"He is greater than me but I stand on his shoulders."

- G.B. Shaw about Shakespeare

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A peep into the past gives a vision for the future. The review of the past researches gives insight into the present problems. Many angularities and rough surfaces of the present problems can be straightened and made smooth with the help of the past researches. The review helps the investigator in preparing his own research design of the problem on hand. At the same time it also acquaints the investigator with the limitations of the tools and procedure used by the past researchers as well as the problems faced by them in carrying out the researches. As a result of this the investigator gets enough confidence to shoulder the burden of his research problem. With these objectives in sight, the investigator thought it worthwhile to review the past researches on readability. For the sake of convenience, the review is divided into two broad groups, namely the researches done in foreign countries and those done in India. They are described in the following paragraphs:

3.1 Researches in Foreign Countries:

The researches on readability in the foreign countries are legion. This suggests that they are particularly conscious of the levels of difficulty of reading materials
and the reading ability of the reader. In India such type of researches has not yet started, though a solitary example can be cited. The researches that would be mentioned in the pages to come would throw some light on the direction in which the research on readability is going on. They would also point out the relevance of the problem which the present investigator has sought to work with.

3.2 Researches on Readability of Reading Materials With Reference to Their Placement at Various Grade-levels:

Study I:

Ruth1 carried out a research on "Evaluation of the reading ease of materials from the 1959 Career Information Kit Supplement of the SRA Occupation File. For determining the reading ease score he used the Flesch Readability Formula.

The occupational reading materials were designed for use at the high school level. The readability levels of reading materials were determined by selecting five or more samples from each of 85 SRA Occupational Briefs and 35 other items were included in the 1959 Career Information Kit. Reading Ease Scores were determined by applying 1948 Flesch Readability Formula.

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The study revealed that the reading ease grade levels were found to fluctuate from grade 9 to 16+, with a mean of 14.7. This level was judged by the author to be too high for the majority of the high school students.

It was also incidentally found out that though the materials used a simple vocabulary, its readability was increased by the use of longer sentences.

Particularly in this case it is quite interesting to note that the simple vocabulary if used in long and complex structures would raise the readability of the material.

**Study II:**

**Study of the readability of Physics and Chemistry Textbooks:**

Milton D. Jacobsen\(^2\) was the man to take up this study. He assessed the relative reading difficulty of the textbooks by using Underling test and analyses of variance with samples from texts not used in the public high schools. The Underling test was administered to students of randomly selected schools. The size of the sample has not been reported in the paper.

The study revealed that there was a wide range of reading difficulty in Physics as well as Chemistry textbooks.

Study III:

A research in which two readability formulas were used has been reported jointly by Smith and Heddens on "the readability of experimental mathematics materials".

They applied the Spache Readability formula and the Dale-Chall formula to selected groups of primary and intermediate experimental mathematics materials to examine the merits of the 'discovery method' in relation to readability. The former formula has been used for primary materials while the latter for intermediate materials.

The general findings of the study suggest that the readability levels of the reading materials are too high for the pupils for whom they are intended. All the portions of the material are not at appropriate levels. The readability levels do not appear to increase in a manner consistent with the assigned grade levels.

The same authors in the next issue of 'Arithmetic Teacher' reported similar research on readability having the title "The readability of elementary Mathematics Books".


4. Ibid, pp. 467-68.
They examined the readability level of five textbooks for grades 1 to 6. They have applied the Spache readability formula for primary grades while for the intermediate grades they used the Dale-Chall formula.

Smith and Reddens concluded that the readability level of the textbook was generally above the assigned grade level. There was also considerable variation in readability among the texts concerned. There was also variation in readability within each text.

Study IV:

"The Readability of Basal Social Studies Materials" was carried out by Val Arnsdorf. 3

For the purpose of assessing the readability levels of 25 books for use in the primary and intermediate grades, he used the Spache formula for the former and the Dale-Chall formula for the latter grades.

One hundred samples were taken randomly for analysis from one-third of each text.

The general finding was that all but three of the 25 books had readability levels in line with the publisher's recommended sequence when the estimate was based upon the entire text; but the 12 of the texts were found to progress

in difficulty from the first third through the last third of the text material.

