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## How to determine the readability of a physics text

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### Abstract

The educational text of textbooks of physics has many defects. It is necessary to underline its overcrowding with inaccessible materials for a pupil.

The establishment of parameters the text difficult and set of aspects still needs to be distinguished. Under the term, «readership» the sum of those factors which promote successful reading, with the account as to complexity of the text, and preparation of level of the reader (age, formation) is meant. Complexity of the text consists in particular its maintenances, in logic construction, in it informed.

The formula of complexity of the text should be simple. It is necessary to use numerical (empirical) coefficients into formulas. Purpose of these coefficients is clear mathematically: to counterbalance an order of members and to "open" an interval of a scale of difficulty. Factors are needed to be rounding.

Usage of formulas doesn't exclude acknowledged and inculcation methods of checking the quality of textbooks. These methods keep their value. Formulas allow to improve methods of estimation of the quality of textbooks and to receive the united indexes of difficulty of material`s transferring on which basis it is possible to develop an objective criteria of optimum difficulty of the educational text.

**Key words:** Abstractness, physical term, text complexity, readability formula.

The direct source and companion of the pupil`s knowledge is the school textbook [1]. It should contain the volume of knowledge considered by the program, that is obligatory for the pupil. The textbook should reflect the nearest achievements in the given science, stand at a high level pedagogically and methodically; consider age and features of the pupil, should be penetrated with didactic principles of training; should be written in the correct literary language, etc. The Educational text should be written so that in the pupil must feel pleasure and makes him/her love to knowledge, lities of independent work on the book.

As a rule, the educational text of textbooks of physics has many defects. It is necessary to underline its overcrowding with inaccessible materials for a pupil (the school textbook shouldn't represent the abstract of higher school). We should remember that at school we bring up not a

physicist, and the thinker, a developed person who owns the basis of a science and is capable to use received general education in practice.

The text is a difficult system formation, that also means multi-dimensional and in multi-flatness. The text characteristics conditionally are divide into outward and inside ones [2]. Such characteristics belong to outward i.e. formal as the length of a word, which is expressed by quantity of letters or a syllable; the length of the sentence and distribution of this length to the whole length of all the text; quantity of different kinds of definition, verbs and the parts of speech, a different parity of this quantity; quantity of dependent sentence of different kinds and etc. Formal parameters of the text can be used while designing the formula of reading that gives the chance to estimate the sum which affects on learning the text for a certain group of readers.

Such parameters belong to internal ones of the text, which will be established not at the result of formal calculation, that is possible without understanding the text, but by meaningful analysis of the text content. The text content may contain the facts, theoretical regulations, compliance with the analysis and the facts and theories. The content of the text contains three systems of information- a system of fact information, theory information and reflex information.

The system of reflex information includes the content of that part of the text which expresses the relation to the facts and theories, gives them an estimation, it is often accompanied by emotional remarks and passages. If the basic function of the system of fact information and the system of theory information is informing about something, the function of reflex elements of the text is structuring of perceptions and understanding in the process of information. I.e. when the text includes reflex elements, there is created a certain accent and relation to any information.

The establishment of parameters the text difficult and set of aspects still needs to be distinguished. Under the term, «readership» the sum of those factors which promote successful reading, with the account as to complexity of the text, and preparation of level of the reader (age, formation) is meant. Complexity of the text consists in particular its maintenances, in logic construction, in it informed etc. [3]. Some parameters are discussed in the literature treated by us: length of the sentence - all researchers agree with it, length of a word, a percentage quantity of difficult, foreign, long words, terms; abstractiveness connected with noun repetition. Different authors use these parameters in different combinations.

Certainly complexity of the text isn't exhausted by this, but it is a subject for the next researches. That is why we must satisfy by that what we have.

There are spread the formulas defining complexity of the text's readability [4]. They define complexity of the text only according to some characteristics, but it is not enough.

The formula of complexity of the text should be simple, therefore almost all authors choose a rectilinear dependence, basically with two parameters. Some of them use three (seldom more) parameters. It is necessary to use numerical (empirical) coefficients into formulas. Purpose of these coefficients is clear mathematically: to counterbalance an order of members and to "open" an interval of a scale of difficulty. But these coefficients are often used incorrectly, to put it mildly, are entered incorrectly, they do not contain figures of 4 or 5. For example, Dix's and Shtaiver's formula includes 236,96 numerical free members. If in this number all figures are reliable, its maximum error is

0,005/236,96=0,002 %. Reaching such «fantastic» accuracy in pedagogical researches is impossible, unreal. Unfortunately, the considerable part of authors does not pay attention to this, and the formulas are overloaded by "too exact" coefficients. Factors are needed to be rounding.

