *Kathy Schrock's Guide for Educators,* http://www.capecod.net/schrockguide, July 16th, 1998.

21. M. H. Markel, *Technical Writing: Situations and Strategies,* 2nd Edition, St. Martin's Press, New York, 1988.

22. D. Pattow and W. Wresch, *Communicating Technical Information: A Guide for the Electronic Age*, Prentice Hall, Englewood Cliffs, New Jersey, 1993.

23. Word Version 6.0.1 for Power Macintosh, Microsoft Corporation, Redmond, WA.

24. R. Kelly, The Rosary, in *Sudden Fiction: American Short-Short Stories,* R. Shapard and J. Thomas (eds.), Peregrine Smith, Salt Lake City, UT, p. 176, 1986.

25. D. Q. Haney, Doctors Still Leery of Using Drug to Treat Strokes: Clot Busting Medication Can Be Lethal When Bleeding Is in the Brain, *The Knoxville News-Sentinel,* p. A-7, February 8, 1998

26. B. London and J. Upton, *Photography,* 5th Edition, Harper Collins, New York, 1994.

27. *The Chicago Manual of Style,* 14th Ed., University of Chicago Press, Chicago, 1993.

28. E. Dale and J. O’Rourke, *The Living Word Vocabulary: The Words We Know: A National Vocabulary Inventory Study,* Dome Press, Elgin, Illinois, 1979.

29. E. Dale and J. O’Rourke, *Supplement to Existing 1976 Edition of the Living Word Vocabulary,* Dome Press, Elgin, Illinois, 1979.

30. Guido H. Stempel III, Statistical Designs for Content Analysis, in *Research Methods in Mass Communication*, 2nd Edition, G. H. Stempel III and B. Westley (eds.), Prentice Hall, Englewood Cliffs, New Jersey, pp. 137–149, 1989.

31. M. K. Vachon and R. E. Haney, A Procedure for Determining the Level of Abstraction of Science Reading Material, *Journal of Research in Science Teaching, 28*:4, pp. 342–352, 1991.

32. F. Smith, *Understanding Reading: A Psycholinguistic Analysis of Reading and Learning to Read,* 2nd Edition, Holt, Rinehart and Winston, New York, 1978.

33. P. Moore, Rhetorical vs. Instrumental Approaches to Teaching Technical Communication, *Technical Communication, 44*:2, pp. 163–173, 1997.

34. G. R. Klare, A Second Look at the Validity of Readability Formulas, *Journal of Reading Behavior, 8:*2, pp. 129–152, 1976.

35. R. F. Smith, How Consistently Do Readability Tests Measure the Difficulty of Newswriting? *Newspaper Research Journal, 5:*4, pp. 1–8, 1984.

36. S. Pinker*, The Language Instinct: How the Mind Creates Language*, William Morrow and Company, New York, 1994.

37. The House That Jack Built, in *Better Homes and Gardens Story Book,* Betty O'Connor (ed.), Meredith Publishing Co., Des Moines, Iowa, pp. 37–44, 1950.

38. D. Bush, The Tantalizing Technology of English, in *Proceedings of the 45th Int. Technical Communication Conference,* Society for Technical Communication, Anaheim, California, pp. 493–496, 1998.

39. J. E. McEneaney, Neural Networks for Readability Analysis, *Journal of Educational Psychology, 36,* pp. 217–228, 1945.

40. E. T. Goetz, R. E. Reynolds, D. L. Schallert, and D. I. Radin, Reading in Perspective: What Real Cops and Pretend Burglars Look for in a Story, Center for the Study of Reading, University of Illinois, Urbana-Champaign, IL, Technical Report No. 266, October 1982.

41. M. D. T. De Jong and L. R. Lentz, Expert Judgments versus Reader Feedback: A Comparison of Text Evaluation Techniques, *Journal of Technical Writing and Communication, 26:*4, pp. 507–519, 1996.