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Adaptation of the readability formulas into the Turkish science textbooks

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Abstract

Whether a textbook is written according to the student's level or not, it should be measured with the help of the readability formulas. Instead of this kind of assessment, general assessment that is not based on scientific parameters is used for textbooks evaluation in many countries. In this study, the readability concept and its relation with the FLES, FOG, SMOG and FRY formulas, which have international validity, were introduced. These formulas were applied to six science textbooks taught at the primary schools of 6, 7 and 8 grades in Turkey and the results were discussed. It was found out that the formulas could not provide valid results for the Turkish science textbooks. Furthermore, the CLOZE test was applied to 120 primary school students in order to define whether readability levels of the Turkish science textbooks are appropriate for the investigated students' level or not. By this way, the Turkish science textbooks were criticized. According to the results obtained from the CLOZE test, some original readability formulas have been adapted into the Turkish language.

Keywords: Readability Formulas; Turkish Science Textbooks; CLOZE test

1. Introduction

A textbook is a kind of material that consists of subject matters that should be taught in a defined period of time during course programs. Textbooks are supposed to offer students opportunities to learn scientific knowledge and are being used as an indispensable source that effects seriously what students learn and what teachers teach [1]. Starting from this point, textbooks are accepted as an interactive tool to facilitate effective learning.

Science textbooks are also assumed as an important source for by most of the teachers. Science teachers usually take aims-objectives, learning strategies from the textbooks and while preparing questions for classroom examination, they mostly benefit from textbooks. If the used textbooks are covered weak content, complex terms and are not written in an explicit language, teachers as well as students have troubles in using them [2].

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If textbooks are to be accomplished their functions properly in teaching and learning process, they should have some characteristics. In our country, the task of writing textbook had traditionally only belonged to the National Ministry of Education (MEB) until 1991. The private sectors have been allowed to write textbooks then. However, the written textbooks must be appropriate for the criteria determined by the Practice and Manner Council. Following this decision, many textbooks were written for one science course. As a result, quantity and quality of textbooks were naturally increased.

Along with the Practice and Manner Council Scale, new scale development studies including branch differences have been encountered at the literature [3, 4]. Unfortunately, the majority of these scales are not specified in measuring all the characteristics that should be in textbooks. However, textbook evaluation scales in the areas of physics and chemistry were developed which are more private [5, 6]. Characteristics that should be situated in a quality textbook are arranged under some sub-titles in these textbook evaluation scales. However, the textbook readability concept has not been considered in detail. Students' reading and understanding subject matter clearly from the textbooks are concerned with their readability levels and ages. Students' fast reading and understanding level of the textbook may be described as that book's readability level [3]. Sentence length in a text, syllable numbers in words, connection among idea numbers expressed in each sentence, guided sentence used in paragraphs and continuity in ideas are directly related to a text's readability [2].

To determine readability levels of the written materials, readability formulas are being used widely in the related literature. From these formulas, such as FLESH, FOG, SMOG, FRY have a national validity and used frequently to determine the readability levels of the textbooks [7-9]. In addition, CLOZE readability test is being used for the same purpose [10, 11]. All teachers can easily use these tests and formulas. The concept of readability level is related to the level of student's fluently reading book and how much understand what has been read rather than difficulty and easiness level of subject in the text [12]. However, complexity and difficulty of a text is concerned with the sentence length. Much longer the sentences in the text are more complex the text is. Likewise, syllable numbers in each word also belong to the words' difficulty. While basic words usually have one syllable, difficult words have so many syllables. Sentence length and syllable numbers are the main factors on the ground of the readability formulas.

In our county it is believed that in the process of writing textbooks evaluation scales, the readability formulas and tests have not been taken into consideration. However, adapting present readability formulas into the Turkish textbooks, because of the difference of syllabus and sentence structure from English, the results are thought to be different from English. In this study, to evaluate Turkish textbooks properly, the present readability formulas will be re-structured for the Turkish language.

1. 2. CLOZE test

. In measuring readability of written materials with student participation, phases of the The CLOZE test such as structure, administration, measurement and interpretation are explained below [10, 11].

1.2.1. Construction

. A text not read by students before and contains about 275 words is chosen.
. First sentence is not taken into consideration. Starting from the second sentence as being

appropriate for the studied levels, such as for high school level, one of every five words is thrown coincidentally. For middle school level, one word from 7-9 words is thrown. For primary school level, one word of 15 words may be thrown coincidentally. Then these thrown words recorded at a different place.

. Every wiped word's place is defined with bold.