There is a principle question: whether it is necessary to do out and use such formulas?

Usage of formulas doesn't exclude acknowledged and inculcation methods of checking the quality of textbooks: expert estimations, experimental check at school etc. These methods keep their value. Formulas allow to improve methods of estimation of the quality of textbooks and to receive the united indexes of difficulty of material's transferring on which basis it is possible to develop an objective criteria of optimum difficulty of the educational text. It is possible to estimate by formulas the manuscript before the tests at school. It allows to accelerate preparation of high-quality textbooks. And though usage of formulas to textbooks is not simple, it nevertheless is much cheaper and operative than carrying out of relevant experiments.

The estimation with formulas is a statistical estimation which demands definition of level of reliability, what probability of correct result? It's very difficult to do this and so far none of the authors has it. Despite this, usage of formulas is reasonable.

At the result of analysis of formulas it is possible to say that for the characteristic of syntactic complexity almost all authors use length of the sentence. From our point of view this parameter is the most effective. It is proved also by the fact that between difficult and easy readable texts a difference of average length of the sentence is  $(8-50)/5 = 60$  %. But the method of calculation of length is differs. While calculating average length of the sentence in the educational text we divide the number of words on the number of sentence.

At calculation of number of words in the sentence, we do not include the unions in number of words in physical text; words units when one of the words has an auxiliary function and has no an independent meaning; such combination of words when two words express a single whole concept. The number of words in the text is make with a letter **n**.

If at sentence calculation, the compound sentence represents connection of two short full sentences of identical structure with the unions "and", "i.e." or a comma is considered as two short sentences. In others cases, sentences are not «a simple mechanical sum» of two short sentences and that is why they are considered as one sentences. In the educational text the number of sentences is marked with a letter **N**.

It is well known that the statistical set is not characterized with only average length, in our case an average length of the sentence. It is necessary to use the second parameter – a dispersion which characterizes dispersion round an average. None of the author does not use such characteristic in formulas. We consider it as a principle lack and we think that it is necessary to use an appropriate member into the formula. It is obvious that complexity is characterized by a share of long sentences. Therefore we take it in parameter, in particular we count long sentences, containing 12 and more words, divide them into total number of the sentences.

Almost all authors have taken the length of a word as a parameter reflecting the lexical complexity, but they define it differently. Our main aim is a semantic analysis of the educational text, therefore we cannot agree with those formal rules when there are considered interval between words,

a blank place, signs of punctuation. The special literature strengthens our point of view [5], where there are analyzed peculiarities of 100 languages of the world according to the length of a word: the length is determined by the number of phonemes. As in the Georgian language the sound coincides a letter, it is obvious that the length of a word is defined by number of letters (since the word form changeable, in the special literature it is called as usage of words and its length is a letter chain from defect to defect). Unfortunately, among the analysis of 100 languages the Georgian languages is not included. Therefore we can rely only on our researches – educational texts. We have unexpectedly received that in educational physical with different complexity the average length of a word is changed slightly: 7,59-7,54=0,7 %, while the average length of the sentence is changed within 60 %. We suppose it is reflecting of specificity of the Georgian language. And this specificity is beyond our competence, therefore our opinion isn't stated thoroughly. That is why for our purposes the length of a word will not be useful as a parameter of readability.

Which parameter can we also use for characteristic of readability? Every day the pupil meets the following terms: distance, time, speed. But as soon as we define speed as physical size, it is difficult for the majority of pupils to acquire it. Why? Abtractiveness of physical terms considerably is much higher than daily terms and the should seek the reason in it. Therefore let`s take «abtractiveness» as the third parameter in the formula.

How can we define abtractiveness, connected with physical concept, the term? The analysis of our data has convinced us that the most simple, but the effective characteristic is the quantity of physical terms per a sentence. Its calculation rule is the following: we calculate the total number of terms, at calculation it is necessary to consider that terms may be changed with pronouns. It is clear these pronouns should be replaced with appropriate terms. Total number of terms which we will mark as a letter **q**, we divide into total number of the sentences and we receive the quantity of terms per a sentence.