Study V:

"Assessment of accuracy of grade level placements by publishers for 200 basic readers for grades 1 to 3 and other books for grades 4 to 8." 6

Mills and Richardson reported this study in Reading Teacher (1963). They used the Spache readability formula for the former and the Dale-Chall formula for the latter books to determine their readability indices.

The primary materials were graded by remedial clinicians according to Spache formula while the Dale-Chall formula was used for books at upper grade levels. Using these formulas as criteria, it was found that only about one-half of the primary materials were appropriately labelled, while the results of intermediate grades were comparable to those found in the study of elementary texts.

A further evaluation of 20 of the books that varied from the publisher's recommended grade-placements, indicated that 80 per cent were above the grade level recommended and 20 per cent below it.

6. Mills, Robert, (et. al.): "What do Publishers Mean by 'Grade Level'?"; The Reading Teacher; Vol. 16, No. 6, (March, 63); pp. 359-362.
A pure academic interest was shown in the problem of readability of science textbooks. Lockwood reported the innumerable studies of Mallison and his co-workers. Their purpose was to determine the levels of reading difficulty of textbooks for the areas of elementary science, junior high school science, general science, high school biology, and high school physics.

They used the modified Flesch formula to determine the levels of reading difficulty. They selected one sample passage for each 100 pages for analysis. In all they had taken not less than five passages from any one textbook. These samples then were analyzed by using the Flesch formula.

In general, the following findings are reported:

i. The readability levels of many textbooks are too high for the students.

ii. The differences between the readability levels of the easiest and most difficult textbooks are significant.

iii. The average levels of readability of some textbooks are satisfactory although there are difficult passages for some students in the grade levels.

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iv. There are varied levels of readability of the textbooks designed for the same field of science.

v. Earlier passages and the later passages of the textbooks seem to be equal in difficulty.

vi. Non-technical vocabularies are used in many textbooks of science, although they could be written with easier synonyms.

vii. Recently published textbooks in science are as variable in their readability as earlier books which have been analyzed.

viii. The only valid criterion for selecting a science book should be the level of reading difficulty of the book.

3.3 Research on Readability of Textbooks With Reference to Reading Ability of the Grade Pupils:

The textbooks are meant to be read by the pupils. It is a big question whether the students are able to read the textbooks which are prepared especially for them and profit by their use. A few investigations in this area are reported here to shed light on the questions: How is the textbook used by the pupils with reference to their reading ability? Do the authors of various textbooks consider the reading ability of the readers for whom they are writing?
Study I:

Comparison of the readability of five industrial arts textbooks with the reading ability of all ninth grade general shop students.8

Wilber S. Miller studied this problem with the objective of determining the readability of industrial arts textbooks with reference to the reading ability of the students.

For this he first assessed the readability of the five textbooks by using both the formulas of Dale-Chall and Flesch. The readability thus determined with the help of the formulas were compared with the reading abilities of all ninth grade students on silent reading comprehension section of the Iowa Tests of Basic Skills.

The findings showed that these texts ranged from grade levels 9.25 to 10.0 with a median grade level of 9.5, on the composite readability rating. The individual text varied widely in readability, from 7 grade levels in one text to 11 grade levels in another text according to different samples within each text. Since 70 per cent of students were reading below the ninth grade level, the major parts of each text were above the students' level of reading ability.

This led to state that there is no consistency in writing the textbooks. Some portion is easy while a bulk is much beyond the reading ability of the pupils.

Study II:

Similar research is reported by Lerroy Ottley. His problem of research was "the readability of science textbooks for grades 4, 5 and 6." He determined the readability of the science textbooks by the revised (1961) Lorge readability formula. It was found that the texts at all those grade levels differed little in difficulty. That means they have more or less the same readability level although they are meant for different grades of 4, 5 and 6. Thus, the fourth grade texts were far too difficult for fourth graders while the sixth grade texts were well suited for sixth graders.

There is one more study about the readability of the mathematics textbooks which is also reviewed in the paragraph that follows:

Study III:

"Readability of the mathematics textbooks".