1.2.2. Administration (practice)

. It is explained to the students that this study and chosen text is only aimed for a research.
. Cloze test procedure is explained by few sentences.
. Sufficient time is given to all students for filling in the blanks.

1.2.3. Measurement

. The chosen text will be accepted as true. Synonymous words will not be accepted as true.
. An answer key will be prepared in respect to the words in original example and evaluation will be done according to that.
. Whether the readability level of book is convenient for classroom level is determined by considering students' individual achievements and general achievement of class.

1.2.4. Interpretation

. The text from which students take the mark between 40 and 60 may be accepted that the students can read it for the aim of competition. But, students may be encountered some problems. To solve these problems, a reading guide is required.
. If students take over 60 points from the text, it may be accepted that the examined book is extremely convenient for student level. In this case, no reading guide is required.
. If students take under 40 points from the text, it may be accepted that the examined book is probably difficult for students. In order to get benefit from this textbook, the students will need many reading guides or the textbook should be rewritten or changed with another appropriate one.

Carefully examination of the procedures of readability formulas and The CLOZE test, it is seen that syllable construction and sentence lengths of present readability formulas are directly related with each other. Different languages have different syllable numbers and sentence lengths situated in a sentence. Such as at the FRY graphic prepared for English, it is seen that although average syllable number in 100 hundred words of paragraph is 180 mostly [13], on the other hand, in the Turkish textbooks this degree changes between 280 and 300. Consequently readability formulas prepared for the English language cannot work for the Turkish ones. Therefore, if these formulas are to be applied for the other languages, they should be reorganized for the other languages.

CLOZE test is a process of completely independent from grammar and syllable construction and consist of construction, administration, measurement and interpretation phases. The most important average of the CLOZE test is to be required students' involvement. In addition, that this test is not depended on the factors such as average syllable and sentence length increase the validity of this method. In order to find out readability level of a book, The CLOZE test results should be used as an important reference.

Table 1. Some Readability Formulas and Application Stages

1-The Flesch Formula

Select at least three samples of 100 words.

- Count the average length of syllables in each 100-word sample (Y).

Calculate the average length of the sentences in the samples (X).

Calculate the Reading ease Score (RES) using the Flesch formula:

Reading Ease Score = 206,835-[(X . 1,015) + (Y. 0,846)]

where X =average sentence lenght in words Y = average number of syllables per 100 words.

Examples: RES 90 + :very easy, e.g. comics

60-70 : standard, e.g. mass non-finction.

30-50 : academics prose

Change the Reading Ease Score to a US grade level using this table:

Reading Ease Score (RES)	*Flesch grade level (FLG)*
Over 70	-((RES-150)/10)
Over 60	- ((RES-110)/5)
Over 50	-((RES-93)3.33)
Under 50	-((RES-140)/6.66)

Add 5 to the Flesch grade level to give the reading age of the text.

2. The FOG (Frequency of Gobbledegook) Test

Select sample passages of exactly 100 words.

Calculate the average sentence length (S), i.e. the average number of words per sentence.

Calculate the percentage of polysyllabic words (words of the syllables or more) in each sample and find the average (N).

Calculate the US grade level using the formula:

US grade level = 0.4 (S+N)

Find the reading age by adding 5 to the US grade level.

3. The FRY readability graph

Select random samples of exactly 100 words (at least three samples and preferably more).

Count the number of sentences in each sample. For a part sentence count the number of words and expire as a franction of the length of the last sentence, to the nearest onetenth.

Counth the number of syllables in each 100-word sample. (For numerals and abbreviations count one syllable for each symbol, e.g. ASE is there).

Mark a dot on the graph where the average number of sentences and the average number of syllables in the samples intersects. The dot's position gives the US grade level.

Add 5 to the US grade level to give the reading age.

4. The SMOG formula

Select three sample passages, each consisting of ten sentences-one from beginning, one from the middle and one from the end of the text.

Count the total number of words of three syllables or more in the thirty sentences selected.

Find the square root of total.

Add 8 to give the reading age in years.

Source: Ref. [13]

1.3. Purpose

The aim of this study is two fold: to apply the present readability formulas into the Turkish science textbooks; to adapt these formulas into the Turkish context.

2. Material and method

In order to fulfill the above purposes, procedures below were followed in sequence.