Thus, for level definition of readability we offer a rectilinear formula with three parameters:

$$X=(n+10p+q)/N=L+10S+T$$

Where **n** – number of words in the text, **N** – number of sentences in the text, **L=n/N** – an average length of the sentence, **p** – number of long (with 12 and more words) sentences, **S=p/N** – a share of long sentences, **q** - number of terms in the text, and **T=q/N** – an average number of terms per a sentence.

The coefficient 10 for the second member is necessary to “counterbalance” an order of members, for coefficients aren't necessary for other members.

For estimation of readability we made the next scale: if **X** is in an interval of 5–8, the educational text is easy, in an interval of 9-11 – the text is average, and in 12 and more – it is a difficult level.

Usage of the given formula is reasonable for natural subjects.

What volume of the text should we chose for formula usage? There exists different methods of choice of volume selection. It is not matter which method we choose, it is important not to forget that the total number of sentences shouldn't be less than 100 for reliability of the results. It is 4-5 pages for different format of the educational text.

Of course it is not always inevitable establishment of complexity of the educational text with formulas, sometimes all is clear. From the above-mentioned it must be clear that if in the educational text the average length of the sentence is more than 15 words, it is clear without usage of any formula that such text is with a high level of complexity. The same is told about the average number of terms. The number of new notions (terms) should to be limited on one page. Their admissible number is changed depending on the age of pupils. For pupils of transition age the average number of new notions on one page should not exceed 2-4. It is for understandable level, i.e. when it is necessary to explain new notions. As for usage level, the average number of new terms should not exceed 0,2 – 0,5. As we see the pupil of transition age can understand 2 – 4 new terms on one page but when he/she needs to use them, he/she cannot do it. He/she uses new terms less than 10 times.

This is about usage of new terms on one page, but it is necessary to keep a certain moderation while using the number of new words on one page.

If these parameters are not kept, it is clear without any formula that the text is difficult and hardly understandable.

### **The literature**

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# როგორ განვსაზღვროთ ფიზიკის ტექსტის კითხვადობა

ნანა მაისურამე

სოხუმის სახელმწიფო უნივერსიტეტი

## აბსტრაქტი

ტექსტის კითხვადობის პარამეტრების დადგენა რთულია და ჯერ კიდევ სხვადასხვა ასპექტი გასარკვევის. „კითხვადობის“ ტერმინის ქვეშ ვგულისხმობთ იმ ფაქტორების ჯამს, რომლებიც ხელს უწყობენ წარმატებულ კითხვას, როგორც ტექსტის სირთულის, ასევე მკითხველის მომზადების ხარისხის გათვალისწინებით. ტექსტის სირთულე მდგომარეობს მისი შინაარსის თავისებურებებში, ლოგიკურ აგებაში, მისი მასალის ინფორმაციულობაში.

ტექსტის სირთულის განმსაზღვრელი ფორმულა მარტივი უნდა იყოს, ფორმულებში საჭიროა რიცხვითი კოეფიციენტების შეტანა. ამ კოეფიციენტების დანიშნულება მათემატიკურად გასაგებია: წევრების რიგი გაწონასწორდეს და სირთულის სკალის ინტერვალი „გაიშალოს“.

საჭიროა კოეფიციენტების დამრგვალება სათანადო სიზუსტით, მითუმეტეს, რომ ეს ამარტივებს მათ გამოყენებას.

ფორმულების გამოყენება არ გამორიცხავს სახელმძღვანელოთა ხარისხის შესამოწმებელ აღიარებულ და დამკვიდრებულ მეთოდებს. ეს მეთოდები ინარჩუნებენ თავის მნიშვნელობას. ფორმულები კი შესაძლებლობას იძლევა სახელმძღვანელოს ხარისხის შეფასების მეთოდების სრულყოფისა და მასალების გადმოცემის სირთულის ერთიანი ინდექსების მიღებას, რომელთა საფუძველზე შეიძლება დამუშავდეს სასწავლო ტექსტის ოპტიმალური სირთულის ობიექტური კრიტერიუმები.

**საკვანძო სიტყვები:** აბსტრაქტულობა, ფიზიკური ტერმინი, ტექსტის სირთულე, კითხვადობის ფორმულა.