References:


Wiegand reported a study in which he compared the readability levels of high school mathematics texts used in Pittsburgh with the observed reading performance levels of high school students. He used the Dale-Chall readability formula to determine the levels of readability of 9 textbooks of mathematics. To assess the reading ability of students he used standardized reading tests.

The general finding was that the readability levels of the books were higher than the level of the reading ability of most students.

Likewise Belden has studied the relationship of the readability of Biology textbooks in relation to the reading ability of tenth grade students.

**Study IV**

"Relationship of readability of 5 high school Biology textbooks with the reading ability of tenth grade students".11

Belden used the Dale-Chall readability formula for the purpose of assessing the readability levels of the textbooks. He administered the Nelson-Denny Reading Test to know the reading scores of 357 tenth grade biology students.

He accepted the criterion that the reading achievement levels of students using a textbook should be one grade above the difficulty level of the book. The author found that the five books he studied met this criterion for the following percentage of students per book:

37.0, 39.5, 42.3, 49.6 and 58.5

He concluded that only one of the five books was appropriate in terms of its difficulty in relation to student reading achievement for over one-half of the students, that is 58.5 percent.

3.4 Research Involving Different Levels of Readability:

The following researches were carried out to know whether reading material having low readability level had any impact on the comprehension scores of the readers:

Study I:

Keenan and Bell investigated whether the improved and simplified way of writing would be effective in conveying the message.

They prepared two versions of the fire rules for state hospital. One style retained the old format while

the other version had a simplified style with an improvement over old one in terms of usage and sentence length.

Both the versions were assessed for their readability by means of Flesch formula and it was found that the simplified version was of a low readability level. The administrators of the hospital compared the two versions of writing point-by-point and they found that both of them contained the same information.

Effectiveness of communication was measured by knowing (a) number of times each version was read and (b) comprehension scores.

The nursing staff of the hospital was the sample. They read either the traditional or the simplified version of the rules. The numbers for traditional and the simplified versions were 199 and 190 respectively. A follow-up questionnaire confirmed that the groups read the rules with no significant difference, that is, traditional 35.7 ‰ while simplified 42.8 ‰.

Keenan and Bell concluded that the people who read simplified version scored higher than the readers of the traditional version.

Study II:

A classical study on readability levels is reported by
MoTaggart Aubrey in which the investigator attempted to evaluate both the Flesch and the Dale-Chall readability formulas as objective aids in selecting health textbooks for high school and further to determine the effect of health knowledge on student's comprehension of selected health passages.

In designing the experiment he included 257 students of nine classes of ninth-grade. They were given health knowledge test, Intelligence Test and the Reading Test. The students were divided into two groups with Good Health Knowledge and Poor Health Knowledge. Each of these groups then was randomly divided into three main sub-groups. Students from these sub-groups were matched on the basis of intelligence and reading ability. Control Group B read the nine original passages from the health texts; while the experimental group C read the same passages but they were rewritten to a lower level of readability of seventh grade. Another experimental group A read the same nine passages rewritten to a higher level of readability of twelfth grade. The comprehension of each group was assessed by the students' ability to answer questions after reading the nine passages, schematically the experimental design was as follows:

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<table>
<thead>
<tr>
<th>Groups</th>
<th>Reading Ability levels</th>
<th>Health Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>12th grade (Experimental)</td>
<td>Good</td>
</tr>
<tr>
<td>B</td>
<td>9th grade (Control)</td>
<td>Poor</td>
</tr>
<tr>
<td>C</td>
<td>7th grade (Experimental)</td>
<td></td>
</tr>
</tbody>
</table>

The mean comprehension scores were compared for each group.

**Findings:**

i. Students with good health knowledge score significantly higher than those with poor health knowledge.

ii. In the good health section, significant differences were observed between groups reading at 7th and 12th grade levels and also between those reading at the 7th and 9th grade levels. In case of the groups having poor health knowledge, no significant differences were observed.

iii. When comparing saw means which include good and poor health knowledge sections, a significant difference was observed between groups reading at 7th and 12th grade levels and also between those reading at the 7th and 9th grade levels.
Study III:

David L. Williams reported an investigation on "Rewritten science material and reading comprehension". \(^{14}\)

The purpose of the study was to compare the effect on pupils' comprehension when sixth grade pupils read science materials which were found to be of higher and lower readability levels.