- Readability formulas given in Table 1 were scrutinized.
- Readability level and readability age of 9 science textbooks' used in 6, 7 and 8 grades of primary schools counted and recorded separately from each other with the help of readability formulas.
- The CLOZE test was applied to the sample group of 180 students selected by chance from six different classrooms of two primary schools.
- As taking the reference of The CLOZE test results, some of the readability formulas not valid for the Turkish textbooks was tried to adapt into the Turkish context. With the help of this process, new readability formulas were reestablished from the current formulas valid for the Turkish context.

3. Findings

All kinds of readability formulas explained at Table 1 have been applied to the selected science textbooks. The obtained data was presented at Table 2.

Table 2. Application results of some readability formulas obtained from the Turkish science textbooks

Readability Formulas ⇨ / Textbooks ⇩	FLESH (RES value)	FOG (Readability age)	FRY	SMOG (Readability age)	Expected readability age
6. Grade MEB Publishing house	171	8	M	16	12
7. Grade MEB Publishing house	160	7	M	18	13
8. Grade MEB Publishing house	140	8	M	17	14
6. Grade Private Publishing house (I)	150	9	M	18	12
7. Grade Private Publishing house (I)	163	8	M	17	13
8. Grade Private Publishing house (I)	145	6	M	19	14
6. Grade Private Publishing house (II)	155	8	M	16	12
7. Grade Private Publishing house (II)	160	7	M	18	13
8. Grade Private Publishing house (II)	165	9	M	15	14

M = Because of the fact that found values have been out of FRY graphic, the results are accepted as meaningless

As seen from Table 2, findings obtained from the original readability formulas were not consisted with the expected readability age.

The CLOZE test was applied to the sample group of 120 students. In the content of the CLOZE test's evaluation phase, students' grades were separated into to three categories. These are student numbers under 40 point, between 40-60 point and over 60 point were determined for each textbook.

Table 3. The CLOZE test results of the investigated science textbooks

Science textbooks	*Student number under 40 point*	*Student number between 40-60 point*	*Student numbers over 60 point*	*Total student number*
6. Grade MEB Publishing house	16	4	0	20
7. Grade MEB Publishing house	12	8	0	20
8. Grade MEB Publishing house	14	6	0	20
6. Grade Private Publishing house (I)	7	7	6	20
7. Grade Private Publishing house(I)	4	12	4	20
8. Grade Private Publishing house(I)	7	8	5	20
6. Grade Private Publishing house(II)	6	7	7	20
7. Grade Private Publishing house(II)	3	11	6	20
8. Grade Private Publishing house(II)	5	7	8	20

As seen from the table 3, students' marks taken from textbooks of MEB publishing houses are situated under 40 point and between 40-60 point. However, at the textbooks prepared by private publishing house, students' marks are situated into each three groups.

4. Results

Due to the difficulties summarized at Table 4, readability formulas could not give the exact results in the process of examining the Turkish textbooks. These difficulties are thought to come from differences in the sentence and syllable construction between the Turkish and English languages. Consequently, it is resulted that the present readability formulas situated in the related literature with their original form, are not valid in evaluating the Turkish textbooks.

Table 4. Problems encountered in adapting the readability formulas into the Turkish language

FLESH	In the process of applying this formula, as the first phase RES extreme values are seen too much, therefore FLESH class level value is found meaningless. For this reason, counting has not been done.
FOG	If application is done similarly, readability age is found 3-4 ages low.
FRY	Although FRY graphic (average sentence lengths against to syllable number graphic) prepared for the English textbooks, the higher syllable number value is 280, on the other hand, for the Turkish textbooks this value is over 300. For this reason, obtained findings are seemed to be meaningless.
SMOG	In this method related to multi syllable number, multi-syllable words', total numbers at chosen paragraphs are proportional with average syllable number. Therefore the results couldn't be taken exactly.

The results obtained from the CLOZE test were summarized below:

- The private sector textbooks have had higher points from the CLOZE test. In the process of students' reading the textbooks from which they took the mark between 40 and 60, it is not thought that they can be encountered more problems.
- It is a noticed negative result that at none of science textbooks prepared by MEB, students took top 60 point.
- At textbooks prepared by the private sectors, it is seen clearly that readability level is higher than the others. But, especially publishing house sector in European countries are concerned with readability concept the closely [2].

5. Implications

Taking reference of the readability formulas in hand and obtained test results of the CLOZE, FOG and SMOG formulas that are not available for the Turkish language were tried to adapt into the Turkish context by considering Turkish sentence and syllable construction.