One chapter from a sixth-grade science textbook was assessed for its readability level by using the Yoakam readability formula. The same chapter was rewritten to a third-grade level of readability. In the rewritten material, simpler words were used in place of difficult and non-technical words. The technical words were explained and elucidated. The long and complex sentences were rephrased and shortened to make the thoughts more clear and distinct.

The readability level of the original science material was found to be of 7.5 grade; while the rewritten material was of a third-grade level of readability.

A total of 417 pupils as sample from fifteen sixth-grade classrooms of Illinois community took part in the study. Pupils were randomly selected to form the control and experimental groups. Within the groups the students were

stratified according to their reading achievement determined by the Stanford Achievement Test. Three achievement levels were used: (i) pupils reading above grade level, 7.2+, (ii) those reading at grade level, 5.1 - 7.1 and (iii) those reading below level, 5.0.

The control group read original version while the experimental group read the rewritten material. Both the groups were given a reading comprehension test after they had read the versions of the reading materials.

Findings:

i. The pupils reading at "low ability" (below level) scored significantly higher when they read sixth-grade rewritten material of low readability.

ii. The pupils reading at "average and above average ability" read with greater speed and better comprehension when they read rewritten material of low readability.

iii. All sixth-grade pupils increased their reading rate and comprehension scores when they read rewritten material of low readability.

The findings of this investigation has numerous implications which are as follows:

i. The current science textbooks are difficult to comprehend for pupils for whom they are prepared.
ii. Selection committee for the textbook should evaluate the book in terms of its readability level before the book is selected.

iii. All readers read with greater speed and better comprehension when materials are easy.

iv. The authors should take into account the factor of reading ability of the pupils for whom the book is being written. They should write one or two grade below the level of reading ability of the pupils.

From the researches described in the foregoing pages it could be seen that the investigators have used different readability formulas for measuring readability of the reading materials.

At this juncture it would be wise to look into the details of the formulas used by various investigators and to study the various factors involved in them.

3.5 Factors Included in Various Readability Formulas:

The detailed review of the readability formulas revealed that they include to a large degree one or more of the following elements:

i. measure of vocabulary,

ii. sentence length,

iii. number of syllables per 100 words,
iv. number of prepositional phrases, and
v. number of pronouns.

These elements involved in the formula depend to a large extent on the kind of readability formula used by the various investigators. Ruddell's investigation showed that:

"The multiple correlations coefficients derived by correlation of specific elements with independent comprehension measures have produced coefficients ranging from .51 to .72. It is evident from these findings that the above specific factors account for only 26 to 51 percent of variance in the comprehension scores. The major proportion of the variance was left unaccounted for by the factors involved in the investigation.15

The former pioneering investigators on readability such as Dale and Chall, Flesch, Large, Robinson and Steinberg, and Jenkins have all emphasized the factor of organization of language structure in the readability control of written materials. Strickland's16 report recommends that the effect of similarity on the nature, variety and control of sentence structure in written language patterns and children's oral language patterns should be emphasized in readability research. Accordingly Ruddell17 carried out an ingenious


design of the experiment in which he used some passages of reading materials. Out of these passages, some were rewritten to a low grade readability level by using high frequency of language structures used by children. The investigator concluded that reading comprehension is largely dependent on the similarity of language structure in the reading material and the oral expressions of the children. Such a similarity in higher frequency produces greater reading scores.

Besides these, attempts are also made to study the relationship between the readability determined by readability formulas and teacher's estimate of the difficulty of the reading materials.

3.6 Teacher's Estimate of Reading Difficulty and the Measures of Readability Formulas:

Study 1:

There is one aspect of readability on which Harrington conducted a study to determine whether the readability formulas make assessment of the reading difficulty more consistent than estimates made by reading experts. Of the reading difficulty of the same passages.

For the purpose of research, 199 samples from 39 science books were taken. Out of 199, 21 samples were selected randomly and sent to 66 teachers who were considered 'reading experts'. Together with the samples, instructions as to how estimates of reading difficulty should be made were also supplied. The same passages were then analyzed by the readability formulas.

The investigator reported that there was no consistency between the two methods of estimating the readability levels of the samples. The estimates made by readability formulas were much more consistent than the estimates of the teachers.

Study II:

In the Mallinson's study, the above study was repeated but two elementary teachers worked together with the experts who were employed to assess the readability levels of the passages.

The result indicated that the median difference is 1.0 year for measurement by reading formula, it is 3.0 years for reading expert's estimates, it is 4.0 years for elementary teacher's estimates.

It was concluded that for estimating the reading difficulty of science textbooks, the use of readability formulas is justified at least for elementary science textbooks.

19. Ibid., p. 301.
The researches cited above lead to state that with the application of readability formulas it becomes easy to determine the readability levels of different reading materials. The experimental designs and readability formulas used by different investigators were different. As a result of this they touched different dimensions of the problem and thereby have increased the scope of the research in this area.

The following research, which does not investigate the readability of the books, is nevertheless cited. It does not, even cursorily, mention the classics of readability formulas. In spite of this, the present investigator cannot resist the temptation of mentioning it in this chapter. There are two reasons justifying its inclusion:

1. The investigation throws light on the vocabulary of science textbooks.

2. It also shows the methods of developing science vocabulary.

3.7 Study About the Science Vocabulary:

The study pertaining to the science vocabulary was taken up by Curtis and is reported by Lockwood.20

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The study seeks to answer the following five questions:

i. Are the vocabularies used in science textbooks too difficult for the pupils?

ii. Can the level of vocabulary of science textbooks, hindering the understanding, be determined by some method? From what level should the simplification of vocabulary begin?

iii. Does the use of non-scientific and non-essential vocabulary contribute to reading difficulty of science textbooks?

iv. Do present textbooks of science include adequate definitions and repetition for the understanding of essential vocabulary?

v. What are the important terms which should be mastered?

In order to answer the above questions, under the directions of Curtis, the data for the study were obtained from one hundred master's theses. The lists of words were obtained by examining the glossaries of various textbooks. This list was compared with the lists made by others such as Thorndike's. The words were then submitted to qualified teachers in order to estimate their worth for inclusion in the syllabus. From the data thus obtained, lists of essential and desirable words were prepared.

From the analysis of the above data, Curtis found that:
i. Both the technical and non-technical vocabularies of science textbooks are so difficult that the pupils cannot comprehend them.

ii. There is no adequate provision for repetition of difficult scientific terms and non-technical words.

iii. The difficulty created by non-scientific and non-technical words is too great.

iv. The scientific terms occurring in the books are hardly defined.

v. The definitions of scientific terms may appear in the textbooks after the terms have been used before in the course.

This study, though not pertaining exactly to the readability of the textual material, has really helped the present investigator to arrive at the method of locating the difficult terminology used in science textbook called 'impatilexas'.

3.8 A Research carried out in India:

By and large it could be said that the various readability formulas described in the preceding chapter and their use in the researches mentioned earlier in this chapter have all been developed for English language. Except one, no researcher made an attempt to use these formulas in our country for any Indian language. Impressed by the great
achievements and the benefits of the readability technique, B.S. Bhagolival tried to evolve similar techniques for studying the readability of Hindi materials. He undertook a study to see whether:

1. readability formulas developed for English language could be applied to Hindi language;

ii. they could predict the difficulty of the materials written in Hindi language;

iii. they could reveal the comparative significance of the various components of readability in Hindi language, and

iv. the formulas used for Hindi language could be considered as statistically valid, reliable and objective.

With the above objectives in mind, he examined 29 formulas. Many of these formulas depend for their vocabulary load on word lists. Such word-lists are not available in Hindi. So their application to Hindi materials was out of question. Some others depend on reading tests in English. These too were rejected. At last, four readability formulas were chosen for the study of the readability of Hindi materials. These were Johnson's formula (1930), Flesch's Reading Ease formula (1948), Farr-Jenkins and Paterson's formula (1951) and Gunning's formula (1952).