5.1. Firstly, FOG readability formulas were examined

The original form of FOG test was given in detail at Table 1. According to the original form of the formula, US value should be 7, 8, and 9 for 6, 7 and 8 grades in sequence. In this way, by supplementing 5, it may give the exact readability age. However, considering the Turkish syllable construction and average sentence length, to make US value 7 for 6 grade level, (N+S) value should be at least 15 or 0.4 value in the original formula should increase. In order to do this, a reference point is required. CLOZE test results can be accepted as the reference point. By using the CLOZE test results (in Table 3), readability levels of three textbooks, which have higher readability levels, can be taken as reference point. Average sentence length and the value of average syllable number of these three books were presented below in Table 5.

Table 5. Average sentence length (S) and Polysyllabic words' average (N) values of sample paragraphs taken from private publishing houses' textbooks

Textbooks/values	Average sentence length (S)	Polysyllabic words' average (N)	(N+S)
6. Grade Private Publishing house (I)	8.0	3,1	11.1
7. Grade Private Publishing house (I)	9.0	2.9	11.9
8. Grade Private Publishing house (I)	9.5	3.3	12.8
6. Grade Private Publishing house (II)	8.1	3,2	11.3
7. Grade Private Publishing house (II)	9.2	2.8	12.0
8. Grade Private Publishing house (II)	9.6	3.1	12.7

As seen from the Table 5, (N+S) values of the examined textbooks take the value between 11 and 13. If we use these values in the original formula, US= 0.4 (N+S) and Readability Age = US+5, in order to make these formulas valid for the Turkish context some reorganization of these are required.

Considering that the students at grade 6 levels are about 12 years old in our country, six grade science textbooks' readability age is supposed to be 12. If readability age is equal to 12 = US +5, US value for six grade level is supposed to be at least 7 for the Turkish context. By supplementing coefficient K_1 instead of 0.4 at the original formula, it is reached to the equity of US = K_1 (N+S). If we situated the necessary values into the formulas;

$$7= K_1 (12),\ K_1= 7/12 \text{ and } K_1=0{,}583$$

is reached.

In the same way, when the same procedures have been applied for textbooks at grade 7 and 8, two new *K* values can be obtained. These are $K_2 = 0{,}615$ and $K_3 = 0{,}642$ in sequence. From the equity of $K_{average} = (K_1 + K_2 + K_3)/3$, $K_{average}$ *value is nearly found as* 0,613. After following all these procedures, FOG formula is constructed for the Turkish context in the form as below,

$$US = 0.61\ (N + S)$$

Then supplementing 5 to this formula, readability age is reached to the US class level as to be at the original formula.

5.2. Secondly, the original SMOG formula was examined

It is a formula that based on three and more syllables in words of a sentence. However, in a source, which explains how readability formulas have been adapted into the English textbooks, as related sentence lengths and average syllable numbers, it has been reached the values of 8,5 average sentences and 2,1 average syllable [2]. These values in the current

Turkish science textbooks consist of 9-10 words in an average sentence and appropriately 3 syllables in a word. Therefore, the original SMOG formula is not able to work for the Turkish language. In the process of adapting the SMOG formula into the Turkish context, a comparison between Turkish average syllable numbers and English average syllable numbers were done. Although in the original formula, words including three syllables were taken into consideration, to adapt it into the Turkish language four or more syllable words were taken into consideration instead. The textbooks used for CLOZE test were also used for the adaptation of the SMOG formula. Findings are presented at Table 6.

Table 6. Total number of words of four syllables or more and square root values in the thirty sentences selected from Private Publishing house textbooks.

Textbooks/ values	number of words of four syllables or more in 30 sentences	Square root (nearly)
6. Grade Private Publishing house (I)	49	7
7. Grade Private Publishing house (I)	70	8,4
8. Grade Private Publishing house (I)	66	8,1
6. Grade Private Publishing house (II)	46	6,8
7. Grade Private Publishing house (II)	74	8,6
8. Grade Private Publishing house (II)	78	8,8

In the original form of the SMOG formula when supplementing 8 to this square root value, the readability age could be found. However, for the Turkish language if supplemented 8 to the square root, invalid values are reached. Consequently, it is thought that 5 value should be supplemented to this square root value in order to reach more valid values. In addition, because of the fact that findings obtained from the process of applying FRY readability formula seem to be outside of the FRG graphic, this formula is not valid for the Turkish context. In order to achieve this, deeper grammar knowledge is required. Therefore, an adaptation of the FRY readability formula was not investigated in depth. It will be the subject of the future study.

Because of the fact that RES results are high at the FLESH formula and it has an equity consisting of two phases, it is also though that an adaptation of the FLESH formula for the Turkish context would not be healthy

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