He selected 31 stories from four Hindi Magazines of wide circulation so as to represent a wide variety of the material with regard to interest, difficulty and language used. He analyzed 31 stories keeping in view the different elements of different readability formulas which were selected for the purpose. These formulas required the counting of number of one syllable-, two syllable-, three syllable-, and four syllable-words, the number of sentences, and the number of words in the passages. Hindi being a phonetic language, it is very difficult to syllabise the word objectively. So before applying these formulas to the passage, he studied reliability coefficients of correlations by way of intra and inter analysis. For this purpose, he selected 8 passages and analyzed them keeping in view the different components of readability. At the same time he also asked two other persons to analyze the components of readability. From the data he could find out that the different components could be counted objectively because the intra-analyst reliability coefficients range from .93 to 1.00 for the different components. This suggests that these elements can be objectively applied in Hindi.

For most of the components of readability formulas, the inter-analyst reliability coefficients were found to be between .84 and .99 while the count of syllables in words did not give high reliability coefficients which ranged from -.36 to + .55. This was expected because of subjectivity
The different formulas use different scores for expressing their levels of readability. For the purpose of comparing them, the scores were transformed into standard scores. From the validation results of different formulas, the Gunning's formula was rejected because it yielded low coefficient of correlation with the other three formulas. The result also showed that Flesch's formula correlated highly with Farr-Jenkins and Paterson's formula, the coefficient of correlation being .85. The coefficient of correlation by using these formulas for the English language was also .93, which is very close to Bhagoliwal's study. Johnson's formula also correlated highly with Farr-Jenkins and Paterson's formula, the coefficient of correlation being .88. From the results, Bhagoliwal observed,

"the estimate of the difficulty level in Hindi can best be based on any combination of the formula of Flesch, Johnson and Farr-Jenkins and Paterson. But if we are to use only one formula we should better rely on Farr-Jenkins and Paterson's formula whose coefficients of correlations with the rest of the two are +.88 and +.86." 22

Moreover, he also subjected his data to factor analysis for studying the component that affects the readability as

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22. Ibid. p. 20.
well as common factors in formulas under study. The results of the factor analysis revealed that the factor of word length gets highest positive loading of .96, the factor of sentence length gets high positive loading of .78; while the factor of word-complexity (four-syllable words) gets positive loading of .85. From the results of the statistical analysis of variance, Bhagoliwal rightly asserts that:

"the two factors, word length and sentence length account for more than 74 per cent of the total variance. Any readability formula taking into consideration these two factors can very well predict the difficulty level of the subject material in Hindi." 23

In brief, he came to the following conclusions:

i. The passages varied widely with regard to readability components or elements.

ii. The method of counting these components are highly objective because of high intra-analyst correlation coefficients.

iii. As regards inter-analyst reliability, high coefficients of correlations are found for the number of words, number of sentences, number of one-syllable words and total number of syllables. But for two syllable-, three syllable-, and four syllable-words, the coefficients of correlations are not high.

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23. Ibid., p. 21.
Bhagoliwal observed that "these readability formulae could be more objectively used in Hindi which do not include the counts of poly-syllable words." 24

iv. On the basis of validation results it can be said that "except Gunning's formula, all other formulas were highly inter-correlated and that Farr-Jenkins-and-Paterson's formula was found to be the best for prediction of the readability of the Hindi material, if the readability index is to be based on a single formula." 25

v. As regards the components or elements of readability, for factor analysis, he suggested the incorporation of the factors of word length and sentence length as the two best variables which could be relied upon for the composition of readability formula for Hindi.

Shri B.S. Bhagoliwal did a Yeoman's service to the cause of readability research in India by studying the reliability, validity and applicability of various formulas developed for English to Hindi. His research will have very significant bearings on the issues involved in the present investigation. In fact, Bhagoliwal's study has paved the way for the readability research, the present investigator has undertaken in the sense that the study has given the

24. Ibid., p. 22.
25. Ibid., p. 22.
much needed insight for the selection of components of readability and the appropriate readability formula for his project. It has also suggested the necessary modification to be made in the readability formula which the present investigator has selected. It has also provided a springboard - a desideratum in the form of Farr-Jenkins-and-Paterson's formula with which the reliability of the selected formula could be tested.